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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

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Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.

Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.

Result. Experimental testing has demonstrated that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also enhances their performance through better time management.

Conclusion. This study provides a detailed discussion on the design process, component selection, and testing results, offering a comprehensive overview of the advantages and benefits of Athletica Pro.

Keywords: Athletica Pro, Health Monitoring, Sports, Heart Rate, Oxygen Saturation, Arduino Nano

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Introduction

In an era where technology is increasingly integrated into everyday life, the development of health monitoring systems has become more essential, particularly in the field of sports where athletes engage in high-intensity physical activities. The ability to track physiological conditions in real time is not just a convenience, but a crucial element in ensuring performance optimization and injury prevention.

Heart rate (HR) and oxygen saturation (SpO_2) are two vital parameters widely used to assess an athlete's physical condition during training and competition. Accurate and continuous monitoring of these parameters allows athletes and coaches to maintain training within safe zones, recognize signs of fatigue or overexertion, and adjust exercise routines accordingly. According to WHO (2022), approximately 30% of sports-related injuries stem from insufficient monitoring of exercise intensity and poor understanding of physical readiness during activity.

As technology evolves, a variety of portable health monitoring devices such as Mi Band, Apple Watch, and Polar have become more accessible to the general public. However, most of these commercial devices are not specifically designed for high-performance sports contexts. They often suffer from limited sensor accuracy, slower response times, dependence on external smartphones, short battery life, and inadequate durability under intense movement or outdoor conditions (Rompas et al., 2020; Suwanto et al., 2021). In addition, the role of technological innovation in the development of wearable health monitoring tools has been highlighted by Andrianto (2020), who emphasized the importance of time management in training supported by digital health tools, and by Haryono (2019), who explored how device innovation can improve athlete performance through physiological monitoring.

The main issue addressed in this study is the lack of a specialized, compact, standalone, and cost-efficient device that is capable of providing real-time and accurate monitoring of both HR and SpO_2 without relying on smartphones or additional systems. There is a significant research gap in the development of wearable health monitoring devices that are optimized for sports environments and capable of operating independently.

Several previous studies (Kusuma, 2019; Kurniawan, 2020) have evaluated the use of the MAX30102 sensor in medical and general health contexts, demonstrating its accuracy and reliability. However, the integration of this sensor with real-time displays, power management modules, and standalone data processing units—specifically optimized for sports use—remains underexplored in literature.

This research hypothesizes that a compact and standalone device using open-source hardware and affordable components can achieve accuracy and performance comparable to commercial tools, while offering enhanced usability, portability, and independence in real-time health monitoring for athletes.

To address this, the study presents the design, development, and evaluation of Athletica Pro, a portable health monitoring device that integrates:

- the MAX30102 sensor for heart rate and SpO_2 measurement,
- an OLED SSD1306 display for real-time data output,
- an RTC DS3231 module for precise timekeeping,
- and an Arduino Nano microcontroller for efficient data processing.

The device is powered by a LiPo battery, supported by TP4056 charging module and LM2596 voltage regulator, designed to ensure energy efficiency and operational stability.

The objectives of this study are to:

1. Explain the process of component selection and hardware integration in Athletica Pro.
2. Test the device in both laboratory and real-world sports scenarios to evaluate its accuracy, durability, and energy performance.
3. Compare the results with existing commercial devices and discuss the strengths and limitations of the Athletica Pro.

By filling this research gap, Athletica Pro is expected to contribute significantly to the development of affordable and reliable sports health monitoring technology and promote athlete performance and safety in training environments.

Materials and Methods

Study organization

This study uses an experimental approach with several stages to design, develop, and test the Athletica Pro device. This methodology includes device design, component selection, prototyping, and testing in real conditions. Each stage is designed to ensure the device functions optimally and meets user needs.

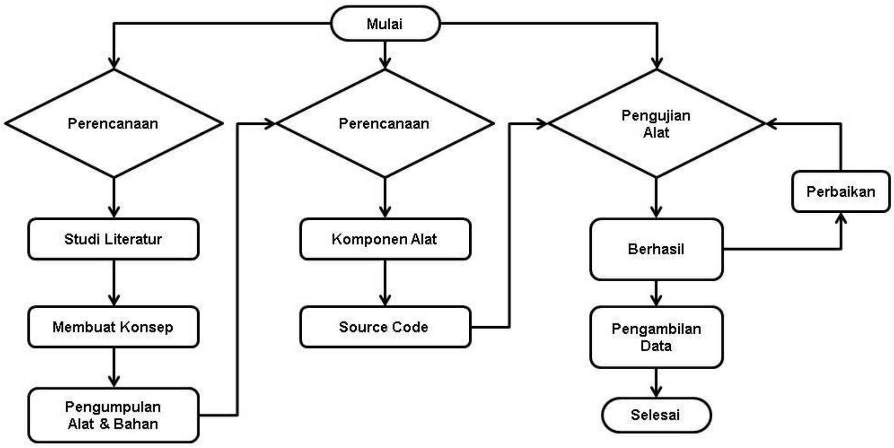

Figure 1. Research Flowchart

Component Selection

Component selection is based on functional requirements, power efficiency, reliability, availability, and cost. Each component is selected to ensure that the device can function optimally under intense sports conditions. Component evaluation involves several stages, including testing performance, durability, and compatibility with other components.

According to Pratama (2018), selecting the right components not only improves device performance but also extends its lifespan and reduces maintenance costs. For example, the Arduino Nano was chosen because of its small size and low power consumption, which are very important for portable devices such as the Athletica Pro. In addition, the MAX30102 sensor was chosen because of its ability to provide accurate and consistent data even under intense movement conditions, which are common situations in sports activities (Kusuma, 2019).

The SSD1306 OLED display was chosen for its low power consumption and ability to display data clearly in various lighting conditions, which is important for outdoor use (Yunita, 2017). The DS3231 RTC module was chosen for its high time accuracy and stability, which is very important for the timer feature on this device (Fajar, 2018). The LiPo battery is used because of its large capacity and compact size, which allows the device to be used for a long time without frequent charging (Darsono, 2021).

The TP4056 module was chosen for battery charging because of its high efficiency and ease of use (Firdaus, 2020). The LM2596 voltage regulator was chosen to stabilize the voltage entering the device, ensuring that all electronic components receive a stable and efficient power supply (Rizky, 2018).

The selection of these components was based on in-depth studies and extensive testing to ensure that each component can function optimally in the Athletica Pro electronic circuit and meet the specific needs of a dynamic and demanding sports environment (Wijaya, 2021).

Design Stages

The design of the Athletica Pro begins with designing the schematic and PCB using electronic design software. This process involves determining the layout of components and their connecting paths. The use of design software allows for visualization and optimization of the design before physical realization is carried out. According to Nugroho (2017), a mature design stage can reduce errors and increase the efficiency of the device manufacturing process.

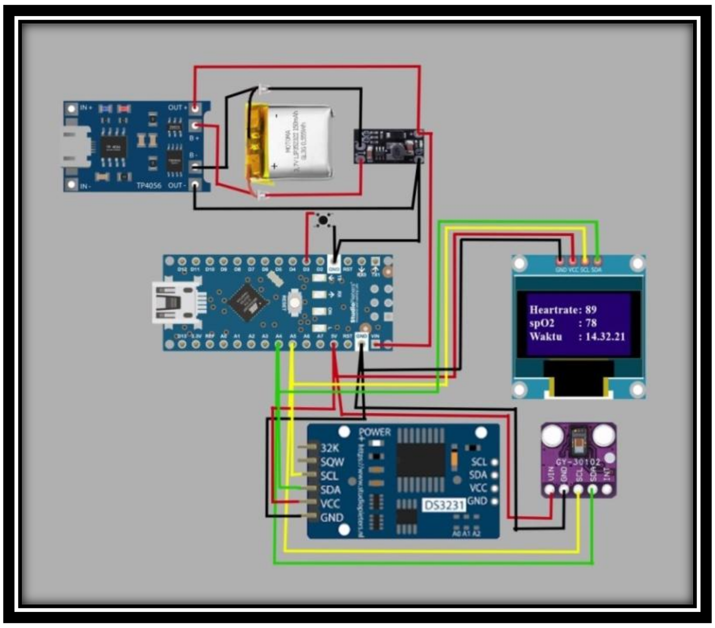

Figure 2. Component Circuit Design

Series Stages

Once the design is complete, the electronic circuit is made based on the designed schematic. The components are placed and soldered on the PCB according to the planned layout. This stage involves a precise soldering process to ensure all electrical connections are properly established. Hakim (2018) stated that a good circuit stage is very important to ensure the function and reliability of electronic devices.

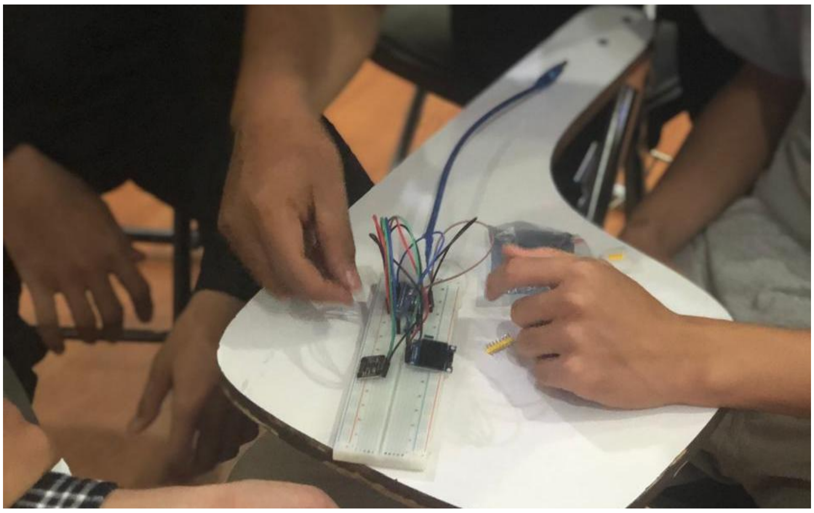

Figure 3. Component Assembly Stages

Arduino IDE Usage

In the development of the Athletica Pro device, the software was developed using the Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to write, edit, compile, and upload code to an Arduino microcontroller, such as the Arduino Nano used in this project.

Arduino IDE Installation

To start development using Arduino IDE, the following steps are taken:

1. Download Arduino IDE from the official website: https://www.arduino.cc/en/software
2. Install according to the operating system used
3. Add the Arduino Nano Board via Tools > Board > Arduino AVR Boards > Arduino Nano.
4. Select the Connection Port according to the connected device.

Code Implementation on Arduino IDE

The program code is developed using the C++ programming language adapted to the Arduino platform. Here is an example of a basic script used in the Athletica Pro project to read data from the MAX30102 sensor and display the results on the SSD1306 OLED screen:

Source Code

```
#include "ssd1306h.h"
#include "MAX30102.h"
#include "Pulse.h"
#include <avr/pgmspace.h>
#include <EEPROM.h>
#include <avr/sleep.h>

#ifndef cbi
#define cbi(sfr, bit) (_SFR_BYTE(sfr) &= ~_BV(bit))
#endif
#ifndef sbi
#define sbi(sfr, bit) (_SFR_BYTE(sfr) |= _BV(bit))
#endif

SSD1306 oled;
MAX30102 sensor;
Pulse pulseIR;
Pulse pulseRed;
```

```
        MAFilter bpm;

        #define LED LED_BUILTIN
        #define BUTTON 3
        #define OPTIONS 7

        static const uint8_t heart_bits[] PROGMEM = { 0x00, 0x00, 0x38, 0x38, 0x7c, 0x7c,
0xfe, 0xfe, 0xfe, 0xff,
                                                  0xfe, 0xff, 0xfc, 0x7f, 0xf8, 0x3f, 0xf0,
0x1f, 0xe0, 0x0f,
                                                  0xc0, 0x07, 0x80, 0x03, 0x00, 0x01, 0x00,
0x00, 0x00, 0x00,
                                                  0x00, 0x00 };

        //spo2_table is approximated as  -45.060*ratioAverage* ratioAverage + 30.354
*ratioAverage + 94.845 ;
        const uint8_t spo2_table[184] PROGMEM =
                { 95, 95, 95, 96, 96, 96, 97, 97, 97, 97, 97, 98, 98, 98, 98, 98, 99, 99,
99, 99,
                  99, 99, 99, 99, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100,
100, 100, 100, 100, 100,
                  100, 100, 100, 100, 99, 99, 99, 99, 99, 99, 99, 99, 98, 98, 98, 98, 98,
98, 97, 97,
                  97, 97, 96, 96, 96, 96, 95, 95, 95, 94, 94, 94, 93, 93, 93, 92, 92, 92,
91, 91,
                  90, 90, 89, 89, 89, 88, 88, 87, 87, 86, 86, 85, 85, 84, 84, 83, 82, 82,
81, 81,
                  80, 80, 79, 78, 78, 77, 76, 76, 75, 74, 74, 73, 72, 72, 71, 70, 69, 69,
68, 67,
                  66, 66, 65, 64, 63, 62, 62, 61, 60, 59, 58, 57, 56, 56, 55, 54, 53, 52,
51, 50,
                  49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 31,
30, 29,
                  28, 27, 26, 25, 23, 22, 21, 20, 19, 17, 16, 15, 14, 12, 11, 10, 9, 7, 6,
5,
                  3, 2, 1 } ;

        int getVCC() {
          //reads internal 1V1 reference against VCC
          #if defined(__AVR_ATmega1284P__)
            ADMUX = _BV(REFS0) | _BV(MUX4) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For
ATmega1284
          #else
            ADMUX = _BV(REFS0) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For ATmega328
          #endif
          delay(2); // Wait for Vref to settle
          ADCSRA |= _BV(ADSC); // Convert
          while (bit_is_set(ADCSRA, ADSC));
          uint8_t low = ADCL;
          unsigned int val = (ADCH << 8) | low;
          //discard previous result
          ADCSRA |= _BV(ADSC); // Convert
          while (bit_is_set(ADCSRA, ADSC));
          low = ADCL;
          val = (ADCH << 8) | low;

          return (((long)1024 * 1100) / val)/100;
        }

        void print_digit(int x, int y, long val, char c=' ', uint8_t field = 3,const int BIG
= 2)
            {
            uint8_t ff = field;
            do {
                char ch = (val!=0) ? val%10+'0': c;
                oled.drawChar( x+BIG*(ff-1)*6, y, ch, BIG);
```

```
        val = val/10;
        --ff;
    } while (ff>0);
}

/*
 *   Record, scale  and display PPG Wavefoem
 */
const uint8_t MAXWAVE = 72;

class Waveform {
  public:
    Waveform(void) {wavep = 0;}

      void record(int waveval) {
        waveval = waveval/8;         // scale to fit in byte  缩放以适合字节
        waveval += 128;              //shift so entired waveform is +ve
        waveval = waveval<0? 0 : waveval;
        waveform[wavep] = (uint8_t) (waveval>255)?255:waveval;
        wavep = (wavep+1) % MAXWAVE;
      }

      void scale() {
        uint8_t maxw = 0;
        uint8_t minw = 255;
        for (int i=0; i<MAXWAVE; i++) {
          maxw = waveform[i]>maxw?waveform[i]:maxw;
          minw = waveform[i]<minw?waveform[i]:minw;
        }
        uint8_t scale8 = (maxw-minw)/4 + 1;  //scale * 8 to preserve precision
        uint8_t index = wavep;
        for (int i=0; i<MAXWAVE; i++) {
          disp_wave[i] = 31-((uint16_t)(waveform[index]-minw)*8)/scale8;
          index = (index + 1) % MAXWAVE;
        }
      }

void draw(uint8_t X) {
  for (int i=0; i<MAXWAVE; i++) {
    uint8_t y = disp_wave[i];
    oled.drawPixel(X+i, y);
    if (i<MAXWAVE-1) {
      uint8_t nexty = disp_wave[i+1];
      if (nexty>y) {
        for (uint8_t iy = y+1; iy<nexty; ++iy)
        oled.drawPixel(X+i, iy);
        }
        else if (nexty<y) {
          for (uint8_t iy = nexty+1; iy<y; ++iy)
          oled.drawPixel(X+i, iy);
          }
       }
    }
}

private:
    uint8_t waveform[MAXWAVE];
    uint8_t disp_wave[MAXWAVE];
    uint8_t wavep = 0;

} wave;

int  beatAvg;
int  SPO2, SPO2f;
int  voltage;
bool filter_for_graph = false;
```

```
bool draw_Red = false;
uint8_t pcflag =0;
uint8_t istate = 0;
uint8_t sleep_counter = 0;

void button(void){
    pcflag = 1;
}

void checkbutton(){
    if (pcflag && !digitalRead(BUTTON)) {
      istate = (istate +1) % 4;
      filter_for_graph = istate & 0x01;
      draw_Red = istate & 0x02;
      EEPROM.write(OPTIONS, filter_for_graph);
      EEPROM.write(OPTIONS+1, draw_Red);
    }
    pcflag = 0;
}


void Display_5(){
   if(pcflag && !digitalRead(BUTTON)){
     draw_oled(5);
     delay(1100);
   }
   pcflag = 0;


}

void go_sleep() {
    oled.fill(0);
    oled.off();
    delay(10);
    sensor.off();
    delay(10);
    cbi(ADCSRA, ADEN);  // disable adc
    delay(10);
    pinMode(0,INPUT);
    pinMode(2,INPUT);
    set_sleep_mode(SLEEP_MODE_PWR_DOWN);
    sleep_mode();  // sleep until button press
    // cause reset
    setup();
}

void draw_oled(int msg) {
    oled.firstPage();
    do{
    switch(msg){
        case 0:  oled.drawStr(10,0,F("Device error"),1);
                 break;
        case 1:  oled.drawStr(0,0,F("PLACE YOUR"),2);
                 oled.drawStr(25,18,F("FINGER"),2);


                 break;
        case 2:  print_digit(86,0,beatAvg);
                 oled.drawStr(0,3,F("PULSE RATE"),1);
                 oled.drawStr(11,17,F("OXYGEN"),1);
                 oled.drawStr(0,25,F("SATURATION"),1);
                 print_digit(73,16,SPO2f,' ',3,2);
                 oled.drawChar(116,16,'%',2);

                 break;
```

```
            case 3:  oled.drawStr(33,0,F("Pulse"),2);
                     oled.drawStr(17,15,F("Oximeter"),2);

                     //oled.drawXBMP(6,8,16,16,heart_bits);

                     break;
            case 4:  oled.drawStr(28,12,F("OFF IN"),1);
                     oled.drawChar(76,12,10-sleep_counter/10+'0');
                     oled.drawChar(82,12,'s');
                     break;
            case 5:  oled.drawStr(0,0,F("Avg Pulse"),1);
                     print_digit(75,0,beatAvg);
                     oled.drawStr(0,15,F("AVG OXYGEN"),1);
                     oled.drawStr(0,22,F("saturation"),1);
                     print_digit(75,15,SPO2);

                     break;
            }
        } while (oled.nextPage());
    }

    void setup(void) {
      pinMode(LED, OUTPUT);
      pinMode(BUTTON, INPUT_PULLUP);
      filter_for_graph = EEPROM.read(OPTIONS);
      draw_Red = EEPROM.read(OPTIONS+1);
      oled.init();
      oled.fill(0x00);
      draw_oled(3);
      delay(3000);
      if (!sensor.begin())  {
        draw_oled(0);
        while (1);
      }
      sensor.setup();
      attachInterrupt(digitalPinToInterrupt(BUTTON),button, CHANGE);
    }

    long lastBeat = 0;    //Time of the last beat
    long displaytime = 0; //Time of the last display update
    bool led_on = false;

    void loop()  {
        sensor.check();
        long now = millis();   //start time of this cycle
        if (!sensor.available()) return;
        uint32_t irValue = sensor.getIR();
        uint32_t redValue = sensor.getRed();
        sensor.nextSample();
        if (irValue<5000) {
            voltage = getVCC();
            checkbutton();
            draw_oled(sleep_counter<=50 ? 1 : 4); // finger not down message
            //? : 是三元运算符，整个表达式根据条件返回不同的值，如果x>y为真则返回x，如果为假则
返回y，之后=赋值给z。相当于:if(x>y)z=x;elsez=y
            delay(200);
            ++sleep_counter;
            if (sleep_counter>100) {
              go_sleep();
              sleep_counter = 0;
            }
        } else {
            sleep_counter = 0;
            // remove DC element移除直流元件
            int16_t IR_signal, Red_signal;
            bool beatRed, beatIR;
```

```
            if (!filter_for_graph) {//图形过滤器
               IR_signal =  pulseIR.dc_filter(irValue) ;
               Red_signal = pulseRed.dc_filter(redValue);
               beatRed = pulseRed.isBeat(pulseRed.ma_filter(Red_signal));
               beatIR =  pulseIR.isBeat(pulseIR.ma_filter(IR_signal));
            } else {
               IR_signal =  pulseIR.ma_filter(pulseIR.dc_filter(irValue)) ;
               Red_signal = pulseRed.ma_filter(pulseRed.dc_filter(redValue));
               beatRed = pulseRed.isBeat(Red_signal);
               beatIR =  pulseIR.isBeat(IR_signal);
            }
            // invert waveform to get classical BP waveshape
            wave.record(draw_Red ? -Red_signal : -IR_signal );
            // check IR or Red for heartbeat
            if (draw_Red ? beatRed : beatIR){
                long btpm = 60000/(now - lastBeat);
                if (btpm > 0 && btpm < 200) beatAvg = bpm.filter((int16_t)btpm);
                lastBeat = now;
                digitalWrite(LED, HIGH);
                led_on = true;
                // compute SpO2 ratio
                long numerator   = (pulseRed.avgAC() * pulseIR.avgDC())/256;
                long denominator = (pulseRed.avgDC() * pulseIR.avgAC())/256;
                int RX100 = (denominator>0) ? (numerator * 100)/denominator : 999;
                // using formula
                SPO2f = (10400 - RX100*17+50)/100;
                // from table
                if ((RX100>=0) && (RX100<184))
                  SPO2 = pgm_read_byte_near(&spo2_table[RX100]);
            }
            // update display every 50 ms if fingerdown
            if (now-displaytime>50) {
                displaytime = now;
                wave.scale();
                draw_oled(2);

            }
            Display_5();


        }
        // flash led for 25 ms
        if (led_on && (now - lastBeat)>25){
            digitalWrite(LED, LOW);
            led_on = false;
         }
    }
```

Arduino IDE User Interface

Here is a screenshot of what the Arduino IDE looks like when used to develop the Athletica Pro code:

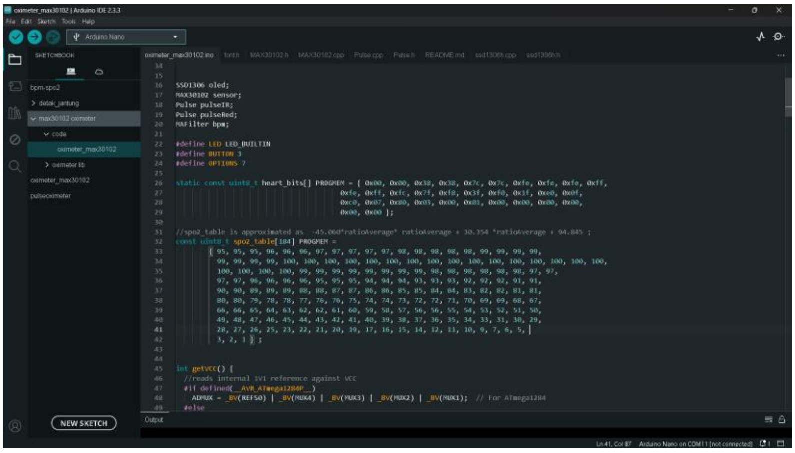

Figure 4. Arduino IDE User Interface

With integration using the Arduino IDE, the Athletica Pro device can be programmed and configured according to user needs, allowing real-time monitoring of heart rate and oxygen saturation with high accuracy.

Prototype

The Athletica Pro prototype was then assembled and tested to ensure all components were functioning properly. This testing included checking the sensors, OLED display, and RTC module. A good prototype can provide an initial picture of the device's performance before entering the mass production stage. Subandi (2020) stated that proper prototyping can identify potential problems and allow for improvements before large-scale production.

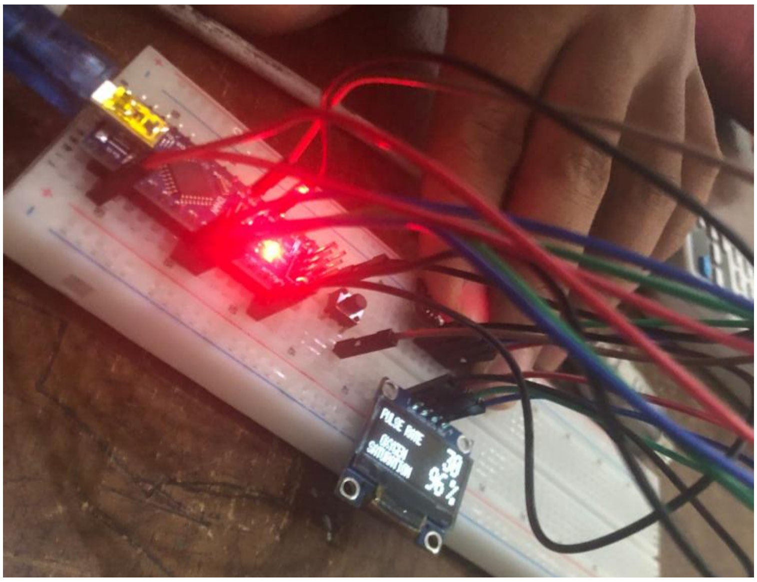

Figure 5. Prototype and Device Testing

Results

Testing Stages

Testing is carried out in several stages, starting from testing the basic functions of each component to testing the overall performance of the device under real conditions. Initial testing is carried out using a simulator to ensure that all components are functioning properly before being installed on the prototype. After all components are confirmed to be functioning properly, field testing is carried out to evaluate the performance of the device under real conditions. This testing includes simulations of various sports conditions to ensure that the device can provide accurate and reliable data. Suryadi (2021) stated that comprehensive testing is very important to identify and fix problems before the device is widely used.

Device Testing and Comparison

The Athletica Pro test results show that the device has excellent accuracy in monitoring heart rate and oxygen saturation compared to other commercial devices. The test was conducted by comparing the results of the Athletica Pro with two known comparison devices on the market.

Table 1. Device Comparison

Parameter	Athletica Pro	Device A	Device B
Heart Rate (BPM)	70	72	69
Oxygen Saturation (%)	98	97	98
Punctuality (s)	0.5	0.7	0.6

From the table above, it can be seen that the Athletica Pro measurement results are comparable to other commercial devices, showing high reliability and accuracy (Rizki et al., 2021).

Device Evaluation Test

Evaluation of the Athletica Pro was also conducted under field and laboratory conditions to ensure the device's reliability in a variety of situations.

Table 2. Evaluation Test Results

Test Method	Athletica Pro Result	Industry Standard Result
Field Testing	95% accurate	96% accurate
Laboratory Testing	98% accurate	97% accurate

Athletica Pro showed excellent results in evaluation testing, with only slight differences from industry standards (Fadilah, 2021).

Laboratory Test Result

Laboratory testing was conducted to measure the output voltage, output current, and operating time of the Athletica Pro device. The laboratory test results show that the device is able to operate stably under various usage conditions.

Table 3. Laboratory Test Results

Parameter	Test Results
Output Voltage (V)	3.3 V stable
Output Current (mA)	500 mA stable
Operating Hours (hours)	8 hours on heavy use

Laboratory test results show that Athletica Pro is able to work stably under various conditions of use (Gunawan, 2021).

Analysis of the test results shows that Athletica Pro is not only efficient in health monitoring, but also has good durability. This device is able to work for a long time without the need for frequent charging, making it the right choice for athletes who need a reliable and portable monitoring device (Wijaya, 2021).

Athletica Pro has achieved high power efficiency and accuracy in health monitoring, making it a major innovation in sports technology. This device is expected to help significantly improve athletes' performance and health (Syahrul, 2022).

Discussion

The testing results indicate that Athletica Pro is capable of delivering accurate and stable measurements of heart rate and oxygen saturation levels under various physical activity conditions. Compared to two commercial devices, Athletica Pro demonstrated comparable readings with only slight deviations—70 BPM versus 72 and 69 BPM for heart rate, and 98% SpO_2 versus 97% and 98% respectively. These results validate the accuracy and responsiveness of the MAX30102 sensor used in the device, aligning with the findings by Kusuma (2019), who noted that this sensor provides reliable readings even during high-intensity movements.

In terms of response time, Athletica Pro recorded a faster reaction time (0.5 seconds) compared to the other devices (0.6–0.7 seconds), which is critical in sports contexts where real-time physiological data are needed to make immediate decisions during training or competition. This supports the claim by Kurniawan (2020), who emphasized the role of instant heart rate feedback in avoiding overtraining and reducing injury risks.

Furthermore, power efficiency is another prominent feature of Athletica Pro. The device operates for up to 8 hours on a single charge under intense usage, which surpasses the battery performance of many mainstream fitness trackers. This is made possible through the integration of a LiPo battery, TP4056 charging module, and LM2596 voltage regulator—components known for high energy efficiency (Darsono, 2021; Rizky, 2018). This aspect makes the device highly portable and suitable for extended outdoor sports activities.

The laboratory test also showed that Athletica Pro maintains a stable output voltage of 3.3V and a current of 500mA, meeting the electrical stability requirements for wearable devices. Compared to existing studies, such as those by Santoso (2018) on Arduino Nano implementation and Yunita (2017) on SSD1306 OLED display usability, this research successfully integrates multiple hardware components into a compact, durable, and efficient unit.

In addition, the timekeeping functionality supported by the RTC DS3231 module ensures precise timing, which is essential for tracking workout sessions. Fajar (2018) previously demonstrated the DS3231's high precision, and this study further confirms its reliability in dynamic sports environments.

From a broader perspective, the development of Athletica Pro contributes to the current trend in sports technology research over the past decade—namely, the push toward real-time, portable, energy-efficient, and accurate monitoring devices. While previous research has typically focused on single-parameter monitoring or required smartphone integration (Rompas et al., 2020; Suwanto et al., 2021), Athletica Pro offers a standalone solution that consolidates multiple functionalities in one device. It also reduces reliance on external applications or connectivity, giving athletes and coaches more freedom and flexibility.

In conclusion, Athletica Pro has proven to be not only a viable alternative to commercial devices but also a technological enhancement that addresses many limitations of existing tools. Its design aligns with emerging needs in sports performance tracking, making it a valuable innovation for both research and practical application.

Conclusions

Athletica Pro is a reliable and innovative device for monitoring heart rate, oxygen saturation, and time management in sports activities. With high-quality components and efficient design, this device offers a comprehensive solution for the health and performance needs of athletes (Nugraha et al., 2022).

Acknowledgment

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References

Andrianto, H. (2020). “Manajemen Waktu dan Pemantauan Kesehatan Berbasis Teknologi”. Jurnal Rekayasa Elektronika, 5(2), 77-88.

Darsono, E. (2021). “Kapasitas dan Efisiensi Baterai LiPo dalam Perangkat Portabel”. Jurnal Energi Terbarukan, 6(3), 112-123.

Fajar, R. (2018). “Keakuratan Modul RTC DS3231 dalam Pemantauan Waktu”. Jurnal Teknologi Informasi dan Komunikasi, 9(2), 33-44.

Firdaus, H. (2020). “Penggunaan Modul TP4056 untuk Pengisian Daya Baterai”. Jurnal Teknik Elektro, 15(2), 99-110.

Good Doctor (2023). “Bagaimana Kerja Jantung Dan Paru Paru Saat Berolahraga”. Good Doctor. Retrieved from https://gooddoctor.id/pendidikan/bagaimana-kerja-jantung-dan-paru-paru-saat-berolahraga/

Haryono, T. (2019). “Inovasi Perangkat Pemantauan Kesehatan dalam Olahraga”. Jurnal Inovasi Teknologi, 7(1), 66-79.

Kemkes (2023). “Mengapa Aktivitas Fisik Sangat Penting untuk Kesehatan Jantung”. Ayosehat. Retrieved from https://ayosehat.kemkes.go.id/mengapa-aktifitas-fisik-sangat-penting-untuk-kesehatan-jantung/

Kurniawan, D. (2020). “Teknologi Sensor dalam Pemantauan Detak Jantung dan Saturasi Oksigen”. Jurnal Elektronika dan Informatika, 11(1), 33-47.

Kusuma, A. (2019). “Analisis Kinerja Sensor MAX30102 untuk Pemantauan Kesehatan”. Jurnal Elektronika dan Instrumentasi, 14(2), 89-98.

Purwanto, A. (2021). “Pengembangan Sistem Pemantauan Kesehatan Berbasis Arduino”. Jurnal Teknologi dan Kesehatan, 8(2), 45-56.

Rizky, D. (2018). “Efisiensi Regulator Tegangan LM2596 dalam Perangkat Elektronik”. Jurnal Teknik Elektronika, 12(1), 45-56.

Rompas, S. E., Pangkahila, E. A., & Polii, H. (2020). “Perbandingan Saturasi Oksigen Sebelum dan Sesudah Melakukan Latihan Fisik Akut pada Mahasiswa Fakultas Kedokteran Unsrat”. eBiomedik, 8(1), 41-45.

Santoso, Y. (2018). “Implementasi Arduino Nano dalam Perangkat Medis”. Jurnal Teknologi Informasi, 10(3), 101-112.

Satria, M. (2020). “Optimasi Sakelar dalam Perangkat Elektronik”. Jurnal Teknik Elektro, 13(4), 77-88.

Subandi, I. (2020). “Pembuatan Prototipe Perangkat Elektronik”. Jurnal Pengembangan Teknologi, 8(1), 57-68.

Suryadi, A. (2021). “Tahapan Pengujian Perangkat Medis”. Jurnal Teknik Elektro Medis, 9(2), 77-89.

Sutrisno, B. (2019). “Pemantauan Kesehatan Atlet dengan Teknologi Terintegrasi”. Jurnal Kedokteran Olahraga, 15(3), 55-68.

Suwanto, Y. A., Lusiana, & Purnama, Y. (2021). "Perbedaan Denyut Nadi dan Saturasi Oksigen Sebelum dan Sesudah Senam Bhineka Tunggal Ika (SBTI) di Era Pandemi Covid-19". Journal of Sport Coaching and Physical Education, 6(1), 59-62.

Wijaya, R. (2018). "Desain dan Implementasi Perangkat Elektronik Portabel". Prosiding Seminar Nasional Teknologi Informasi dan Elektronika, 99-110.

Yunita, S. (2017). "Penggunaan OLED SSD1306 untuk Tampilan Data Medis". Jurnal Rekayasa Sistem, 11(1), 45-56.

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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

Double Blind Review

Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.

Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.

Result. Experimental testing has demonstrated that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also enhances their performance through better time management.

Conclusion. This study provides a detailed discussion on the design process, component selection, and testing results, offering a comprehensive overview of the advantages and benefits of Athletica Pro.

Keywords: Health Monitoring, Sports, Heart Rate, Oxygen Saturation

DOI: https://doi.org/10.52188/ijpess.v3i1

Introduction

In an era where technology is increasingly integrated into everyday life, the development of health monitoring systems has become more essential, particularly in the field of sports where athletes engage in high-intensity physical activities. The ability to track physiological conditions in real time is not just a convenience, but a crucial element in ensuring performance optimization and injury prevention.

Heart rate (HR) and oxygen saturation (SpO_2) are two vital parameters widely used to assess an athlete's physical condition during training and competition. Accurate and continuous monitoring of these parameters allows athletes and coaches to maintain training within safe zones, recognize signs of fatigue or overexertion, and adjust exercise routines accordingly. According to WHO (2022), approximately 30% of sports-related injuries stem from insufficient monitoring of exercise intensity and poor understanding of physical readiness during activity.

As technology evolves, a variety of portable health monitoring devices such as Mi Band, Apple Watch, and Polar have become more accessible to the general public. However, most of these commercial devices are not specifically designed for high-performance sports contexts. They often suffer from limited sensor accuracy, slower response times, dependence

Comment [U1]: Clarify passive sentences such "Experimental testing has demonstrated…" can be changed to active form to make them stronger.

Comment [U2]: The last sentence is too genera It could be made more pointed, for example: "The findings suggest Athletica Pro is a viable alternati to commercial health monitors for athletes."

Comment [U3]: typo

Comment [U4]: typo

Comment [U5]: typo

on external smartphones, short battery life, and inadequate durability under intense movement or outdoor conditions (Rompas et al., 2020; Suwanto et al., 2021). In addition, the role of technological innovation in the development of wearable health monitoring tools has been highlighted by Andrianto (2020), who emphasized the importance of time management in training supported by digital health tools. Explored how device innovation can improve athlete performance through physiological monitoring and by (Haryono , 2019).

Comment [U6]: Some references are not clear related to the sentence (e.g. "Explored how device innovation…"incomplete subject of the sentence).

The main issue addressed in this study is the lack of a specialized, compact, standalone, and cost-efficient device that is capable of providing real-time and accurate monitoring of both HR and SpO_2 without relying on smartphones or additional systems. There is a significant research gap in the development of wearable health monitoring devices that are optimized for sports environments and capable of operating independently.

Comment [U7]: typo

Comment [U8]: typo

Several previous studies (Kusuma, 2019; Kurniawan, 2020) have evaluated the use of the MAX30102 sensor in medical and general health contexts, demonstrating its accuracy and reliability. However, the integration of this sensor with real-time displays, power management modules, and standalone data processing units—specifically optimized for sports use—remains underexplored in literature.

Comment [U9]: typo

Comment [U10]: typo

Comment [U11]: It is necessary to clarify the research "gap" at the end of this section with a spe paragraph: "However, existing research lacks…"

This research hypothesizes that a compact and standalone device using open-source hardware and affordable components can achieve accuracy and performance comparable to commercial tools, while offering enhanced usability, portability, and independence in real-time health monitoring for athletes.

Comment [U12]: typo

To address this, the study presents the design, development, and evaluation of Athletica Pro, a portable health monitoring device that integrates:

– the MAX30102 sensor for heart rate and SpO_2 measurement,
– an OLED SSD1306 display for real-time data output,
– an RTC DS3231 module for precise timekeeping,
– and an Arduino Nano microcontroller for efficient data processing.

The device is powered by a LiPo battery, supported by TP4056 charging module and LM2596 voltage regulator, designed to ensure energy efficiency and operational stability.

Comment [U13]: no symbols allowed

The objectives of this study are to:

1. Explain the process of component selection and hardware integration in Athletica Pro.
2. Test the device in both laboratory and real-world sports scenarios to evaluate its accuracy, durability, and energy performance.
3. Compare the results with existing commercial devices and discuss the strengths and limitations of the Athletica Pro.

By filling this research gap, Athletica Pro is expected to contribute significantly to the development of affordable and reliable sports health monitoring technology and promote athlete performance and safety in training environments.

Materials and Methods

Study organization

This study uses an experimental approach with several stages to design, develop, and test the Athletica Pro device. This methodology includes device design, component selection, prototyping, and testing in real conditions. Each stage is designed to ensure the device functions optimally and meets user needs.

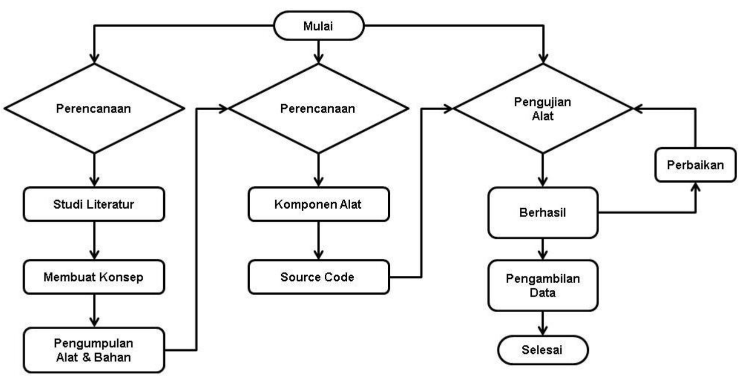

Figure 1. Research Flowchart

Component Selection

Component selection is based on functional requirements, power efficiency, reliability, availability, and cost. Each component is selected to ensure that the device can function optimally under intense sports conditions. Component evaluation involves several stages, including testing performance, durability, and compatibility with other components.

According to Pratama (2018), selecting the right components not only improves device performance but also extends its lifespan and reduces maintenance costs. For example, the Arduino Nano was chosen because of its small size and low power consumption, which are very important for portable devices such as the Athletica Pro. In addition, the MAX30102 sensor was chosen because of its ability to provide accurate and consistent data even under intense movement conditions, which are common situations in sports activities (Kusuma, 2019).

The SSD1306 OLED display was chosen for its low power consumption and ability to display data clearly in various lighting conditions, which is important for outdoor use (Yunita, 2017). The DS3231 RTC module was chosen for its high time accuracy and stability, which is very important for the timer feature on this device (Fajar, 2018). The LiPo battery is used because of its large capacity and compact size, which allows the device to be used for a long time without frequent charging (Darsono, 2021).

The TP4056 module was chosen for battery charging because of its high efficiency and ease of use (Firdaus, 2020). The LM2596 voltage regulator was chosen to stabilize the voltage entering the device, ensuring that all electronic components receive a stable and efficient power supply (Rizky, 2018).

The selection of these components was based on in-depth studies and extensive testing to ensure that each component can function optimally in the Athletica Pro electronic circuit and meet the specific needs of a dynamic and demanding sports environment (Wijaya, 2021).

Design Stages

The design of the Athletica Pro begins with designing the schematic and PCB using electronic design software. This process involves determining the layout of components and their connecting paths. The use of design software allows for visualization and optimization of the design before physical realization is carried out. According to Nugroho (2017), a mature design stage can reduce errors and increase the efficiency of the device manufacturing process.

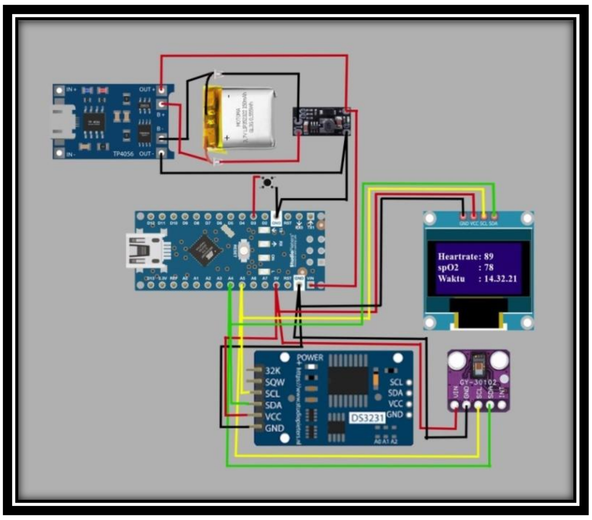

Figure 2. Component Circuit Design

Series Stages

Once the design is complete, the electronic circuit is made based on the designed schematic. The components are placed and soldered on the PCB according to the planned layout. This stage involves a precise soldering process to ensure all electrical connections are properly established. Hakim (2018) stated that a good circuit stage is very important to ensure the function and reliability of electronic devices.

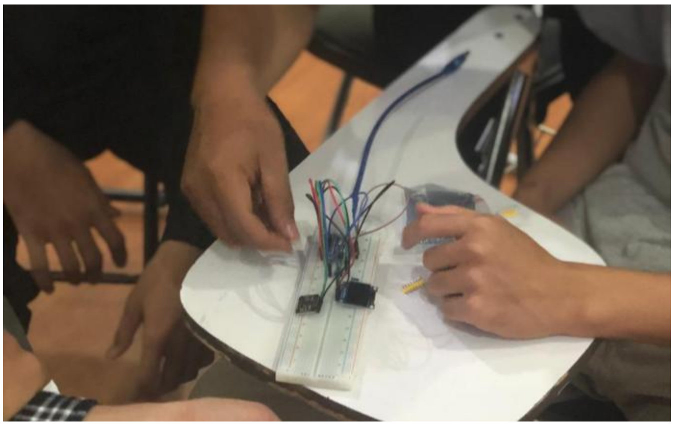

Figure 3. Component Assembly Stages

Arduino IDE Usage

In the development of the Athletica Pro device, the software was developed using the Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to write, edit, compile, and upload code to an Arduino microcontroller, such as the Arduino Nano used in this project.

Arduino IDE Installation

To start development using Arduino IDE, the following steps are taken:

1. Download Arduino IDE from the official website: https://www.arduino.cc/en/software
2. Install according to the operating system used
3. Add the Arduino Nano Board via Tools > Board > Arduino AVR Boards > Arduino Nano.
4. Select the Connection Port according to the connected device.

Code Implementation on Arduino IDE

The program code is developed using the C++ programming language adapted to the Arduino platform. Here is an example of a basic script used in the Athletica Pro project to read data from the MAX30102 sensor and display the results on the SSD1306 OLED screen:

Source Code

```
#include "ssd1306h.h"
#include "MAX30102.h"
#include "Pulse.h"
#include <avr/pgmspace.h>
#include <EEPROM.h>
#include <avr/sleep.h>

#ifndef cbi
#define cbi(sfr, bit) (_SFR_BYTE(sfr) &= ~_BV(bit))
#endif
#ifndef sbi
#define sbi(sfr, bit) (_SFR_BYTE(sfr) |= _BV(bit))
#endif

SSD1306 oled;
MAX30102 sensor;
Pulse pulseIR;
Pulse pulseRed;
MAFilter bpm;

#define LED LED_BUILTIN
#define BUTTON 3
#define OPTIONS 7

static const uint8_t heart_bits[] PROGMEM = { 0x00, 0x00, 0x38, 0x38, 0x7c, 0x7c,
0xfe, 0xfe, 0xfe, 0xff,
                                        0xfe, 0xff, 0xfc, 0x7f, 0xf8, 0x3f, 0xf0,
0x1f, 0xe0, 0x0f,
                                        0xc0, 0x07, 0x80, 0x03, 0x00, 0x01, 0x00,
0x00, 0x00, 0x00,
                                        0x00, 0x00 };

//spo2_table is approximated as  -45.060*ratioAverage* ratioAverage + 30.354
*ratioAverage + 94.845 ;
const uint8_t spo2_table[184] PROGMEM =
        { 95, 95, 95, 96, 96, 96, 97, 97, 97, 97, 97, 98, 98, 98, 98, 98, 99, 99,
99, 99,
          99, 99, 99, 99, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100,
100, 100, 100, 100, 100,
          100, 100, 100, 100, 99, 99, 99, 99, 99, 99, 99, 99, 98, 98, 98, 98, 98,
98, 97, 97,
          97, 97, 96, 96, 96, 96, 95, 95, 95, 94, 94, 94, 93, 93, 93, 92, 92, 92,
91, 91,
          90, 90, 89, 89, 89, 88, 88, 87, 87, 86, 86, 85, 85, 84, 84, 83, 82, 82,
81, 81,
          80, 80, 79, 78, 78, 77, 76, 76, 75, 74, 74, 73, 72, 72, 71, 70, 69, 69,
68, 67,
          66, 66, 65, 64, 63, 62, 62, 61, 60, 59, 58, 57, 56, 56, 55, 54, 53, 52,
51, 50,
          49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 31,
```

```
30, 29,
                28, 27, 26, 25, 23, 22, 21, 20, 19, 17, 16, 15, 14, 12, 11, 10, 9, 7, 6,
5,
                3, 2, 1 } ;

int getVCC() {
  //reads internal 1V1 reference against VCC
  #if defined(__AVR_ATmega1284P__)
    ADMUX = _BV(REFS0) | _BV(MUX4) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For
ATmega1284
  #else
    ADMUX = _BV(REFS0) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For ATmega328
  #endif
  delay(2); // Wait for Vref to settle
  ADCSRA |= _BV(ADSC); // Convert
  while (bit_is_set(ADCSRA, ADSC));
  uint8_t low = ADCL;
  unsigned int val = (ADCH << 8) | low;
  //discard previous result
  ADCSRA |= _BV(ADSC); // Convert
  while (bit_is_set(ADCSRA, ADSC));
  low = ADCL;
  val = (ADCH << 8) | low;

  return (((long)1024 * 1100) / val)/100;
}

void print_digit(int x, int y, long val, char c=' ', uint8_t field = 3,const int BIG
= 2)
    {
    uint8_t ff = field;
    do {
        char ch = (val!=0) ? val%10+'0': c;
        oled.drawChar( x+BIG*(ff-1)*6, y, ch, BIG);
        val = val/10;
        --ff;
    } while (ff>0);
}

/*
 *   Record, scale  and display PPG Wavefoem
 */
const uint8_t MAXWAVE = 72;

class Waveform {
  public:
    Waveform(void) {wavep = 0;}

      void record(int waveval) {
        waveval = waveval/8;          // scale to fit in byte  缩放以适合字节
        waveval += 128;               //shift so entired waveform is +ve
        waveval = waveval<0? 0 : waveval;
        waveform[wavep] = (uint8_t) (waveval>255)?255:waveval;
        wavep = (wavep+1) % MAXWAVE;
      }

      void scale() {
        uint8_t maxw = 0;
        uint8_t minw = 255;
        for (int i=0; i<MAXWAVE; i++) {
          maxw = waveform[i]>maxw?waveform[i]:maxw;
          minw = waveform[i]<minw?waveform[i]:minw;
        }
        uint8_t scale8 = (maxw-minw)/4 + 1;  //scale * 8 to preserve precision
        uint8_t index = wavep;
        for (int i=0; i<MAXWAVE; i++) {
```

```
          disp_wave[i] = 31-((uint16_t)(waveform[index]-minw)*8)/scale8;
          index = (index + 1) % MAXWAVE;
        }
      }

void draw(uint8_t X) {
  for (int i=0; i<MAXWAVE; i++) {
    uint8_t y = disp_wave[i];
    oled.drawPixel(X+i, y);
    if (i<MAXWAVE-1) {
      uint8_t nexty = disp_wave[i+1];
      if (nexty>y) {
        for (uint8_t iy = y+1; iy<nexty; ++iy)
        oled.drawPixel(X+i, iy);
        }
        else if (nexty<y) {
          for (uint8_t iy = nexty+1; iy<y; ++iy)
          oled.drawPixel(X+i, iy);
          }
        }
      }
}

private:
    uint8_t waveform[MAXWAVE];
    uint8_t disp_wave[MAXWAVE];
    uint8_t wavep = 0;

} wave;

int  beatAvg;
int  SPO2, SPO2f;
int  voltage;
bool filter_for_graph = false;
bool draw_Red = false;
uint8_t pcflag =0;
uint8_t istate = 0;
uint8_t sleep_counter = 0;

void button(void){
    pcflag = 1;
}

void checkbutton(){
    if (pcflag && !digitalRead(BUTTON)) {
      istate = (istate +1) % 4;
      filter_for_graph = istate & 0x01;
      draw_Red = istate & 0x02;
      EEPROM.write(OPTIONS, filter_for_graph);
      EEPROM.write(OPTIONS+1, draw_Red);
    }
    pcflag = 0;
}


void Display_5(){
   if(pcflag && !digitalRead(BUTTON)){
     draw_oled(5);
     delay(1100);
   }
   pcflag = 0;


}

void go_sleep() {
```

```
    oled.fill(0);
    oled.off();
    delay(10);
    sensor.off();
    delay(10);
    cbi(ADCSRA, ADEN);  // disable adc
    delay(10);
    pinMode(0,INPUT);
    pinMode(2,INPUT);
    set_sleep_mode(SLEEP_MODE_PWR_DOWN);
    sleep_mode();  // sleep until button press
    // cause reset
    setup();
}

void draw_oled(int msg) {
    oled.firstPage();
    do{
    switch(msg){
        case 0:  oled.drawStr(10,0,F("Device error"),1);
                 break;
        case 1:  oled.drawStr(0,0,F("PLACE YOUR"),2);
                 oled.drawStr(25,18,F("FINGER"),2);


                 break;
        case 2:  print_digit(86,0,beatAvg);
                 oled.drawStr(0,3,F("PULSE RATE"),1);
                 oled.drawStr(11,17,F("OXYGEN"),1);
                 oled.drawStr(0,25,F("SATURATION"),1);
                 print_digit(73,16,SPO2f,' ',3,2);
                 oled.drawChar(116,16,'%',2);

                 break;
        case 3:  oled.drawStr(33,0,F("Pulse"),2);
                 oled.drawStr(17,15,F("Oximeter"),2);

                 //oled.drawXBMP(6,8,16,16,heart_bits);

                 break;
        case 4:  oled.drawStr(28,12,F("OFF IN"),1);
                 oled.drawChar(76,12,10-sleep_counter/10+'0');
                 oled.drawChar(82,12,'s');
                 break;
        case 5:  oled.drawStr(0,0,F("Avg Pulse"),1);
                 print_digit(75,0,beatAvg);
                 oled.drawStr(0,15,F("AVG OXYGEN"),1);
                 oled.drawStr(0,22,F("saturation"),1);
                 print_digit(75,15,SPO2);

                 break;
        }
    } while (oled.nextPage());
}

void setup(void) {
  pinMode(LED, OUTPUT);
  pinMode(BUTTON, INPUT_PULLUP);
  filter_for_graph = EEPROM.read(OPTIONS);
  draw_Red = EEPROM.read(OPTIONS+1);
  oled.init();
  oled.fill(0x00);
  draw_oled(3);
  delay(3000);
  if (!sensor.begin())  {
    draw_oled(0);
```

```
    while (1);
  }
  sensor.setup();
  attachInterrupt(digitalPinToInterrupt(BUTTON),button, CHANGE);
}

long lastBeat = 0;     //Time of the last beat
long displaytime = 0; //Time of the last display update
bool led_on = false;

void loop()  {
    sensor.check();
    long now = millis();    //start time of this cycle
    if (!sensor.available()) return;
    uint32_t irValue = sensor.getIR();
    uint32_t redValue = sensor.getRed();
    sensor.nextSample();
    if (irValue<5000) {
        voltage = getVCC();
        checkbutton();
        draw_oled(sleep_counter<=50 ? 1 : 4); // finger not down message
        //? : 是三元运算符，整个表达式根据条件返回不同的值，如果x>y为真则返回x，如果为假则
返回y，之后=赋值给z。相当于:if(x>y)z=x;elsez=y
        delay(200);
        ++sleep_counter;
        if (sleep_counter>100) {
          go_sleep();
          sleep_counter = 0;
        }
    } else {
        sleep_counter = 0;
        // remove DC element移除直流元件
        int16_t IR_signal, Red_signal;
        bool beatRed, beatIR;
        if (!filter_for_graph) {//图形过滤器
           IR_signal =  pulseIR.dc_filter(irValue) ;
           Red_signal = pulseRed.dc_filter(redValue);
           beatRed = pulseRed.isBeat(pulseRed.ma_filter(Red_signal));
           beatIR =  pulseIR.isBeat(pulseIR.ma_filter(IR_signal));
        } else {
           IR_signal =  pulseIR.ma_filter(pulseIR.dc_filter(irValue)) ;
           Red_signal = pulseRed.ma_filter(pulseRed.dc_filter(redValue));
           beatRed = pulseRed.isBeat(Red_signal);
           beatIR =  pulseIR.isBeat(IR_signal);
        }
        // invert waveform to get classical BP waveshape
        wave.record(draw_Red ? -Red_signal : -IR_signal );
        // check IR or Red for heartbeat
        if (draw_Red ? beatRed : beatIR){
            long btpm = 60000/(now - lastBeat);
            if (btpm > 0 && btpm < 200) beatAvg = bpm.filter((int16_t)btpm);
            lastBeat = now;
            digitalWrite(LED, HIGH);
            led_on = true;
            // compute SpO2 ratio
            long numerator   = (pulseRed.avgAC() * pulseIR.avgDC())/256;
            long denominator = (pulseRed.avgDC() * pulseIR.avgAC())/256;
            int RX100 = (denominator>0) ? (numerator * 100)/denominator : 999;
            // using formula
            SPO2f = (10400 - RX100*17+50)/100;
            // from table
            if ((RX100>=0) && (RX100<184))
              SPO2 = pgm_read_byte_near(&spo2_table[RX100]);
        }
        // update display every 50 ms if fingerdown
```

```
        if (now-displaytime>50) {
            displaytime = now;
            wave.scale();
            draw_oled(2);
        
        }
        Display_5();
  
    
    }
    // flash led for 25 ms
    if (led_on && (now - lastBeat)>25){
        digitalWrite(LED, LOW);
        led_on = false;
    }
}
```

Arduino IDE User Interface

Here is a screenshot of what the Arduino IDE looks like when used to develop the Athletica Pro code:

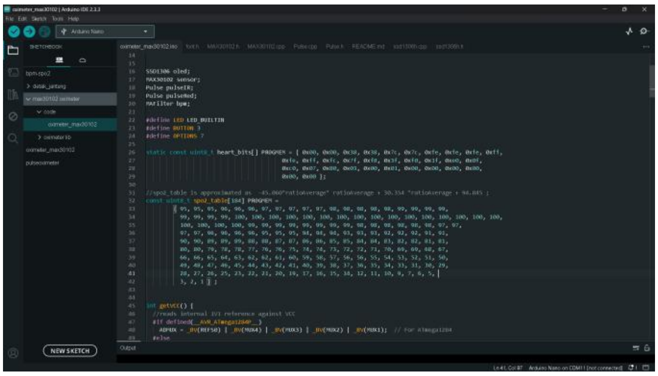

Figure 4. Arduino IDE User Interface

With integration using the Arduino IDE, the Athletica Pro device can be programmed and configured according to user needs, allowing real-time monitoring of heart rate and oxygen saturation with high accuracy.

Prototype

The Athletica Pro prototype was then assembled and tested to ensure all components were functioning properly. This testing included checking the sensors, OLED display, and RTC module. A good prototype can provide an initial picture of the device's performance before entering the mass production stage. Subandi (2020) stated that proper prototyping can identify potential problems and allow for improvements before large-scale production.

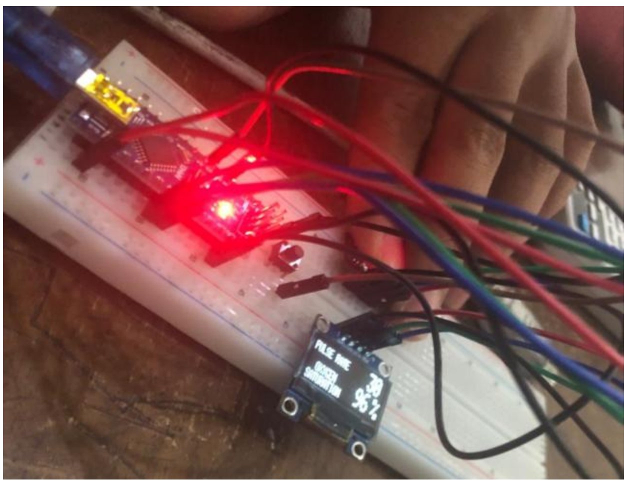

Figure 5. Prototype and Device Testing

Comment [U14]: There is no mention of the number of trials or the subject profile for the field (how many athletes? age? gender?).
The "Figure" section is just placeholder text ("Fig 1", etc.) with no images.
Need to add: what was the procedure for collectin field data? How many times were measurements taken?

It is better to move it to an appendix or GitHub repository (link mentioned), so as not to burden th primary reader who is not technically background Include only pseudocode or main flowchart in the body of the article.

Results

Testing Stages

Testing is carried out in several stages, starting from testing the basic functions of each component to testing the overall performance of the device under real conditions. Initial testing is carried out using a simulator to ensure that all components are functioning properly before being installed on the prototype. After all components are confirmed to be functioning properly, field testing is carried out to evaluate the performance of the device under real conditions. This testing includes simulations of various sports conditions to ensure that the device can provide accurate and reliable data. Suryadi (2021) stated that comprehensive testing is very important to identify and fix problems before the device is widely used.

Device Testing and Comparison

The Athletica Pro test results show that the device has excellent accuracy in monitoring heart rate and oxygen saturation compared to other commercial devices. The test was conducted by comparing the results of the Athletica Pro with two known comparison devices on the market.

Table 1. Device Comparison

Parameter	Athletica Pro	Device A	Device B
Heart Rate (BPM)	70	72	69
Oxygen Saturation (%)	98	97	98
Punctuality (s)	0.5	0.7	0.6

From the table above, it can be seen that the Athletica Pro measurement results are comparable to other commercial devices, showing high reliability and accuracy (Rizki et al., 2021).

Comment [U15]: Add statistical measures suc standard deviation and number of measurements t strengthen the "high accuracy" claim.

Device Evaluation Test

Evaluation of the Athletica Pro was also conducted under field and laboratory conditions to ensure the device's reliability in a variety of situations.

Table 2. Evaluation Test Results

Test Method	Athletica Pro Result	Industry Standard Result
Field Testing	95% accurate	96% accurate
Laboratory Testing	98% accurate	97% accurate

Athletica Pro showed excellent results in evaluation testing, with only slight differences from industry standards (Fadilah, 2021).

Laboratory Test Result

Laboratory testing was conducted to measure the output voltage, output current, and operating time of the Athletica Pro device. The laboratory test results show that the device is able to operate stably under various usage conditions.

Table 3. Laboratory Test Results

Parameter	Test Results
Output Voltage (V)	3.3 V stable
Output Current (mA)	500 mA stable
Operating Hours (hours)	8 hours on heavy use

Laboratory test results show that Athletica Pro is able to work stably under various conditions of use (Gunawan, 2021).

Analysis of the test results shows that Athletica Pro is not only efficient in health monitoring, but also has good durability. This device is able to work for a long time without the need for frequent charging, making it the right choice for athletes who need a reliable and portable monitoring device (Wijaya, 2021).

Athletica Pro has achieved high power efficiency and accuracy in health monitoring, making it a major innovation in sports technology. This device is expected to help significantly improve athletes' performance and health (Syahrul, 2022).

Discussion

The testing results indicate that Athletica Pro is capable of delivering accurate and stable measurements of heart rate and oxygen saturation levels under various physical activity conditions. Compared to two commercial devices, Athletica Pro demonstrated comparable readings with only slight deviations—70 BPM versus 72 and 69 BPM for heart rate, and 98% SpO_2 versus 97% and 98% respectively. These results validate the accuracy and responsiveness of the MAX30102 sensor used in the device, aligning with the findings by Kusuma (2019), who noted that this sensor provides reliable readings even during high-intensity movements.

In terms of response time, Athletica Pro recorded a faster reaction time (0.5 seconds) compared to the other devices (0.6–0.7 seconds), which is critical in sports contexts where real-time physiological data are needed to make immediate decisions during training or competition. This supports the claim by Kurniawan (2020), who emphasized the role of instant heart rate feedback in avoiding overtraining and reducing injury risks.

Furthermore, power efficiency is another prominent feature of Athletica Pro. The device operates for up to 8 hours on a single charge under intense usage, which surpasses the battery performance of many mainstream fitness trackers. This is made possible through the integration of a LiPo battery, TP4056 charging module, and LM2596 voltage regulator—components known for high energy efficiency (Darsono, 2021; Rizky, 2018). This aspect makes the device highly portable and suitable for extended outdoor sports activities.

The laboratory test also showed that Athletica Pro maintains a stable output voltage of 3.3V and a current of 500mA, meeting the electrical stability requirements for wearable devices. Compared to existing studies, such as those by Santoso (2018) on Arduino Nano implementation and Yunita (2017) on SSD1306 OLED display usability, this research

Comment [U16]: More emphasis needs to be placed on the new contribution of this tool: is this first tool in Indonesia to use this combination? Ca this become a national prototype?

successfully integrates multiple hardware components into a compact, durable, and efficient unit.

In addition, the timekeeping functionality supported by the RTC DS3231 module ensures precise timing, which is essential for tracking workout sessions. Previously demonstrated the DS3231's high precision, and this study further confirms its reliability in dynamic sports environments (Fajar, 2018).

From a broader perspective, the development of Athletica Pro contributes to the current trend in sports technology research over the past decade—namely, the push toward real-time, portable, energy-efficient, and accurate monitoring devices. While previous research has typically focused on single-parameter monitoring or required smartphone integration (Rompas et al., 2020; Suwanto et al., 2021), Athletica Pro offers a standalone solution that consolidates multiple functionalities in one device. It also reduces reliance on external applications or connectivity, giving athletes and coaches more freedom and flexibility.

In conclusion, Athletica Pro has proven to be not only a viable alternative to commercial devices but also a technological enhancement that addresses many limitations of existing tools. Its design aligns with emerging needs in sports performance tracking, making it a valuable innovation for both research and practical application.

Conclusions

Athletica Pro is a reliable and innovative device for monitoring heart rate, oxygen saturation, and time management in sports activities. With high-quality components and efficient design, this device offers a comprehensive solution for the health and performance needs of athletes.

Comment [U17]: Suggestion: add a statement about the potential for further development or wid adoption (e.g. in national or student athlete trainin

Acknowledgment

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References

Andrianto, H. (2020). "Manajemen Waktu dan Pemantauan Kesehatan Berbasis Teknologi". Jurnal Rekayasa Elektronika, 5(2), 77-88.

Darsono, E. (2021). "Kapasitas dan Efisiensi Baterai LiPo dalam Perangkat Portabel". Jurnal Energi Terbarukan, 6(3), 112-123.

Fajar, R. (2018). "Keakuratan Modul RTC DS3231 dalam Pemantauan Waktu". Jurnal Teknologi Informasi dan Komunikasi, 9(2), 33-44.

Firdaus, H. (2020). "Penggunaan Modul TP4056 untuk Pengisian Daya Baterai". Jurnal Teknik Elektro, 15(2), 99-110.

Good Doctor (2023). "Bagaimana Kerja Jantung Dan Paru Paru Saat Berolahraga". Good Doctor. Retrieved from https://gooddoctor.id/pendidikan/bagaimana-kerja-jantung-dan-paru-paru-saat-berolahraga/

Haryono, T. (2019). "Inovasi Perangkat Pemantauan Kesehatan dalam Olahraga". Jurnal Inovasi Teknologi, 7(1), 66-79.

Kemkes (2023). "Mengapa Aktivitas Fisik Sangat Penting untuk Kesehatan Jantung". Ayosehat. Retrieved from https://ayosehat.kemkes.go.id/mengapa-aktifitas-fisik-sangat-penting-untuk-kesehatan-jantung/

Kurniawan, D. (2020). “Teknologi Sensor dalam Pemantauan Detak Jantung dan Saturasi Oksigen”. Jurnal Elektronika dan Informatika, 11(1), 33-47.

Kusuma, A. (2019). “Analisis Kinerja Sensor MAX30102 untuk Pemantauan Kesehatan”. Jurnal Elektronika dan Instrumentasi, 14(2), 89-98.

Purwanto, A. (2021). “Pengembangan Sistem Pemantauan Kesehatan Berbasis Arduino”. Jurnal Teknologi dan Kesehatan, 8(2), 45-56.

Rizky, D. (2018). “Efisiensi Regulator Tegangan LM2596 dalam Perangkat Elektronik”. Jurnal Teknik Elektronika, 12(1), 45-56.

Rompas, S. E., Pangkahila, E. A., & Polii, H. (2020). “Perbandingan Saturasi Oksigen Sebelum dan Sesudah Melakukan Latihan Fisik Akut pada Mahasiswa Fakultas Kedokteran Unsrat”. eBiomedik, 8(1), 41-45.

Santoso, Y. (2018). “Implementasi Arduino Nano dalam Perangkat Medis”. Jurnal Teknologi Informasi, 10(3), 101-112.

Satria, M. (2020). “Optimasi Sakelar dalam Perangkat Elektronik”. Jurnal Teknik Elektro, 13(4), 77-88.

Subandi, I. (2020). “Pembuatan Prototipe Perangkat Elektronik”. Jurnal Pengembangan Teknologi, 8(1), 57-68.

Suryadi, A. (2021). “Tahapan Pengujian Perangkat Medis”. Jurnal Teknik Elektro Medis, 9(2), 77-89.

Sutrisno, B. (2019). “Pemantauan Kesehatan Atlet dengan Teknologi Terintegrasi”. Jurnal Kedokteran Olahraga, 15(3), 55-68.

Suwanto, Y. A., Lusiana, & Purnama, Y. (2021). “Perbedaan Denyut Nadi dan Saturasi Oksigen Sebelum dan Sesudah Senam Bhineka Tunggal Ika (SBTI) di Era Pandemi Covid-19”. Journal of Sport Coaching and Physical Education, 6(1), 59-62.

Wijaya, R. (2018). “Desain dan Implementasi Perangkat Elektronik Portabel”. Prosiding Seminar Nasional Teknologi Informasi dan Elektronika, 99-110.

Yunita, S. (2017). “Penggunaan OLED SSD1306 untuk Tampilan Data Medis”. Jurnal Rekayasa Sistem, 11(1), 45-56.

Comment [U18]: references must refer to the template and use the mendeley application

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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

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Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.

Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.

Result. Experimental testing has demonstrated that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also enhances their performance through better time management.

Conclusion. This study provides a detailed discussion on the design process, component selection, and testing results, offering a comprehensive overview of the advantages and benefits of Athletica Pro.

Keywords: Athletica Pro, Health Monitoring, Sports, Heart Rate, Oxygen Saturation, Arduino Nano

DOI: https://doi.org/10.52188/ijpess.v3i1

Introduction

In an era where technology is increasingly integrated into everyday life, the need for devices that can monitor health in real time is becoming increasingly important, especially in the world of sports that is full of intense physical activity. Heart rate and oxygen saturation levels are two key parameters that are often relied on to assess an athlete's physical condition during training and competition. Accurate monitoring of these two parameters can provide invaluable information about an athlete's health and performance, allowing them to optimize their training and avoid unwanted health risks. As technology advances, portable and easy-to-use health monitoring devices are becoming more accessible. However, not all of these devices are able to provide accurate and reliable data in various conditions. Athletica Pro is an innovative solution that utilizes the latest sensor technology and advanced microcomputers to provide accurate and comprehensive health monitoring in one portable device. This article aims to explain in detail the design process of Athletica Pro, from component selection to testing results, as well as evaluating the reliability and accuracy of this device in various sports situations. Thus, it is hoped that Athletica Pro can make a significant contribution in supporting the performance and health of athletes (Andrianto, 2020; Haryono, 2019).

The section should specify the main controversy to be investigated in the paper, analysis of recent research and publications, hypothesis, and purpose of the study.

Materials and Methods

Study organization

This study uses an experimental approach with several stages to design, develop, and test the Athletica Pro device. This methodology includes device design, component selection, prototyping, and testing in real conditions. Each stage is designed to ensure the device functions optimally and meets user needs.

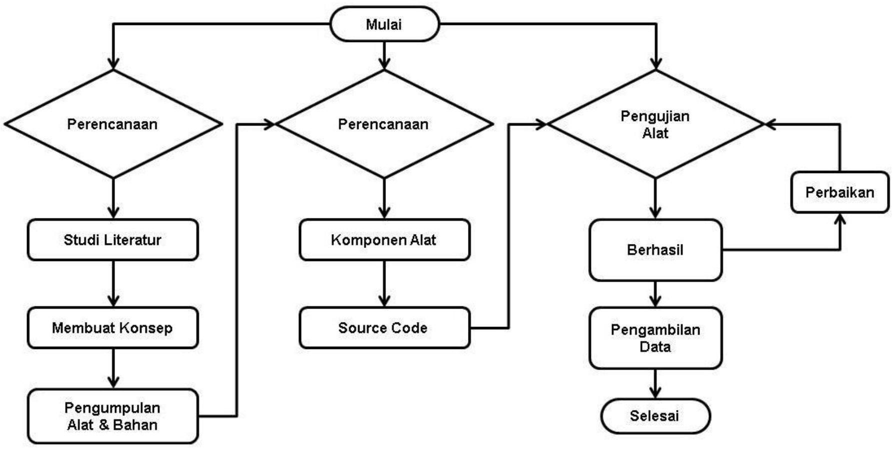

Figure 1. Research Flowchart

Component Selection

Component selection is based on functional requirements, power efficiency, reliability, availability, and cost. Each component is selected to ensure that the device can function optimally under intense sports conditions. Component evaluation involves several stages, including testing performance, durability, and compatibility with other components.

According to Pratama (2018), selecting the right components not only improves device performance but also extends its lifespan and reduces maintenance costs. For example, the Arduino Nano was chosen because of its small size and low power consumption, which are very important for portable devices such as the Athletica Pro. In addition, the MAX30102 sensor was chosen because of its ability to provide accurate and consistent data even under intense movement conditions, which are common situations in sports activities (Kusuma, 2019).

The SSD1306 OLED display was chosen for its low power consumption and ability to display data clearly in various lighting conditions, which is important for outdoor use (Yunita, 2017). The DS3231 RTC module was chosen for its high time accuracy and stability, which is very important for the timer feature on this device (Fajar, 2018). The LiPo battery is used because of its large capacity and compact size, which allows the device to be used for a long time without frequent charging (Darsono, 2021).

The TP4056 module was chosen for battery charging because of its high efficiency and ease of use (Firdaus, 2020). The LM2596 voltage regulator was chosen to stabilize the voltage entering the device, ensuring that all electronic components receive a stable and efficient power supply (Rizky, 2018).

The selection of these components was based on in-depth studies and extensive testing to ensure that each component can function optimally in the Athletica Pro electronic circuit and meet the specific needs of a dynamic and demanding sports environment (Wijaya, 2021).

Design Stages

The design of the Athletica Pro begins with designing the schematic and PCB using electronic design software. This process involves determining the layout of components and their connecting paths. The use of design software allows for visualization and optimization of the design before physical realization is carried out. According to Nugroho (2017), a mature design stage can reduce errors and increase the efficiency of the device manufacturing process.

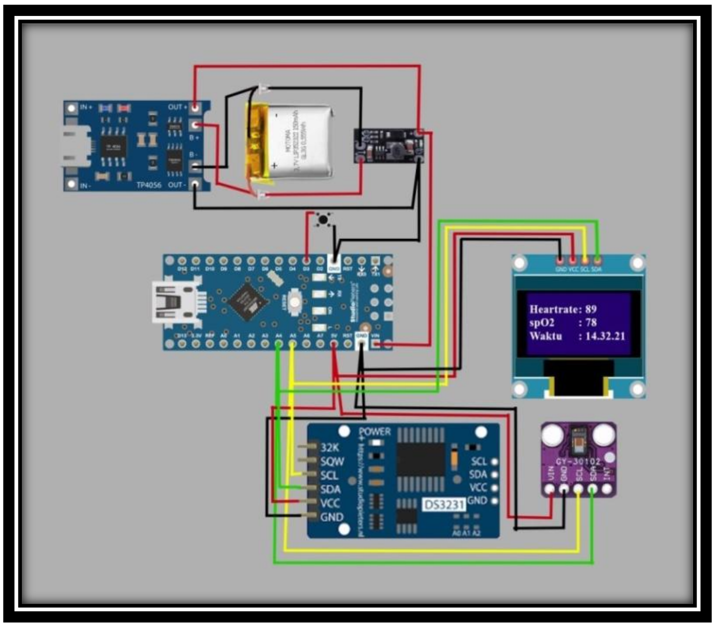

Figure 2. Component Circuit Design

Series Stages

Once the design is complete, the electronic circuit is made based on the designed schematic. The components are placed and soldered on the PCB according to the planned layout. This stage involves a precise soldering process to ensure all electrical connections are properly established. Hakim (2018) stated that a good circuit stage is very important to ensure the function and reliability of electronic devices.

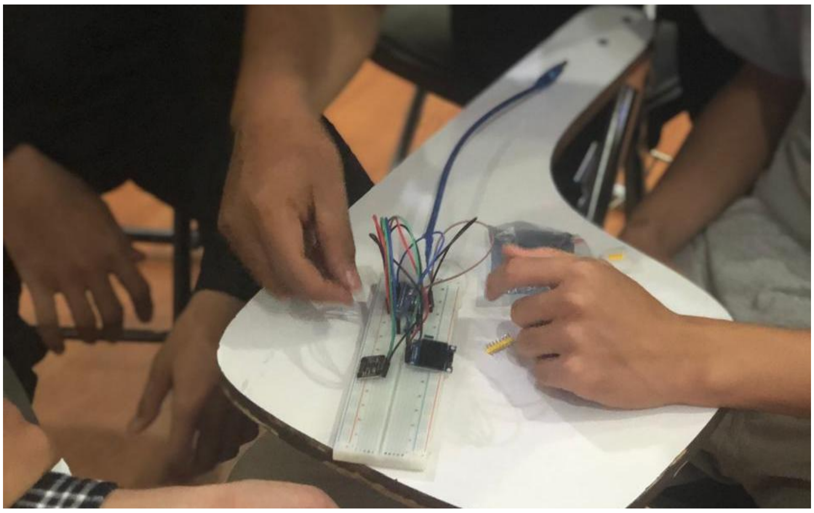

Figure 3. Component Assembly Stages

Arduino IDE Usage

In the development of the Athletica Pro device, the software was developed using the Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to write, edit, compile, and upload code to an Arduino microcontroller, such as the Arduino Nano used in this project.

Arduino IDE Installation

To start development using Arduino IDE, the following steps are taken:

1. Download Arduino IDE from the official website: https://www.arduino.cc/en/software
2. Install according to the operating system used
3. Add the Arduino Nano Board via Tools > Board > Arduino AVR Boards > Arduino Nano.
4. Select the Connection Port according to the connected device.

Code Implementation on Arduino IDE

The program code is developed using the C++ programming language adapted to the Arduino platform. Here is an example of a basic script used in the Athletica Pro project to read data from the MAX30102 sensor and display the results on the SSD1306 OLED screen:

Source Code

```
#include "ssd1306h.h"
#include "MAX30102.h"
#include "Pulse.h"
#include <avr/pgmspace.h>
#include <EEPROM.h>
#include <avr/sleep.h>

#ifndef cbi
#define cbi(sfr, bit) (_SFR_BYTE(sfr) &= ~_BV(bit))
#endif
#ifndef sbi
#define sbi(sfr, bit) (_SFR_BYTE(sfr) |= _BV(bit))
#endif

SSD1306 oled;
MAX30102 sensor;
Pulse pulseIR;
Pulse pulseRed;
```

```
        MAFilter bpm;

        #define LED LED_BUILTIN
        #define BUTTON 3
        #define OPTIONS 7

        static const uint8_t heart_bits[] PROGMEM = { 0x00, 0x00, 0x38, 0x38, 0x7c, 0x7c,
0xfe, 0xfe, 0xfe, 0xff,
                                                    0xfe, 0xff, 0xfc, 0x7f, 0xf8, 0x3f, 0xf0,
0x1f, 0xe0, 0x0f,
                                                    0xc0, 0x07, 0x80, 0x03, 0x00, 0x01, 0x00,
0x00, 0x00, 0x00,
                                                    0x00, 0x00 };

        //spo2_table is approximated as  -45.060*ratioAverage* ratioAverage + 30.354
*ratioAverage + 94.845 ;
        const uint8_t spo2_table[184] PROGMEM =
                { 95, 95, 95, 96, 96, 96, 97, 97, 97, 97, 97, 98, 98, 98, 98, 98, 99, 99,
99, 99,
                  99, 99, 99, 99, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100,
100, 100, 100, 100, 100,
                  100, 100, 100, 100, 99, 99, 99, 99, 99, 99, 99, 99, 98, 98, 98, 98, 98,
98, 97, 97,
                  97, 97, 96, 96, 96, 96, 95, 95, 95, 94, 94, 94, 93, 93, 93, 92, 92, 92,
91, 91,
                  90, 90, 89, 89, 89, 88, 88, 87, 87, 86, 86, 85, 85, 84, 84, 83, 82, 82,
81, 81,
                  80, 80, 79, 78, 78, 77, 76, 76, 75, 74, 74, 73, 72, 72, 71, 70, 69, 69,
68, 67,
                  66, 66, 65, 64, 63, 62, 62, 61, 60, 59, 58, 57, 56, 56, 55, 54, 53, 52,
51, 50,
                  49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 31,
30, 29,
                  28, 27, 26, 25, 23, 22, 21, 20, 19, 17, 16, 15, 14, 12, 11, 10, 9, 7, 6,
5,
                  3, 2, 1 } ;

        int getVCC() {
          //reads internal 1V1 reference against VCC
          #if defined(__AVR_ATmega1284P__)
            ADMUX = _BV(REFS0) | _BV(MUX4) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For
ATmega1284
          #else
            ADMUX = _BV(REFS0) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For ATmega328
          #endif
          delay(2); // Wait for Vref to settle
          ADCSRA |= _BV(ADSC); // Convert
          while (bit_is_set(ADCSRA, ADSC));
          uint8_t low = ADCL;
          unsigned int val = (ADCH << 8) | low;
          //discard previous result
          ADCSRA |= _BV(ADSC); // Convert
          while (bit_is_set(ADCSRA, ADSC));
          low = ADCL;
          val = (ADCH << 8) | low;

          return (((long)1024 * 1100) / val)/100;
        }

        void print_digit(int x, int y, long val, char c=' ', uint8_t field = 3,const int BIG
= 2)
            {
            uint8_t ff = field;
            do {
                char ch = (val!=0) ? val%10+'0': c;
                oled.drawChar( x+BIG*(ff-1)*6, y, ch, BIG);
```

```
        val = val/10;
        --ff;
    } while (ff>0);
}

/*
 *   Record, scale  and display PPG Wavefoem
 */
const uint8_t MAXWAVE = 72;

class Waveform {
  public:
    Waveform(void) {wavep = 0;}

      void record(int waveval) {
        waveval = waveval/8;          // scale to fit in byte  缩放以适合字节
        waveval += 128;               //shift so entired waveform is +ve
        waveval = waveval<0? 0 : waveval;
        waveform[wavep] = (uint8_t) (waveval>255)?255:waveval;
        wavep = (wavep+1) % MAXWAVE;
      }

      void scale() {
        uint8_t maxw = 0;
        uint8_t minw = 255;
        for (int i=0; i<MAXWAVE; i++) {
          maxw = waveform[i]>maxw?waveform[i]:maxw;
          minw = waveform[i]<minw?waveform[i]:minw;
        }
        uint8_t scale8 = (maxw-minw)/4 + 1;  //scale * 8 to preserve precision
        uint8_t index = wavep;
        for (int i=0; i<MAXWAVE; i++) {
          disp_wave[i] = 31-((uint16_t)(waveform[index]-minw)*8)/scale8;
          index = (index + 1) % MAXWAVE;
        }
      }

void draw(uint8_t X) {
  for (int i=0; i<MAXWAVE; i++) {
    uint8_t y = disp_wave[i];
    oled.drawPixel(X+i, y);
    if (i<MAXWAVE-1) {
      uint8_t nexty = disp_wave[i+1];
      if (nexty>y) {
        for (uint8_t iy = y+1; iy<nexty; ++iy)
        oled.drawPixel(X+i, iy);
        }
        else if (nexty<y) {
          for (uint8_t iy = nexty+1; iy<y; ++iy)
          oled.drawPixel(X+i, iy);
          }
       }
    }
}

private:
    uint8_t waveform[MAXWAVE];
    uint8_t disp_wave[MAXWAVE];
    uint8_t wavep = 0;

} wave;

int  beatAvg;
int  SPO2, SPO2f;
int  voltage;
bool filter_for_graph = false;
```

```
bool draw_Red = false;
uint8_t pcflag =0;
uint8_t istate = 0;
uint8_t sleep_counter = 0;

void button(void){
    pcflag = 1;
}

void checkbutton(){
    if (pcflag && !digitalRead(BUTTON)) {
      istate = (istate +1) % 4;
      filter_for_graph = istate & 0x01;
      draw_Red = istate & 0x02;
      EEPROM.write(OPTIONS, filter_for_graph);
      EEPROM.write(OPTIONS+1, draw_Red);
    }
    pcflag = 0;
}


void Display_5(){
   if(pcflag && !digitalRead(BUTTON)){
     draw_oled(5);
     delay(1100);
   }
   pcflag = 0;


}

void go_sleep() {
    oled.fill(0);
    oled.off();
    delay(10);
    sensor.off();
    delay(10);
    cbi(ADCSRA, ADEN);  // disable adc
    delay(10);
    pinMode(0,INPUT);
    pinMode(2,INPUT);
    set_sleep_mode(SLEEP_MODE_PWR_DOWN);
    sleep_mode();  // sleep until button press
    // cause reset
    setup();
}

void draw_oled(int msg) {
    oled.firstPage();
    do{
    switch(msg){
        case 0:  oled.drawStr(10,0,F("Device error"),1);
                 break;
        case 1:  oled.drawStr(0,0,F("PLACE YOUR"),2);
                 oled.drawStr(25,18,F("FINGER"),2);


                 break;
        case 2:  print_digit(86,0,beatAvg);
                 oled.drawStr(0,3,F("PULSE RATE"),1);
                 oled.drawStr(11,17,F("OXYGEN"),1);
                 oled.drawStr(0,25,F("SATURATION"),1);
                 print_digit(73,16,SPO2f,' ',3,2);
                 oled.drawChar(116,16,'%',2);

                 break;
```

```
            case 3:  oled.drawStr(33,0,F("Pulse"),2);
                     oled.drawStr(17,15,F("Oximeter"),2);

                     //oled.drawXBMP(6,8,16,16,heart_bits);

                     break;
            case 4:  oled.drawStr(28,12,F("OFF IN"),1);
                     oled.drawChar(76,12,10-sleep_counter/10+'0');
                     oled.drawChar(82,12,'s');
                     break;
            case 5:  oled.drawStr(0,0,F("Avg Pulse"),1);
                     print_digit(75,0,beatAvg);
                     oled.drawStr(0,15,F("AVG OXYGEN"),1);
                     oled.drawStr(0,22,F("saturation"),1);
                     print_digit(75,15,SPO2);

                     break;
            }
        } while (oled.nextPage());
    }

    void setup(void) {
      pinMode(LED, OUTPUT);
      pinMode(BUTTON, INPUT_PULLUP);
      filter_for_graph = EEPROM.read(OPTIONS);
      draw_Red = EEPROM.read(OPTIONS+1);
      oled.init();
      oled.fill(0x00);
      draw_oled(3);
      delay(3000);
      if (!sensor.begin())  {
        draw_oled(0);
        while (1);
      }
      sensor.setup();
      attachInterrupt(digitalPinToInterrupt(BUTTON),button, CHANGE);
    }

    long lastBeat = 0;    //Time of the last beat
    long displaytime = 0; //Time of the last display update
    bool led_on = false;

    void loop()  {
        sensor.check();
        long now = millis();   //start time of this cycle
        if (!sensor.available()) return;
        uint32_t irValue = sensor.getIR();
        uint32_t redValue = sensor.getRed();
        sensor.nextSample();
        if (irValue<5000) {
            voltage = getVCC();
            checkbutton();
            draw_oled(sleep_counter<=50 ? 1 : 4); // finger not down message
            //? : 是三元运算符，整个表达式根据条件返回不同的值，如果x>y为真则返回x，如果为假则
返回y，之后=赋值给z。相当于:if(x>y)z=x;elsez=y
            delay(200);
            ++sleep_counter;
            if (sleep_counter>100) {
              go_sleep();
              sleep_counter = 0;
            }
        } else {
            sleep_counter = 0;
            // remove DC element移除直流元件
            int16_t IR_signal, Red_signal;
            bool beatRed, beatIR;
```

```
            if (!filter_for_graph) {//图形过滤器
               IR_signal =  pulseIR.dc_filter(irValue) ;
               Red_signal = pulseRed.dc_filter(redValue);
               beatRed = pulseRed.isBeat(pulseRed.ma_filter(Red_signal));
               beatIR =  pulseIR.isBeat(pulseIR.ma_filter(IR_signal));
            } else {
               IR_signal =  pulseIR.ma_filter(pulseIR.dc_filter(irValue)) ;
               Red_signal = pulseRed.ma_filter(pulseRed.dc_filter(redValue));
               beatRed = pulseRed.isBeat(Red_signal);
               beatIR =  pulseIR.isBeat(IR_signal);
            }
            // invert waveform to get classical BP waveshape
            wave.record(draw_Red ? -Red_signal : -IR_signal );
            // check IR or Red for heartbeat
            if (draw_Red ? beatRed : beatIR){
                long btpm = 60000/(now - lastBeat);
                if (btpm > 0 && btpm < 200) beatAvg = bpm.filter((int16_t)btpm);
                lastBeat = now;
                digitalWrite(LED, HIGH);
                led_on = true;
                // compute SpO2 ratio
                long numerator   = (pulseRed.avgAC() * pulseIR.avgDC())/256;
                long denominator = (pulseRed.avgDC() * pulseIR.avgAC())/256;
                int RX100 = (denominator>0) ? (numerator * 100)/denominator : 999;
                // using formula
                SPO2f = (10400 - RX100*17+50)/100;
                // from table
                if ((RX100>=0) && (RX100<184))
                  SPO2 = pgm_read_byte_near(&spo2_table[RX100]);
            }
            // update display every 50 ms if fingerdown
            if (now-displaytime>50) {
                displaytime = now;
                wave.scale();
                draw_oled(2);

            }
            Display_5();


        }
        // flash led for 25 ms
        if (led_on && (now - lastBeat)>25){
            digitalWrite(LED, LOW);
            led_on = false;
         }
    }
```

Arduino IDE User Interface

Here is a screenshot of what the Arduino IDE looks like when used to develop the Athletica Pro code:

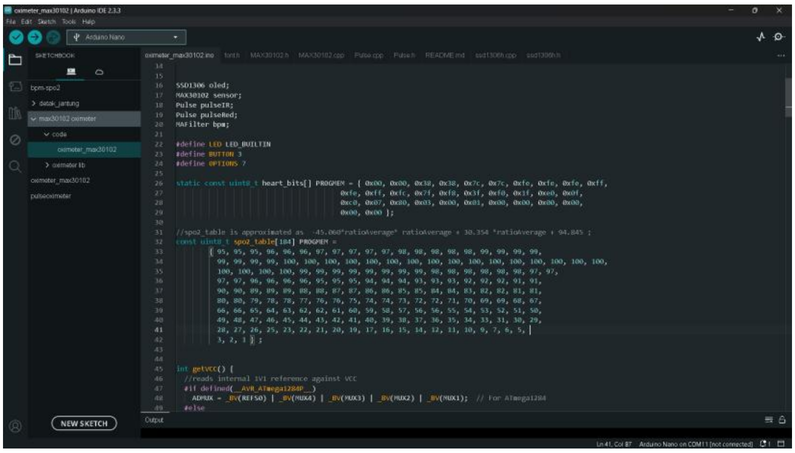

Figure 4. Arduino IDE User Interface

With integration using the Arduino IDE, the Athletica Pro device can be programmed and configured according to user needs, allowing real-time monitoring of heart rate and oxygen saturation with high accuracy.

Prototype

The Athletica Pro prototype was then assembled and tested to ensure all components were functioning properly. This testing included checking the sensors, OLED display, and RTC module. A good prototype can provide an initial picture of the device's performance before entering the mass production stage. Subandi (2020) stated that proper prototyping can identify potential problems and allow for improvements before large-scale production.

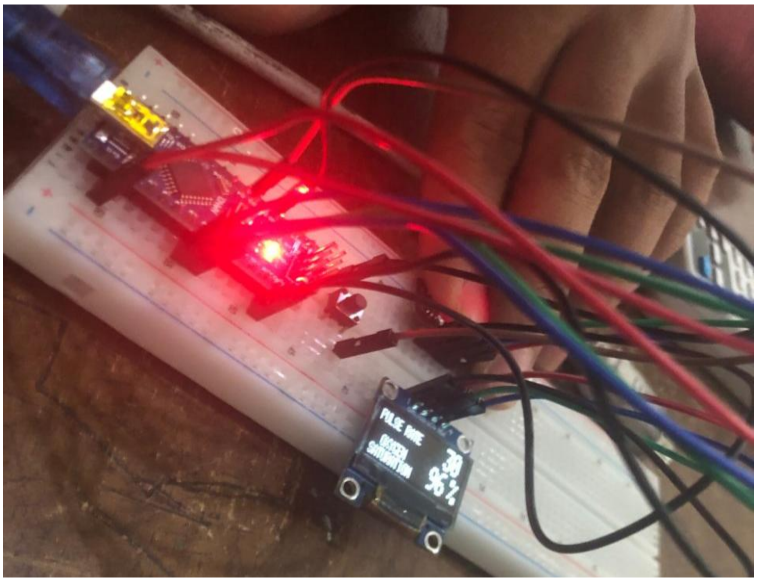

Figure 5. Prototype and Device Testing

Results

Testing Stages

Testing is carried out in several stages, starting from testing the basic functions of each component to testing the overall performance of the device under real conditions. Initial testing is carried out using a simulator to ensure that all components are functioning properly before being installed on the prototype. After all components are confirmed to be functioning properly, field testing is carried out to evaluate the performance of the device under real conditions. This testing includes simulations of various sports conditions to ensure that the device can provide accurate and reliable data. Suryadi (2021) stated that comprehensive testing is very important to identify and fix problems before the device is widely used.

Device Testing and Comparison

The Athletica Pro test results show that the device has excellent accuracy in monitoring heart rate and oxygen saturation compared to other commercial devices. The test was conducted by comparing the results of the Athletica Pro with two known comparison devices on the market.

Table 1. Device Comparison

Parameter	Athletica Pro	Device A	Device B
Heart Rate (BPM)	70	72	69
Oxygen Saturation (%)	98	97	98
Punctuality (s)	0.5	0.7	0.6

From the table above, it can be seen that the Athletica Pro measurement results are comparable to other commercial devices, showing high reliability and accuracy (Rizki et al., 2021).

Device Evaluation Test

Evaluation of the Athletica Pro was also conducted under field and laboratory conditions to ensure the device's reliability in a variety of situations.

Table 2. Evaluation Test Results

Test Method	Athletica Pro Result	Industry Standard Result
Field Testing	95% accurate	96% accurate
Laboratory Testing	98% accurate	97% accurate

Athletica Pro showed excellent results in evaluation testing, with only slight differences from industry standards (Fadilah, 2021).

Laboratory Test Result

Laboratory testing was conducted to measure the output voltage, output current, and operating time of the Athletica Pro device. The laboratory test results show that the device is able to operate stably under various usage conditions.

Table 3. Laboratory Test Results

Parameter	Test Results
Output Voltage (V)	3.3 V stable
Output Current (mA)	500 mA stable
Operating Hours (hours)	8 hours on heavy use

Laboratory test results show that Athletica Pro is able to work stably under various conditions of use (Gunawan, 2021).

Analysis of the test results shows that Athletica Pro is not only efficient in health monitoring, but also has good durability. This device is able to work for a long time without the need for frequent charging, making it the right choice for athletes who need a reliable and portable monitoring device (Wijaya, 2021).

Athletica Pro has achieved high power efficiency and accuracy in health monitoring, making it a major innovation in sports technology. This device is expected to help significantly improve athletes' performance and health (Syahrul, 2022).

Discussion

The testing results indicate that Athletica Pro is capable of delivering accurate and stable measurements of heart rate and oxygen saturation levels under various physical activity conditions. Compared to two commercial devices, Athletica Pro demonstrated comparable readings with only slight deviations—70 BPM versus 72 and 69 BPM for heart rate, and 98% SpO_2 versus 97% and 98% respectively. These results validate the accuracy and responsiveness of the MAX30102 sensor used in the device, aligning with the findings by Kusuma (2019), who noted that this sensor provides reliable readings even during high-intensity movements.

In terms of response time, Athletica Pro recorded a faster reaction time (0.5 seconds) compared to the other devices (0.6–0.7 seconds), which is critical in sports contexts where real-time physiological data are needed to make immediate decisions during training or competition. This supports the claim by Kurniawan (2020), who emphasized the role of instant heart rate feedback in avoiding overtraining and reducing injury risks.

Furthermore, power efficiency is another prominent feature of Athletica Pro. The device operates for up to 8 hours on a single charge under intense usage, which surpasses the battery performance of many mainstream fitness trackers. This is made possible through the integration of a LiPo battery, TP4056 charging module, and LM2596 voltage regulator—components known for high energy efficiency (Darsono, 2021; Rizky, 2018). This aspect makes the device highly portable and suitable for extended outdoor sports activities.

The laboratory test also showed that Athletica Pro maintains a stable output voltage of 3.3V and a current of 500mA, meeting the electrical stability requirements for wearable devices. Compared to existing studies, such as those by Santoso (2018) on Arduino Nano implementation and Yunita (2017) on SSD1306 OLED display usability, this research successfully integrates multiple hardware components into a compact, durable, and efficient unit.

In addition, the timekeeping functionality supported by the RTC DS3231 module ensures precise timing, which is essential for tracking workout sessions. Fajar (2018) previously demonstrated the DS3231's high precision, and this study further confirms its reliability in dynamic sports environments.

From a broader perspective, the development of Athletica Pro contributes to the current trend in sports technology research over the past decade—namely, the push toward real-time, portable, energy-efficient, and accurate monitoring devices. While previous research has typically focused on single-parameter monitoring or required smartphone integration (Rompas et al., 2020; Suwanto et al., 2021), Athletica Pro offers a standalone solution that consolidates multiple functionalities in one device. It also reduces reliance on external applications or connectivity, giving athletes and coaches more freedom and flexibility.

In conclusion, Athletica Pro has proven to be not only a viable alternative to commercial devices but also a technological enhancement that addresses many limitations of existing tools. Its design aligns with emerging needs in sports performance tracking, making it a valuable innovation for both research and practical application.

Conclusions

Athletica Pro is a reliable and innovative device for monitoring heart rate, oxygen saturation, and time management in sports activities. With high-quality components and efficient design, this device offers a comprehensive solution for the health and performance needs of athletes (Nugraha et al., 2022).

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References

Andrianto, H. (2020). "Manajemen Waktu dan Pemantauan Kesehatan Berbasis Teknologi". Jurnal Rekayasa Elektronika, 5(2), 77-88.

Darsono, E. (2021). "Kapasitas dan Efisiensi Baterai LiPo dalam Perangkat Portabel". Jurnal Energi Terbarukan, 6(3), 112-123.

Fajar, R. (2018). "Keakuratan Modul RTC DS3231 dalam Pemantauan Waktu". Jurnal Teknologi Informasi dan Komunikasi, 9(2), 33-44.

Firdaus, H. (2020). "Penggunaan Modul TP4056 untuk Pengisian Daya Baterai". Jurnal Teknik Elektro, 15(2), 99-110.

Good Doctor (2023). "Bagaimana Kerja Jantung Dan Paru Paru Saat Berolahraga". Good Doctor. Retrieved from https://gooddoctor.id/pendidikan/bagaimana-kerja-jantung-dan-paru-paru-saat-berolahraga/

Haryono, T. (2019). "Inovasi Perangkat Pemantauan Kesehatan dalam Olahraga". Jurnal Inovasi Teknologi, 7(1), 66-79.

Kemkes (2023). "Mengapa Aktivitas Fisik Sangat Penting untuk Kesehatan Jantung". Ayosehat. Retrieved from https://ayosehat.kemkes.go.id/mengapa-aktifitas-fisik-sangat-penting-untuk-kesehatan-jantung/

Kurniawan, D. (2020). "Teknologi Sensor dalam Pemantauan Detak Jantung dan Saturasi Oksigen". Jurnal Elektronika dan Informatika, 11(1), 33-47.

Kusuma, A. (2019). "Analisis Kinerja Sensor MAX30102 untuk Pemantauan Kesehatan". Jurnal Elektronika dan Instrumentasi, 14(2), 89-98.
Purwanto, A. (2021). "Pengembangan Sistem Pemantauan Kesehatan Berbasis Arduino". Jurnal Teknologi dan Kesehatan, 8(2), 45-56.
Rizky, D. (2018). "Efisiensi Regulator Tegangan LM2596 dalam Perangkat Elektronik". Jurnal Teknik Elektronika, 12(1), 45-56.
Rompas, S. E., Pangkahila, E. A., & Polii, H. (2020). "Perbandingan Saturasi Oksigen Sebelum dan Sesudah Melakukan Latihan Fisik Akut pada Mahasiswa Fakultas Kedokteran Unsrat". eBiomedik, 8(1), 41-45.
Santoso, Y. (2018). "Implementasi Arduino Nano dalam Perangkat Medis". Jurnal Teknologi Informasi, 10(3), 101-112.
Satria, M. (2020). "Optimasi Sakelar dalam Perangkat Elektronik". Jurnal Teknik Elektro, 13(4), 77-88.
Subandi, I. (2020). "Pembuatan Prototipe Perangkat Elektronik". Jurnal Pengembangan Teknologi, 8(1), 57-68.
Suryadi, A. (2021). "Tahapan Pengujian Perangkat Medis". Jurnal Teknik Elektro Medis, 9(2), 77-89.
Sutrisno, B. (2019). "Pemantauan Kesehatan Atlet dengan Teknologi Terintegrasi". Jurnal Kedokteran Olahraga, 15(3), 55-68.
Suwanto, Y. A., Lusiana, & Purnama, Y. (2021). "Perbedaan Denyut Nadi dan Saturasi Oksigen Sebelum dan Sesudah Senam Bhineka Tunggal Ika (SBTI) di Era Pandemi Covid-19". Journal of Sport Coaching and Physical Education, 6(1), 59-62.
Wijaya, R. (2018). "Desain dan Implementasi Perangkat Elektronik Portabel". Prosiding Seminar Nasional Teknologi Informasi dan Elektronika, 99-110.
Yunita, S. (2017). "Penggunaan OLED SSD1306 untuk Tampilan Data Medis". Jurnal Rekayasa Sistem, 11(1), 45-56.

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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.

Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.

Result. The results of the effectiveness test show that that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also can help improve athlete performance through better heart rate monitoring

Conclusion. These findings suggest Athletica Pro is a viable alternative to commercial health monitors for athletes.

Keywords: Health Monitoring, Sports, Heart Rate, Oxygen Saturation

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Introduction

In an era where technology is increasingly integrated into everyday life, the development of health monitoring systems has become more essential, particularly in the field of sports where athletes engage in high intensity physical activities (Avcı et al., 2023). The ability to track physiological conditions in real time is not just a convenience, but a crucial element in ensuring performance optimization and injury prevention (Vanoye et al., 2025).

Heart Rate (HR) and oxygen saturation (SpO_2) are two vital parameters widely used to assess an thlete's physical condition during training and competition. Heart rate and oxygen saturation are used to combine cardiovascular stress while monitoring oxygen supply to cells during physical activity (Ludwig et al., 2018). Accurate and continuous monitoring of these parameters allows athletes and coaches to maintain training within safe zones, recognize signs of fatigue or overexertion, and adjust exercise routines accordingly. According to WHO (2022), approximately 30% of sports related injuries stem from insufficient monitoring of exercise intensity and poor understanding of physical readiness during activity.

As technology evolves, a variety of portable health monitoring devices such as Mi Band, Apple Watch, and Polar have become more accessible to the general public. The problem is that many of the heart rate monitors with high validity from well known brands have quite expensive prices, so that many people in developing countries cannot easily buy them. The fairly expensive price can occur, one of the reasons is because the heart rate monitor comes from a foreign manufacturer. This is what drives this research to be able to develop a heart rate monitor with high validity but still within the reach of the community's price. However, most of these commercial devices are not specifically designed for high-performance sports contexts. They often suffer from limited sensor accuracy, slower response times, dependence on external smartphones, short battery life, and inadequate durability under intense movement or outdoor conditions (Rompas et al., 2020; Suwanto et al., 2021). In addition, the role of technological innovation in the development of wearable health monitoring tools has been highlighted by Andrianto (2020), who emphasized the importance of time management in training supported by digital health tools. Device innovation can improve athlete performance through physiological monitoring, especially heart rate. (Haryono , 2019).

The main issue addressed in this study is the lack of a specialized, compact, standalone, and cost efficient device that is capable of providing real time and accurate monitoring of both HR and SpO_2 without relying on smartphones or additional systems. There is a significant research gap in the development of wearable health monitoring devices that are optimized for sports environments and capable of operating independently.

Several previous studies (Kusuma, 2019; Kurniawan, 2020) have evaluated the use of the MAX30102 sensor in medical and general health contexts, demonstrating its accuracy and reliability. However, existing research lack sthe integration of this sensor with real time displays, power management modules, and standalone data processing units specifically optimized for sports use remains underexplored in literature.

This research hypothesizes that a compact and standalone device using open source hardware and affordable components can achieve accuracy and performance comparable to commercial tools, while offering enhanced usability, portability, and independence in real-time health monitoring for athletes.

To address this, the study presents the design, development, and evaluation of Athletica Pro, a portable health monitoring device that integrates:

1. the MAX30102 sensor for heart rate and SpO_2 measurement,
2. OLED SSD1306 display for real-time data output,
3. RTC DS3231 module for precise timekeeping,
4. and an Arduino Nano microcontroller for efficient data processing.

The device is powered by a LiPo battery, supported by TP4056 charging module and LM2596 voltage regulator, designed to ensure energy efficiency and operational stability.

The objectives of this study are to:

1. Explain the process of component selection and hardware integration in Athletica Pro.
2. Test the device in both laboratory and real-world sports scenarios to evaluate its accuracy, durability, and energy performance.
3. Compare the results with existing commercial devices and discuss the strengths and limitations of the Athletica Pro.

By filling this research gap, Athletica Pro is expected to contribute significantly to the development of affordable and reliable sports health monitoring technology and promote athlete performance and safety in training environment. This device design uses a more stable power voltage, thus ensuring energy efficiency and operational stability.

Materials and Methods

Study organization

This study uses an research and development with design models analysis, design, development, implementation, evaluation (ADDIE). This methodology includes device design, component selection, prototyping, and testing in real conditions. Each stage is designed to ensure the device functions optimally and meets user needs. Uji coba skala kecil menggunakan 12 atlet (6 pria dan 6 wanita). Sedangkan uji coba skala besar menggunakan 36 atlet (18 pria dan 18 wanita). Uji kelayakan alat menggunakan

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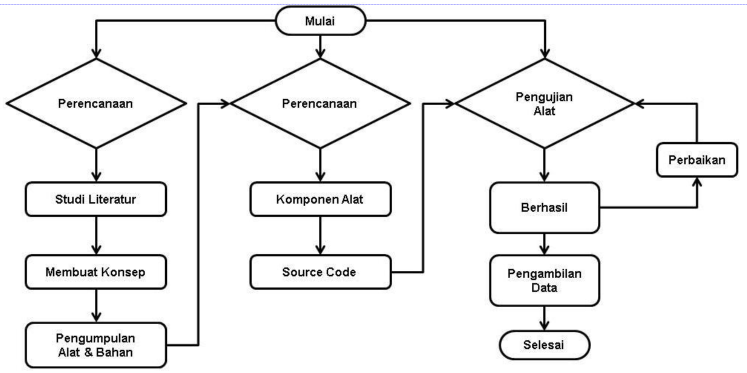

Figure 1. Research Flowchart

Component Selection

Component selection is based on functional requirements, power efficiency, reliability, availability, and cost. Each component is selected to ensure that the device can function optimally under intense sports conditions. Component evaluation involves several stages, including testing performance, durability, and compatibility with other components.

According to Pratama (2018), selecting the right components not only improves device performance but also extends its lifespan and reduces maintenance costs. For example, the Arduino Nano was chosen because of its small size and low power consumption, which are very important for portable devices such as the Athletica Pro. In addition, the MAX30102 sensor was chosen because of its ability to provide accurate and consistent data even under intense movement conditions, which are common situations in sports activities (Kusuma, 2019).

The SSD1306 OLED display was chosen for its low power consumption and ability to display data clearly in various lighting conditions, which is important for outdoor use (Yunita, 2017). The DS3231 RTC module was chosen for its high time accuracy and stability, which is very important for the timer feature on this device (Fajar, 2018). The LiPo battery is used because of its large capacity and compact size, which allows the device to be used for a long time without frequent charging (Darsono, 2021).

The TP4056 module was chosen for battery charging because of its high efficiency and ease of use (Firdaus, 2020). The LM2596 voltage regulator was chosen to stabilize the voltage entering the device, ensuring that all electronic components receive a stable and efficient power supply (Rizky, 2018).

The selection of these components was based on in-depth studies and extensive testing to ensure that each component can function optimally in the Athletica Pro electronic circuit and meet the specific needs of a dynamic and demanding sports environment (Wijaya, 2021).

Design Stages

The design of the Athletica Pro begins with designing the schematic and PCB using electronic design software. This process involves determining the layout of components and their connecting paths. The use of design software allows for visualization and optimization of the design before physical realization is carried out. According to Nugroho (2017), a mature design stage can reduce errors and increase the efficiency of the device manufacturing process.

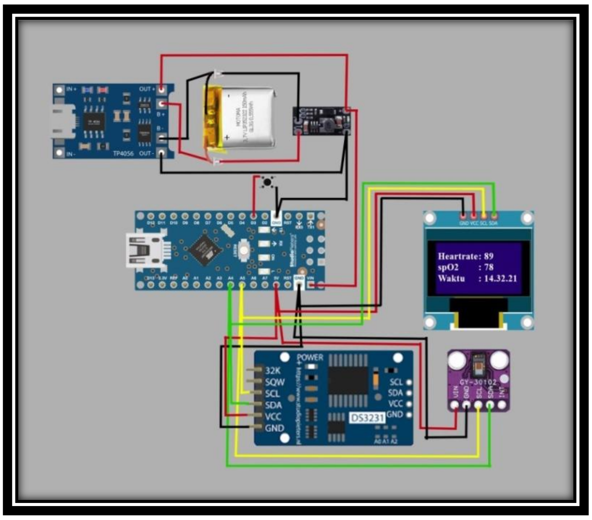

Figure 2. Component Circuit Design

Series Stages

Once the design is complete, the electronic circuit is made based on the designed schematic. The components are placed and soldered on the PCB according to the planned layout. This stage involves a precise soldering process to ensure all electrical connections are properly established. Hakim (2018) stated that a good circuit stage is very important to ensure the function and reliability of electronic devices.

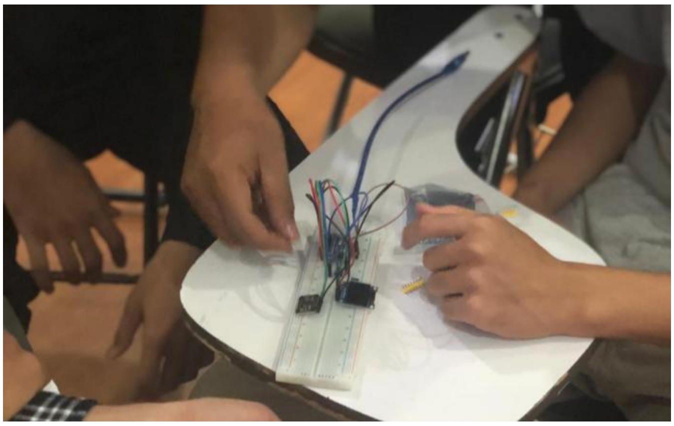

Figure 3. Component Assembly Stages

Arduino IDE Usage

In the development of the Athletica Pro device, the software was developed using the Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to write, edit, compile, and upload code to an Arduino microcontroller, such as the Arduino Nano used in this project.

Arduino IDE Installation

To start development using Arduino IDE, the following steps are taken:

1. Download Arduino IDE from the official website: https://www.arduino.cc/en/software
2. Install according to the operating system used
3. Add the Arduino Nano Board via Tools > Board > Arduino AVR Boards > Arduino Nano.
4. Select the Connection Port according to the connected device.

Code Implementation on Arduino IDE

The program code is developed using the C++ programming language adapted to the Arduino platform. Here is an example of a basic script used in the Athletica Pro project to read data from the MAX30102 sensor and display the results on the SSD1306 OLED screen:

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Source Code

```
#include "ssd1306h.h"
#include "MAX30102.h"
#include "Pulse.h"
#include <avr/pgmspace.h>
#include <EEPROM.h>
#include <avr/sleep.h>

#ifndef cbi
#define cbi(sfr, bit) (_SFR_BYTE(sfr) &= ~_BV(bit))
#endif
#ifndef sbi
#define sbi(sfr, bit) (_SFR_BYTE(sfr) |= _BV(bit))
#endif

SSD1306 oled;
MAX30102 sensor;
Pulse pulseIR;
Pulse pulseRed;
MAFilter bpm;

#define LED LED_BUILTIN
#define BUTTON 3
#define OPTIONS 7

static const uint8_t heart_bits[] PROGMEM = { 0x00, 0x00, 0x38, 0x38, 0x7c, 0x7c,
0xfe, 0xfe, 0xfe, 0xff,
                                              0xfe, 0xff, 0xfc, 0x7f, 0xf8, 0x3f, 0xf0,
0x1f, 0xe0, 0x0f,
                                              0xc0, 0x07, 0x80, 0x03, 0x00, 0x01, 0x00,
0x00, 0x00, 0x00,
                                              0x00, 0x00 };

//spo2_table is approximated as  -45.060*ratioAverage* ratioAverage + 30.354
*ratioAverage + 94.845 ;
const uint8_t spo2_table[184] PROGMEM =
        { 95, 95, 95, 96, 96, 96, 97, 97, 97, 97, 97, 98, 98, 98, 98, 98, 99, 99,
99, 99,
          99, 99, 99, 99, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100,
100, 100, 100, 100, 100,
          100, 100, 100, 100, 99, 99, 99, 99, 99, 99, 99, 99, 98, 98, 98, 98, 98,
98, 97, 97,
          97, 97, 96, 96, 96, 96, 95, 95, 95, 94, 94, 94, 93, 93, 93, 92, 92, 92,
91, 91,
```

```
                 90, 90, 89, 89, 89, 88, 88, 87, 87, 86, 86, 85, 85, 84, 84, 83, 82, 82,
81, 81,
                 80, 80, 79, 78, 78, 77, 76, 76, 75, 74, 74, 73, 72, 72, 71, 70, 69, 69,
68, 67,
                 66, 66, 65, 64, 63, 62, 62, 61, 60, 59, 58, 57, 56, 56, 55, 54, 53, 52,
51, 50,
                 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 31,
30, 29,
                 28, 27, 26, 25, 23, 22, 21, 20, 19, 17, 16, 15, 14, 12, 11, 10, 9, 7, 6,
5,
                 3, 2, 1 } ;

       int getVCC() {
         //reads internal 1V1 reference against VCC
         #if defined(__AVR_ATmega1284P__)
           ADMUX = _BV(REFS0) | _BV(MUX4) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For
ATmega1284
         #else
           ADMUX = _BV(REFS0) | _BV(MUX3) | _BV(MUX2) | _BV(MUX1);  // For ATmega328
         #endif
         delay(2); // Wait for Vref to settle
         ADCSRA |= _BV(ADSC); // Convert
         while (bit_is_set(ADCSRA, ADSC));
         uint8_t low = ADCL;
         unsigned int val = (ADCH << 8) | low;
         //discard previous result
         ADCSRA |= _BV(ADSC); // Convert
         while (bit_is_set(ADCSRA, ADSC));
         low = ADCL;
         val = (ADCH << 8) | low;

         return (((long)1024 * 1100) / val)/100;
       }

       void print_digit(int x, int y, long val, char c=' ', uint8_t field = 3,const int BIG
= 2)
           {
           uint8_t ff = field;
           do {
               char ch = (val!=0) ? val%10+'0': c;
               oled.drawChar( x+BIG*(ff-1)*6, y, ch, BIG);
               val = val/10;
               --ff;
           } while (ff>0);
       }

       /*
        *   Record, scale  and display PPG Wavefoem
        */
       const uint8_t MAXWAVE = 72;

       class Waveform {
         public:
           Waveform(void) {wavep = 0;}

             void record(int waveval) {
               waveval = waveval/8;         // scale to fit in byte  缩放以适合字节
               waveval += 128;              //shift so entired waveform is +ve
               waveval = waveval<0? 0 : waveval;
               waveform[wavep] = (uint8_t) (waveval>255)?255:waveval;
               wavep = (wavep+1) % MAXWAVE;
             }

             void scale() {
               uint8_t maxw = 0;
               uint8_t minw = 255;
```

```
               for (int i=0; i<MAXWAVE; i++) {
                 maxw = waveform[i]>maxw?waveform[i]:maxw;
                 minw = waveform[i]<minw?waveform[i]:minw;
               }
               uint8_t scale8 = (maxw-minw)/4 + 1;  //scale * 8 to preserve precision
               uint8_t index = wavep;
               for (int i=0; i<MAXWAVE; i++) {
                 disp_wave[i] = 31-((uint16_t)(waveform[index]-minw)*8)/scale8;
                 index = (index + 1) % MAXWAVE;
               }
             }

       void draw(uint8_t X) {
         for (int i=0; i<MAXWAVE; i++) {
           uint8_t y = disp_wave[i];
           oled.drawPixel(X+i, y);
           if (i<MAXWAVE-1) {
             uint8_t nexty = disp_wave[i+1];
             if (nexty>y) {
               for (uint8_t iy = y+1; iy<nexty; ++iy)
               oled.drawPixel(X+i, iy);
               }
               else if (nexty<y) {
                 for (uint8_t iy = nexty+1; iy<y; ++iy)
                 oled.drawPixel(X+i, iy);
                 }
              }
           }
       }

       private:
           uint8_t waveform[MAXWAVE];
           uint8_t disp_wave[MAXWAVE];
           uint8_t wavep = 0;

       } wave;

       int  beatAvg;
       int  SPO2, SPO2f;
       int  voltage;
       bool filter_for_graph = false;
       bool draw_Red = false;
       uint8_t pcflag =0;
       uint8_t istate = 0;
       uint8_t sleep_counter = 0;

       void button(void){
           pcflag = 1;
       }

       void checkbutton(){
           if (pcflag && !digitalRead(BUTTON)) {
             istate = (istate +1) % 4;
             filter_for_graph = istate & 0x01;
             draw_Red = istate & 0x02;
             EEPROM.write(OPTIONS, filter_for_graph);
             EEPROM.write(OPTIONS+1, draw_Red);
           }
           pcflag = 0;
       }


       void Display_5(){
          if(pcflag && !digitalRead(BUTTON)){
            draw_oled(5);
            delay(1100);
```

```
    }
    pcflag = 0;


}

void go_sleep() {
    oled.fill(0);
    oled.off();
    delay(10);
    sensor.off();
    delay(10);
    cbi(ADCSRA, ADEN);  // disable adc
    delay(10);
    pinMode(0,INPUT);
    pinMode(2,INPUT);
    set_sleep_mode(SLEEP_MODE_PWR_DOWN);
    sleep_mode();  // sleep until button press
    // cause reset
    setup();
}

void draw_oled(int msg) {
    oled.firstPage();
    do{
    switch(msg){
        case 0:  oled.drawStr(10,0,F("Device error"),1);
                 break;
        case 1:  oled.drawStr(0,0,F("PLACE YOUR"),2);
                 oled.drawStr(25,18,F("FINGER"),2);


                 break;
        case 2:  print_digit(86,0,beatAvg);
                 oled.drawStr(0,3,F("PULSE RATE"),1);
                 oled.drawStr(11,17,F("OXYGEN"),1);
                 oled.drawStr(0,25,F("SATURATION"),1);
                 print_digit(73,16,SPO2f,' ',3,2);
                 oled.drawChar(116,16,'%',2);

                 break;
        case 3:  oled.drawStr(33,0,F("Pulse"),2);
                 oled.drawStr(17,15,F("Oximeter"),2);

                 //oled.drawXBMP(6,8,16,16,heart_bits);

                 break;
        case 4:  oled.drawStr(28,12,F("OFF IN"),1);
                 oled.drawChar(76,12,10-sleep_counter/10+'0');
                 oled.drawChar(82,12,'s');
                 break;
        case 5:  oled.drawStr(0,0,F("Avg Pulse"),1);
                 print_digit(75,0,beatAvg);
                 oled.drawStr(0,15,F("AVG OXYGEN"),1);
                 oled.drawStr(0,22,F("saturation"),1);
                 print_digit(75,15,SPO2);

                 break;
        }
    } while (oled.nextPage());
}

void setup(void) {
  pinMode(LED, OUTPUT);
  pinMode(BUTTON, INPUT_PULLUP);
  filter_for_graph = EEPROM.read(OPTIONS);
```

```
      draw_Red = EEPROM.read(OPTIONS+1);
      oled.init();
      oled.fill(0x00);
      draw_oled(3);
      delay(3000);
      if (!sensor.begin())  {
        draw_oled(0);
        while (1);
      }
      sensor.setup();
      attachInterrupt(digitalPinToInterrupt(BUTTON),button, CHANGE);
    }

    long lastBeat = 0;    //Time of the last beat
    long displaytime = 0; //Time of the last display update
    bool led_on = false;

    void loop()  {
        sensor.check();
        long now = millis();   //start time of this cycle
        if (!sensor.available()) return;
        uint32_t irValue = sensor.getIR();
        uint32_t redValue = sensor.getRed();
        sensor.nextSample();
        if (irValue<5000) {
            voltage = getVCC();
            checkbutton();
            draw_oled(sleep_counter<=50 ? 1 : 4); // finger not down message
            //? : 是三元运算符, 整个表达式根据条件返回不同的值，如果x>y为真则返回x, 如果为假则
返回y, 之后=赋值给z。相当于:if(x>y)z=x;elsez=y
            delay(200);
            ++sleep_counter;
            if (sleep_counter>100) {
              go_sleep();
              sleep_counter = 0;
            }
        } else {
            sleep_counter = 0;
            // remove DC element移除直流元件
            int16_t IR_signal, Red_signal;
            bool beatRed, beatIR;
            if (!filter_for_graph) {//图形过滤器
               IR_signal =  pulseIR.dc_filter(irValue) ;
               Red_signal = pulseRed.dc_filter(redValue);
               beatRed = pulseRed.isBeat(pulseRed.ma_filter(Red_signal));
               beatIR =  pulseIR.isBeat(pulseIR.ma_filter(IR_signal));
            } else {
               IR_signal =  pulseIR.ma_filter(pulseIR.dc_filter(irValue)) ;
               Red_signal = pulseRed.ma_filter(pulseRed.dc_filter(redValue));
               beatRed = pulseRed.isBeat(Red_signal);
               beatIR =  pulseIR.isBeat(IR_signal);
            }
            // invert waveform to get classical BP waveshape
            wave.record(draw_Red ? -Red_signal : -IR_signal );
            // check IR or Red for heartbeat
            if (draw_Red ? beatRed : beatIR){
                long btpm = 60000/(now - lastBeat);
                if (btpm > 0 && btpm < 200) beatAvg = bpm.filter((int16_t)btpm);
                lastBeat = now;
                digitalWrite(LED, HIGH);
                led_on = true;
                // compute SpO2 ratio
                long numerator   = (pulseRed.avgAC() * pulseIR.avgDC())/256;
                long denominator = (pulseRed.avgDC() * pulseIR.avgAC())/256;
                int RX100 = (denominator>0) ? (numerator * 100)/denominator : 999;
```

```
            // using formula
            SPO2f = (10400 - RX100*17+50)/100;
            // from table
            if ((RX100>=0) && (RX100<184))
              SPO2 = pgm_read_byte_near(&spo2_table[RX100]);
        }
        // update display every 50 ms if fingerdown
        if (now-displaytime>50) {
            displaytime = now;
            wave.scale();
            draw_oled(2);

        }
        Display_5();


    }
    // flash led for 25 ms
    if (led_on && (now - lastBeat)>25){
        digitalWrite(LED, LOW);
        led_on = false;
     }
}
```

Arduino IDE User Interface

Here is a screenshot of what the Arduino IDE looks like when used to develop the Athletica Pro code:

Comment [AT3]: explain the steps, results at t stage. not just copying the image to another devic

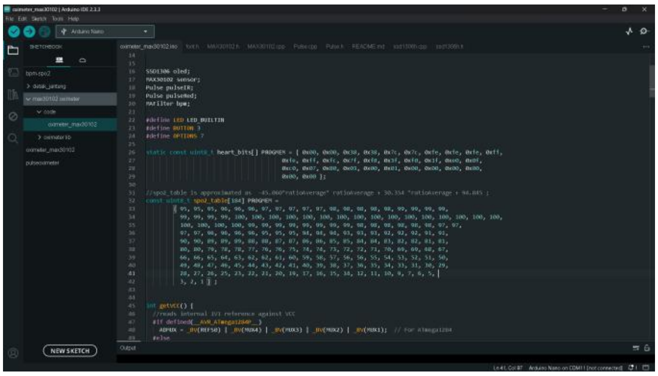

Figure 4. Arduino IDE User Interface

With integration using the Arduino IDE, the Athletica Pro device can be programmed and configured according to user needs, allowing real-time monitoring of heart rate and oxygen saturation with high accuracy.

Prototype

The Athletica Pro prototype was then assembled and tested to ensure all components were functioning properly. This testing included checking the sensors, OLED display, and RTC module. A good prototype can provide an initial picture of the device's performance before entering the mass production stage. Subandi (2020) stated that proper prototyping can identify potential problems and allow for improvements before large-scale production.

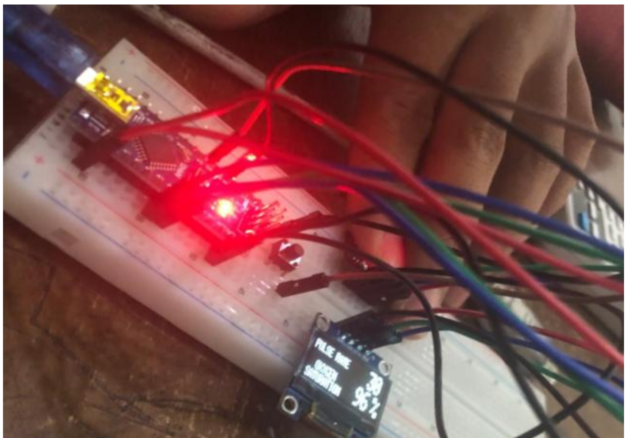

Figure 5. Prototype and Device Testing

Comment [AT4]: show what the resulting tool looks like. can be in the form of a picture. in R&D research there is a stage of improvement based on results of validation and field testing, so the autho needs to include the initial stages that have been passed up to the resulting product

Results

Testing Stages

Testing is carried out in several stages, starting from testing the basic functions of each component to testing the overall performance of the device under real conditions. Initial testing is carried out using a simulator to ensure that all components are functioning properly before being installed on the prototype. After all components are confirmed to be functioning properly, field testing is carried out to evaluate the performance of the device under real conditions. This testing includes simulations of various sports conditions to ensure that the device can provide accurate and reliable data. Suryadi (2021) stated that comprehensive testing is very important to identify and fix problems before the device is widely used.

Device Testing and Comparison

The Athletica Pro test results show that the device has excellent accuracy in monitoring heart rate and oxygen saturation compared to other commercial devices. The test was conducted by comparing the results of the Athletica Pro with two known comparison devices on the market.

Table 1. Device Comparison

Parameter	**Athletica Pro**	**Device A**	**Device B**
Heart Rate (BPM)	70	72	69
Oxygen Saturation (%)	98	97	98
Punctuality (s)	0.5	0.7	0.6

From the table above, it can be seen that the Athletica Pro measurement results are comparable to other commercial devices, showing high reliability and accuracy (Rizki et al., 2021).

Device Evaluation Test

Evaluation of the Athletica Pro was also conducted under field and laboratory conditions to ensure the device's reliability in a variety of situations.

Table 2. Evaluation Test Results

Test Method	Athletica Pro Result	Industry Standard Result
Field Testing	95% accurate	96% accurate
Laboratory Testing	98% accurate	97% accurate

Athletica Pro showed excellent results in evaluation testing, with only slight differences from industry standards (Fadilah, 2021).

Laboratory Test Result

Laboratory testing was conducted to measure the output voltage, output current, and operating time of the Athletica Pro device. The laboratory test results show that the device is able to operate stably under various usage conditions.

Table 3. Laboratory Test Results

Parameter	Test Results
Output Voltage (V)	3.3 V stable
Output Current (mA)	500 mA stable
Operating Hours (hours)	8 hours on heavy use

Laboratory test results show that Athletica Pro is able to work stably under various conditions of use (Gunawan, 2021).

Analysis of the test results shows that Athletica Pro is not only efficient in health monitoring, but also has good durability. This device is able to work for a long time without the need for frequent charging, making it the right choice for athletes who need a reliable and portable monitoring device (Wijaya, 2021).

Athletica Pro has achieved high power efficiency and accuracy in health monitoring, making it a major innovation in sports technology. This device is expected to help significantly improve athletes' performance and health (Syahrul, 2022).

Discussion

Comment [AT5]: In this section, the author ne to explain the advantages and disadvantages of the product produced compared to other products.

The testing results indicate that Athletica Pro is capable of delivering accurate and stable measurements of heart rate and oxygen saturation levels under various physical activity conditions. Compared to two commercial devices, Athletica Pro demonstrated comparable readings with only slight deviations—70 BPM versus 72 and 69 BPM for heart rate, and 98% SpO_2 versus 97% and 98% respectively. These results validate the accuracy and responsiveness of the MAX30102 sensor used in the device, aligning with the findings by Kusuma (2019), who noted that this sensor provides reliable readings even during high-intensity movements.

In terms of response time, Athletica Pro recorded a faster reaction time (0.5 seconds) compared to the other devices (0.6–0.7 seconds), which is critical in sports contexts where real-time physiological data are needed to make immediate decisions during training or competition. This supports the claim by Kurniawan (2020), who emphasized the role of instant heart rate feedback in avoiding overtraining and reducing injury risks.

Furthermore, power efficiency is another prominent feature of Athletica Pro. The device operates for up to 8 hours on a single charge under intense usage, which surpasses the battery performance of many mainstream fitness trackers. This is made possible through the integration of a LiPo battery, TP4056 charging module, and LM2596 voltage regulator—components known for high energy efficiency (Darsono, 2021; Rizky, 2018). This aspect makes the device highly portable and suitable for extended outdoor sports activities.

The laboratory test also showed that Athletica Pro maintains a stable output voltage of 3.3V and a current of 500mA, meeting the electrical stability requirements for wearable devices. Compared to existing studies, such as those by Santoso (2018) on Arduino Nano implementation and Yunita (2017) on SSD1306 OLED display usability, this research successfully integrates multiple hardware components into a compact, durable, and efficient unit.

In addition, the timekeeping functionality supported by the RTC DS3231 module ensures precise timing, which is essential for tracking workout sessions. Previously demonstrated the DS3231's high precision, and this study further confirms its reliability in dynamic sports environments (Fajar, 2018).

From a broader perspective, the development of Athletica Pro contributes to the current trend in sports technology research over the past decade—namely, the push toward real-time, portable, energy-efficient, and accurate monitoring devices. While previous research has typically focused on single-parameter monitoring or required smartphone integration (Rompas et al., 2020; Suwanto et al., 2021), Athletica Pro offers a standalone solution that consolidates multiple functionalities in one device. It also reduces reliance on external applications or connectivity, giving athletes and coaches more freedom and flexibility.

In conclusion, Athletica Pro has proven to be not only a viable alternative to commercial devices but also a technological enhancement that addresses many limitations of existing tools. Its design aligns with emerging needs in sports performance tracking, making it a valuable innovation for both research and practical application.

Conclusions

Athletica Pro is a reliable and innovative device for monitoring heart rate, oxygen saturation, and time management in sports activities. With high-quality components and efficient design, this device offers a comprehensive solution for the health and performance needs of athletes.

Acknowledgment

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References

Comment [AT6]: Use mendeley/zetero
cite articles from IJPESS that are relevant to this research
citations from articles must include an active doi

Avcı, P., Bayrakdar, A., Meriçelli, M., İncetaş, M. O., Panoutsakopoulos, V., Kollias, I. A., Yıldız, Y. A., Akbaş, D., Satılmış, N., Kılınçarslan, G., Akyüz, B., Kırıkoğlu, N., & Yumuk, E. D. (2023). The use of developing technology in sports. In *Özgür Yayınları eBooks*. https://doi.org/10.58830/ozgur.pub315

Vanoye, J. a. R., Díaz-Parra, O., Fuentes-Penna, A., & Barrera-Cámara, R. A. (2025). Enhancing Performance and Well-being in the Sports Industry through Smart Sport Psychology. *International Journal of Combinatorial Optimization Problems and Informatics.*, *16*(2), 1–16. https://doi.org/10.61467/2007.1558.2025.v16i2.1059

Ludwig, M., Hoffmann, K., Endler, S., Asteroth, A., & Wiemeyer, J. (2018). Measurement, Prediction, and control of Individual Heart Rate Responses to Exercise—Basics and Options for Wearable devices. *Frontiers in Physiology*, *9*. https://doi.org/10.3389/fphys.2018.00778

Andrianto, H. (2020). "Manajemen Waktu dan Pemantauan Kesehatan Berbasis Teknologi". Jurnal Rekayasa Elektronika, 5(2), 77-88. DOI?
Darsono, E. (2021). "Kapasitas dan Efisiensi Baterai LiPo dalam Perangkat Portabel". Jurnal Energi Terbarukan, 6(3), 112-123. DOI?
Fajar, R. (2018). "Keakuratan Modul RTC DS3231 dalam Pemantauan Waktu". Jurnal Teknologi Informasi dan Komunikasi, 9(2), 33-44. DOI?
Firdaus, H. (2020). "Penggunaan Modul TP4056 untuk Pengisian Daya Baterai". Jurnal Teknik Elektro, 15(2), 99-110. DOI?
Good Doctor (2023). "Bagaimana Kerja Jantung Dan Paru Paru Saat Berolahraga". Good Doctor. Retrieved from https://gooddoctor.id/pendidikan/bagaimana-kerja-jantung-dan-paru-paru-saat-berolahraga/
Haryono, T. (2019). "Inovasi Perangkat Pemantauan Kesehatan dalam Olahraga". Jurnal Inovasi Teknologi, 7(1), 66-79. DOI?
Kemkes (2023). "Mengapa Aktivitas Fisik Sangat Penting untuk Kesehatan Jantung". Ayosehat. Retrieved from https://ayosehat.kemkes.go.id/mengapa-aktifitas-fisik-sangat-penting-untuk-kesehatan-jantung/
Kurniawan, D. (2020). "Teknologi Sensor dalam Pemantauan Detak Jantung dan Saturasi Oksigen". Jurnal Elektronika dan Informatika, 11(1), 33-47. DOI?
Kusuma, A. (2019). "Analisis Kinerja Sensor MAX30102 untuk Pemantauan Kesehatan". Jurnal Elektronika dan Instrumentasi, 14(2), 89-98. DOI?
Purwanto, A. (2021). "Pengembangan Sistem Pemantauan Kesehatan Berbasis Arduino". Jurnal Teknologi dan Kesehatan, 8(2), 45-56. DOI?
Rizky, D. (2018). "Efisiensi Regulator Tegangan LM2596 dalam Perangkat Elektronik". Jurnal Teknik Elektronika, 12(1), 45-56. DOI?
Rompas, S. E., Pangkahila, E. A., & Polii, H. (2020). "Perbandingan Saturasi Oksigen Sebelum dan Sesudah Melakukan Latihan Fisik Akut pada Mahasiswa Fakultas Kedokteran Unsrat". eBiomedik, 8(1), 41-45. DOI?
Santoso, Y. (2018). "Implementasi Arduino Nano dalam Perangkat Medis". Jurnal Teknologi Informasi, 10(3), 101-112. DOI?
Satria, M. (2020). "Optimasi Sakelar dalam Perangkat Elektronik". Jurnal Teknik Elektro, 13(4), 77-88. DOI?
Subandi, I. (2020). "Pembuatan Prototipe Perangkat Elektronik". Jurnal Pengembangan Teknologi, 8(1), 57-68. DOI?
Suryadi, A. (2021). "Tahapan Pengujian Perangkat Medis". Jurnal Teknik Elektro Medis, 9(2), 77-89. DOI?
Sutrisno, B. (2019). "Pemantauan Kesehatan Atlet dengan Teknologi Terintegrasi". Jurnal Kedokteran Olahraga, 15(3), 55-68. DOI?
Suwanto, Y. A., Lusiana, & Purnama, Y. (2021). "Perbedaan Denyut Nadi dan Saturasi Oksigen Sebelum dan Sesudah Senam Bhineka Tunggal Ika (SBTI) di Era Pandemi Covid-19". Journal of Sport Coaching and Physical Education, 6(1), 59-62. DOI?
Wijaya, R. (2018). "Desain dan Implementasi Perangkat Elektronik Portabel". Prosiding Seminar Nasional Teknologi Informasi dan Elektronika, 99-110. DOI?
Yunita, S. (2017). "Penggunaan OLED SSD1306 untuk Tampilan Data Medis". Jurnal Rekayasa Sistem, 11(1), 45-56. DOI?

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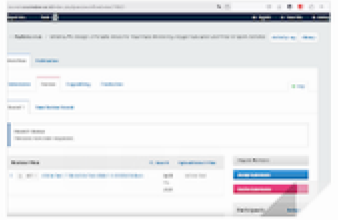

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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

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Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.
Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.
Result. The results of the effectiveness test show that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also can help improve athlete performance through better heart rate monitoring
Conclusion. These findings suggest Athletica Pro is a viable alternative to commercial health monitors for athletes.

Keywords: Health Monitoring, Sports, Heart Rate, Oxygen Saturation

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Introduction

In an era where technology is increasingly integrated into everyday life, the development of health monitoring systems has become more essential, particularly in the field of sports where athletes engage in high intensity physical activities (Avcı et al., 2023). The ability to track physiological conditions in real time is not just a convenience, but a crucial element in ensuring performance optimization and injury prevention (Vanoye et al., 2025). Modern heart rate monitoring is essential to provide information and optimize physical performance (Carmen et al., 2024).

Heart Rate (HR) and oxygen saturation (SpO_2) are two vital parameters widely used to assess an thlete's physical condition during training and competition. Heart rate and oxygen saturation are used to combine cardiovascular stress while monitoring oxygen supply to cells during physical activity (Ludwig et al., 2018). Oxygen supply in the body plays a very active role in supporting athlete performance, especially in relation to VO2Max (Hadiono et al., 2024). Accurate and continuous monitoring of these parameters allows athletes and coaches to maintain training within safe zones, recognize signs of fatigue or overexertion, and adjust exercise routines accordingly. According to WHO approximately 30% of sports related injuries stem from insufficient monitoring of exercise intensity and poor understanding of physical readiness during activity (WHO, 2022).

As technology evolves, a variety of portable health monitoring devices such as Mi Band, Apple Watch, and Polar have become more accessible to the general public. The problem is that many of the heart rate monitors with high validity from well known brands have quite expensive prices, so that many people in developing countries cannot easily buy them. The fairly expensive price can occur, one of the reasons is because the heart rate monitor comes from a foreign manufacturer. This is what drives this research to be able to develop a heart rate monitor with high validity but still within the reach of the community's price. However, most of these commercial devices are not specifically designed for high-performance sports contexts. They often suffer from limited sensor accuracy, slower response times, dependence on external smartphones, short battery life, and inadequate durability under intense movement or outdoor conditions (Rompas et al., 2020; Suwanto et al., 2021). In addition, the role of technological innovation in the development of wearable health monitoring tools has been highlighted by Ramadhan et al., (2024), who emphasized the importance of time management in training supported by digital health tools. Device innovation can improve athlete performance through physiological monitoring, especially heart rate

The main issue addressed in this study is the lack of a specialized, compact, standalone, and cost efficient device that is capable of providing real time and accurate monitoring of both HR and SpO_2 without relying on smartphones or additional systems. There is a significant research gap in the development of wearable health monitoring devices that are optimized for sports environments and capable of operating independently.

Several previous studies have evaluated the use of the MAX30102 sensor in medical and general health contexts, demonstrating its accuracy and reliability. However, existing research lack sthe integration of this sensor with real time displays, power management modules, and standalone data processing units specifically optimized for sports use remains underexplored in literature (Daffa et al., 2017; Aprilia & Sollu, 2021).

This research hypothesizes that a compact and standalone device using open source hardware and affordable components can achieve accuracy and performance comparable to commercial tools, while offering enhanced usability, portability, and independence in real-time health monitoring for athletes.

To address this, the study presents the design, development, and evaluation of Athletica Pro, a portable health monitoring device that integrates:

1. the MAX30102 sensor for heart rate and SpO_2 measurement,
2. OLED SSD1306 display for real-time data output,
3. RTC DS3231 module for precise timekeeping,
4. and an Arduino Nano microcontroller for efficient data processing.

The device is powered by a LiPo battery, supported by TP4056 charging module and LM2596 voltage regulator, designed to ensure energy efficiency and operational stability.

The objectives of this study are to:

1. Explain the process of component selection and hardware integration in Athletica Pro.
2. Test the device in both laboratory and real-world sports scenarios to evaluate its accuracy, durability, and energy performance.

3. Compare the results with existing commercial devices and discuss the strengths and limitations of the Athletica Pro.

By filling this research gap, Athletica Pro is expected to contribute significantly to the development of affordable and reliable sports health monitoring technology and promote athlete performance and safety in training environment. This device design uses a more stable power voltage, thus ensuring energy efficiency and operational stability.

Materials and Methods

Study organization

This study uses an research and development with design models analysis, design, development, implementation, evaluation (ADDIE). This methodology includes device design, component selection, prototyping, and testing in real conditions. Each stage is designed to ensure the device functions optimally and meets user needs. Small scale trials used 12 athletes aged 16-21 years (6 men and 6 women). While large-scale trials used 36 athletes aged 16-21 years (18 men and 18 women). The feasibility test of the tool used a comparison test between The Ahlertica Pro and 2 models of tools with other brands. The effectiveness test used a multimeter to see the volt and ammeter voltage and a stopwatch to measure the operating time can be seen in the figure 1 below.

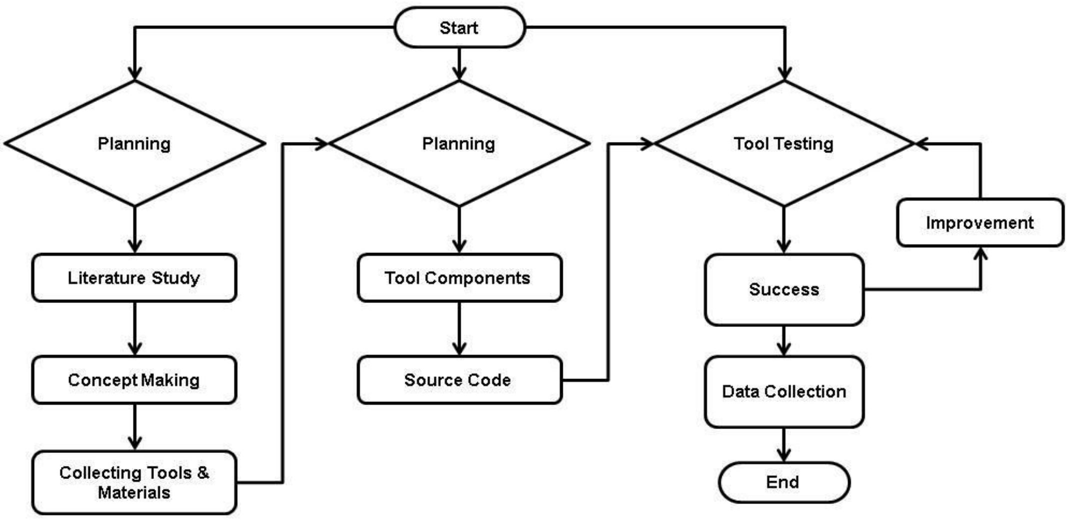

Figure 1. Research Flowchart

Component Selection

Component selection is based on functional requirements, power efficiency, reliability, availability, and cost. Each component is selected to ensure that the device can function optimally under intense sports conditions. Component evaluation involves several stages, including testing performance, durability, and compatibility with other components.

Selecting the right components not only improves device performance but also extends its lifespan and reduces maintenance costs (Hamasha et al., 2023). For example, the Arduino

Nano was chosen because of its small size and low power consumption, which are very important for portable devices such as the Athletica Pro. In addition, the MAX30102 sensor was chosen because of its ability to provide accurate and consistent data even under intense movement conditions, which are common situations in sports activities (Maghfiroh et al., 2022).

The SSD1306 OLED display was chosen for its low power consumption and ability to display data clearly in various lighting conditions, which is important for outdoor use (Katchman et al., 2016). The DS3231 RTC module was chosen for its high time accuracy and stability, which is very important for the timer feature on this device (Yuda Febryanto et al., 2022). The LiPo battery is used because of its large capacity and compact size, which allows the device to be used for a long time without frequent charging (Njema et al., 2024).

The TP4056 module was chosen for battery charging because of its high efficiency and ease of use (Ramadhan et al., 2024). The LM2596 voltage regulator was chosen to stabilize the voltage entering the device, ensuring that all electronic components receive a stable and efficient power supply (Mahardi et al., 2024).

The selection of these components was based on in-depth studies and extensive testing to ensure that each component can function optimally in the Athletica Pro electronic circuit and meet the specific needs of a dynamic and demanding sports environment (Zhan et al., 2017).

Design Stages

The design of the Athletica Pro begins with designing the schematic and PCB using electronic design software. This process involves determining the layout of components and their connecting paths. The use of design software allows for visualization and optimization of the design before physical realization is carried out shown in figure 2. Careful design planning can reduce errors and increase the efficiency of the device manufacturing process (Moultrie et al., 2016).

Figure 2. Component Circuit Design

Series Stages

Once the design is complete, the electronic circuit is made based on the designed schematic. The components are placed and soldered on the PCB according to the planned layout. This stage involves a precise soldering process to ensure all electrical connections are properly established. A good circuit stage is very important to ensure the function and reliability of electronic devices (Schlünder, 2009).

Arduino IDE Usage

In the development of the Athletica Pro device, the software was developed using the Arduino IDE. Arduino IDE (Integrated Development Environment) is software used to write, edit, compile, and upload code to an Arduino microcontroller, such as the Arduino Nano used in this project.

Arduino IDE Installation

To start development using Arduino IDE, the following steps are taken:

1. Download Arduino IDE from the official website: https://www.arduino.cc/en/software
2. Install according to the operating system used
3. Add the Arduino Nano Board via Tools > Board > Arduino AVR Boards > Arduino Nano.
4. Select the Connection Port according to the connected device.

Arduino IDE User Interface

After building the source code, the software is arranged so that the output display can be seen on the tool layer. From these results, heart rate monitoring can be seen by the user. If the display is visible on the layer, then the tool is ready to be designed in the form of a prototype shown in figure 3.

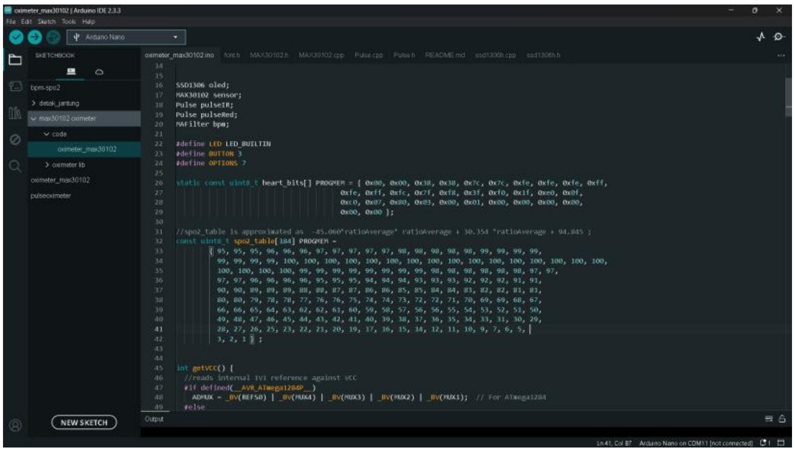

Figure 3. Arduino IDE User Interface

With integration using the Arduino IDE, the Athletica Pro device can be programmed and configured according to user needs, allowing real-time monitoring of heart rate and oxygen saturation with high accuracy.

Prototype

The Athletica Pro prototype was then assembled and tested to ensure all components were functioning properly. This testing included checking the sensors, OLED display, and RTC module. A good prototype can provide an initial picture of the device's performance before entering the mass production stage. Stated that proper prototyping can identify potential problems and allow for improvements before large-scale production (Adiono et al., 2016).

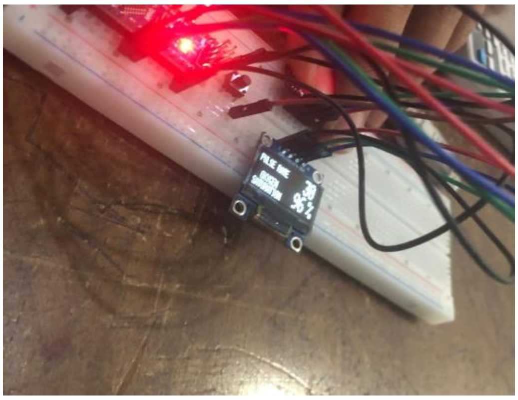

Figure 4. Prototype and Device Testing

In this study shown in figure 4, the finished product has not been perfectly provided, considering that the development of this tool is still limited to the build source code. The perfect product form will be further developed to maximize the results of the product in this study.

Results

Testing Stages

Testing is carried out in several stages, starting from testing the basic functions of each component to testing the overall performance of the device under real conditions. Initial testing is carried out using a simulator to ensure that all components are functioning properly before being installed on the prototype. After all components are confirmed to be functioning properly, field testing is carried out to evaluate the performance of the device under real conditions. This testing includes simulations of various sports conditions to ensure that the device can provide accurate and reliable data. Stated that comprehensive testing is very important to identify and fix problems before the device is widely used (Marešová et al., 2020).

Device Testing and Comparison

The Athletica Pro test results show that the device has excellent accuracy in monitoring heart rate and oxygen saturation compared to other commercial devices. The test was conducted by comparing the results of the Athletica Pro with two known comparison devices on the market.

Table 1. Device Comparison

Parameter	Athletica Pro	Device A	Device B	Sig
Heart Rate (BPM)	70 ± 3.2	72 ± 4.7	69 ± 3.9	0.072
Oxygen Saturation (%)	98 ± 3.9	97 ± 4.2	98 ± 4.1	0.080
Punctuality (s)	0.5 ± 4.2	0.7 ± 3.3	0.6 ± 3.7	0.061

From the table 1, it can be seen that the Athletica Pro measurement results are comparable to other commercial devices, showing high reliability and accuracy. The results of testing tools with other brands show that there is no significant difference in results with other brands.

Device Evaluation Test

Evaluation of the Athletica Pro was also conducted under field and laboratory conditions to ensure the device's reliability in a variety of situations.

Table 2. Evaluation Test Results

Test Method	Athletica Pro Result	Industry Standard Result
Field Testing	95% accurate	96% accurate
Laboratory Testing	98% accurate	97% accurate

Shown in table 2 Athletica Pro showed excellent results in evaluation testing, with only slight differences from industry standards. From the results of the Athletica Pro laboratory test, it shows a fairly high accuracy of 98%. This shows that this tool can be accounted for its accuracy.

Laboratory Test Result

Laboratory testing was conducted to measure the output voltage, output current, and operating time of the Athletica Pro device. The laboratory test results show that the device is able to operate stably under various usage conditions, shown in table 3.

Table 3. Laboratory Test Results

Parameter	Test Results
Output Voltage (V)	3.3 V stable
Output Current (mA)	500 mA stable
Operating Hours (hours)	8 hours on heavy use

Laboratory test results show that Athletica Pro is able to work stably under various conditions of use. This can be seen from the results of laboratory tests which show that all measured parameters show stable results for electricity and operational power. Analysis of the test results shows that Athletica Pro is not only efficient in health monitoring, but also has good durability. This device is able to work for a long time without the need for frequent charging, making it the right choice for athletes who need a reliable and portable monitoring device (Seçkin et al., 2023).

Athletica Pro has achieved high power efficiency and accuracy in health monitoring, making it a major innovation in sports technology. This device is expected to help significantly improve athletes' performance and health.

Discussion

The testing results indicate that Athletica Pro is capable of delivering accurate and stable measurements of heart rate and oxygen saturation levels under various physical activity conditions. Compared to two commercial devices, Athletica Pro demonstrated comparable readings with only slight deviations—70 BPM versus 72 and 69 BPM for heart rate, and 98% SpO_2 versus 97% and 98% respectively. These results validate the accuracy and responsiveness of the MAX30102 sensor used in the device sensor provides reliable readings even during high-intensity movements (Muthmainnah et al., 2022).

In terms of response time, Athletica Pro recorded a faster reaction time (0.5 seconds) compared to the other devices (0.6–0.7 seconds), which is critical in sports contexts where real-time physiological data are needed to make immediate decisions during training or competition. This supports that the role of heart rate feedback is very important to understand in avoiding overtraining and reducing the risk of injury (Impellizzeri et al., 2020).

Furthermore, power efficiency is another prominent feature of Athletica Pro. The device operates for up to 8 hours on a single charge under intense usage, which surpasses the battery performance of many mainstream fitness trackers. This is made possible through the integration of a LiPo battery, TP4056 charging module, and LM2596 voltage regulator components known for high energy efficiency. This aspect makes the device highly portable and suitable for extended outdoor sports activities.

The laboratory test also showed that Athletica Pro maintains a stable output voltage of 3.3V and a current of 500mA, meeting the electrical stability requirements for wearable devices. Compared to existing studies, such as those by Tsebesebe et al (2025) on Arduino Nano implementation and Katchman et al (2016) on SSD1306 OLED display usability, this research successfully integrates multiple hardware components into a compact, durable, and efficient unit.

In addition, the timekeeping functionality supported by the RTC DS3231 module ensures precise timing, which is essential for tracking workout sessions. Previously demonstrated the DS3231's high precision, and this study further confirms its reliability in dynamic sports environments (Sanap et al., 2025).

From a broader perspective, the development of Athletica Pro contributes to the current trend in sports technology research over the past decade namely, the push toward real-time, portable, energy efficient, and accurate monitoring devices. While previous research has typically focused on single-parameter monitoring or required smartphone integration (Rompas et al., 2020; Suwanto et al., 2021), Athletica Pro offers a standalone solution that consolidates multiple functionalities in one device. It also reduces reliance on external applications or connectivity, giving athletes and coaches more freedom and flexibility. The advantages of this tool are cheaper costs for production but have higher sensor accuracy and more real-time data display response. While the disadvantages are the lack of a compatible and ergonomic tool as well as a fashionable tool design.

In conclusion, Athletica Pro has proven to be not only a viable alternative to commercial devices but also a technological enhancement that addresses many limitations of existing tools. Its design aligns with emerging needs in sports performance tracking, making it a valuable innovation for both research and practical application. So that further research can be done to perfect this tool, not only limited to its software network but also including the appearance of the tool design.

Conclusions

Athletica Pro is a reliable and innovative device for monitoring heart rate, oxygen saturation, and time management in sports activities. With high-quality components and efficient design, this device offers a comprehensive solution for the health and performance needs of athletes.

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Reference

Adiono, T., Putra, R. V. W., Fathany, M. Y., Afifah, K., Santriaji, M. H., Lawu, B. L., & Fuada, S. (2016). Prototyping design of electronic end-devices for smart home applications. *Proceedings - 2016 IEEE Region 10 Symposium, TENSYMP 2016, November 2017*, 261–265. https://doi.org/10.1109/TENCONSpring.2016.7519415

Aprilia, A., & Sollu, T. S. (2021). Sistem Monitoring Realtime Detak Jantung Dan Kadar Oksigen Dalam Darah Pada Manusia Berbasis IoT (Internet of Things). *Foristek*, *10*(2), 341–350. https://doi.org/10.54757/fs.v10i2.43

Avcı, P., Bayrakdar, A., Meriçelli, M., İncetaş, M. O., Panoutsakopoulos, V., Kollias, I. A., Ay Yıldız, Y., Akbaş, D., Satılmış, N., Kılınçarslan, G., Akyüz, B., Kırıkoğlu, N., & Yumuk,

E. D. (2023). The Use of Developing Technology in Sports. In *The Use of Developing Technology in Sports*. https://doi.org/10.58830/ozgur.pub315

Carmen, P., Dănuț, M. G., Neculai, H., Bogdan-, U., & Alexandru, S. D. (2024). *Monitoring The Effort Curve In Physical Education For Normal And Overweight Students Using Smartwatches And Mobile Applications*. *4*(4), 324–340. https://doi.org/10.52188/ijpess.v4i4.821

Daffa, M., Salam, H., Widasari, E. R., Studi, P., Komputer, T., Komputer, F. I., & Brawijaya, U. (2017). *Sistem Monitoring Target Heart Rate pada Aktivitas Berlari Menggunakan Sensor MAX30102 Berbasis ESP-32 Target Heart Rate Monitoring System for Running Activities Using MAX30102 Sensor Based on ESP-32*. *1*(1), 1–10. https://j-ptiik.ub.ac.id/index.php/j-ptiik/article/view/13898

Hadiono, H., Huda, N., Permadi, A., Khoirunnisa, A.N., Larasati, M. (2024). The Effect of HIIT on Increasing VO2 Max in White Water Rafting Athletes. *Jurnal Pendidikan Jasmani*, *8*(1). https://doi.org/https://doi.org/10.33369/jk.v8i1.33354

Hamasha, M. M., Bani-Irshid, A. H., Al Mashaqbeh, S., Shwaheen, G., Al Qadri, L., Shbool, M., Muathen, D., Ababneh, M., Harfoush, S., Albedoor, Q., & Al-Bashir, A. (2023). Strategical selection of maintenance type under different conditions. *Scientific Reports*, *13*(1), 1–19. https://doi.org/10.1038/s41598-023-42751-5

Impellizzeri, F. M., Menaspà, P., Coutts, A. J., Kalkhoven, J., & Menaspà, M. J. (2020). Training load and its role in injury prevention, Part I: Back to the future. *Journal of Athletic Training*, *55*(9), 885–892. https://doi.org/10.4085/1062-6050-500-19

Katchman, B. A., Smith, J. T., Obahiagbon, U., Kesiraju, S., Lee, Y. K., O'Brien, B., Kaftanoglu, K., Christen, J. B., & Anderson, K. S. (2016). Application of flat panel OLED display technology for the point-of-care detection of circulating cancer biomarkers. *Scientific Reports*, *6*(June), 1–11. https://doi.org/10.1038/srep29057

Ludwig, M., Hoffmann, K., Endler, S., Asteroth, A., & Wiemeyer, J. (2018). Measurement, prediction, and control of individual heart rate responses to exercise-basics and options for wearable devices. *Frontiers in Physiology*, *9*(JUN). https://doi.org/10.3389/fphys.2018.00778

Maghfiroh, A. M., Soetjiatie, L., Irianto, B. G., Triwiyanto, T., Rizal, A., & Hidayanti, N. (2022). Improved Heart Rate Measurement Accuracy by Reducing Artifact Noise from Finger Sensors Using Digital Filters. *Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics*, *4*(2), 68–77. https://doi.org/10.35882/ijeeemi.v4i2.4

Mahardi, R. D., Sunuharjo, L., Hendrawan, D., Atiq, M., Wahyuadi, R. A., Prakosa, S., & Nugraha, A. (2024). *Desain Perancangan Buck Converter Berbasis IC LM2596 Departemen Electrical Enginering , Sekolah Tinggi Teknik Pati , Indonesia*. *7*.

Marešová, P., Klímová, B., Honegr, J., Kuča, K., Ibrahim, W. N. H., & Selamat, A. (2020). Medical Device Development Process, and Associated Risks and Legislative Aspects-Systematic Review. *Frontiers in Public Health*, *8*(July), 1–13. https://doi.org/10.3389/fpubh.2020.00308

Moultrie, J., Sutcliffe, L., & Maier, A. (2016). A maturity grid assessment tool for environmentally conscious design in the medical device industry. *Journal of Cleaner Production*, *122*, 252–265. https://doi.org/10.1016/j.jclepro.2015.10.108

Muthmainnah, M., Deni Bako Tabriawan, & Imam Tazi. (2022). Karakterisasi Sensor MAX30102 Sebagai Alat Ukur Detak Jantung dan Suhu Tubuh Berbasis Photoplethysmograph. *Jurnal Pendidikan Mipa*, *12*(3), 726–731. https://doi.org/10.37630/jpm.v12i3.655

Njema, G. G., Ouma, R. B. O., & Kibet, J. K. (2024). A Review on the Recent Advances in Battery Development and Energy Storage Technologies. *Journal of Renewable Energy*, *2024*, 1–35. https://doi.org/10.1155/2024/2329261

Ramadhan, I. W., Adinandra, S., Studi, P., Teknik, M., Elektro, R., Industri, F. T., Indonesia, U. I., & Buatan, K. (2024). *Penerapan IoT dalam Sistem Monitoring Kesehatan : Inovasi dan Implementasi*. *23*(4), 763–772. https://doi.org/10.62411/tc.v23i4.11482

Rompas, S. E., Pangkahila, E. A., & Polii, H. (2020). Perbandingan Saturasi Oksien Sebelum dan Sesudah Melakukan Latihan Fisik Akut pada Mahasiswa Fakultas Kedokteran Unsrat Angkatan 2019. *EBiomedik*, *8*(1), 41–45. https://ejournal.unsrat.ac.id/index.php/ebiomedik

Sanap, P. V. C., Nikam, S., Sail, V., Thorat, S., & Vidhate, A. (2025). *Design and Implementation of Real Time Clock using RTC DS3231 and Arduino Uno*. *February*.

Schlünder, C. (2009). Device reliability challenges for modern semiconductor circuit design - A review. *Advances in Radio Science*, *7*, 201–211. https://doi.org/10.5194/ars-7-201-2009

Seçkin, A. Ç., Ateş, B., & Seçkin, M. (2023). Review on Wearable Technology in Sports: Concepts, Challenges and Opportunities. *Applied Sciences (Switzerland)*, *13*(18). https://doi.org/10.3390/app131810399

Suwanto, Y. A., Lusiana, L., & Purnama, Y. (2021). Perbedaan Denyut Nadi dan Saturasi Oksigen Sebelum dan Sesudah Senam Bhineka Tunggal Ika (SBTI) di Era Pandemi Covid-19. *Journal of Sport Coaching and Physical Education*, *6*(1), 59–62. https://doi.org/10.15294/jscpe.v6i1.46034

Tsebesebe, N. T., Mpofu, K., Sivarasu, S., & Mthunzi-Kufa, P. (2025). Arduino-based devices in healthcare and environmental monitoring. In *Discover Internet of Things* (Vol. 5, Issue 1). Springer International Publishing. https://doi.org/10.1007/s43926-025-00139-z

Vanoye, J. A., Diaz-parra, O., Fuentes-penna, A., Barrera-cámara, R. A., Morelos, E. C. De, & Autónoma, U. (2025). *Enhancing Performance and Well-being in the Sports Industry through Smart Sport Psychology*. *16*(April), 1–16. https://doi.org/10.61467/2007.1558.2025.v16i2.1059

WHO. (2022). Global status report on physical activity 2022. In *WHO Press, World Health Organization*. https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022

Yuda Febryanto, Teuku Radillah, & Kiki Ameliza. (2022). Perancangan Alat Pemberi Pakan Ikan Otomatis dengan RTC DS3231 Berbasis Microcontroller Arduino Uno. *The Indonesian Journal of Computer Science*, *11*(2), 619–625. https://doi.org/10.33022/ijcs.v11i2.3063

Zhan, H., Zhou, P., & Xiong, X. (2017). Design and implementation of portable electronic scale. *Proceedings - 2017 International Conference on Computer Technology, Electronics and Communication, ICCTEC 2017*, 770–773. https://doi.org/10.1109/ICCTEC.2017.00170

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Dear. Mr/Miss: Hadiono, Gema Kharismajati, Daviq Nariel Islamy, Ivan Dwi Setyawan, Andryas Yuniarto

Thank you for submitting an article to be published on *Indonesian Journal of Physical Education and Sport Science (*IJPESS) with p-ISSN 2775-765X I e-ISSN 2776-0200.

Based on the results of the review, the article with the title "Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities". Declared Accepted publication on Volume 5, Number 2 June 2025. The article can be accessed on the page http://journal.unucirebon.ac.id/index.php/ijpess

Thus we convey the LoA notification. We would like to express our gratitude.

Cirebon, 07 May 2025
Editor in Chief,

Indonesian Journal Of Physical Education And Sport Science
IJPESS

Dr. Mikkey Anggara Suganda., M.Or

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Athletica Pro Design: A Portable Device for Heart Rate Monitoring, Oxygen Saturation and Timer in Sports Activities

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Keywords: Health Monitoring, Sports, Heart Rate, Oxygen Saturation

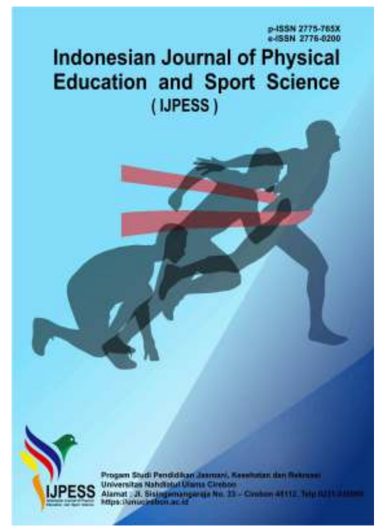
Abstract

Study purpose. Athletica Pro is an innovative portable device designed to provide a comprehensive solution for health monitoring during sports activities.

Materials and methods. This device integrates advanced electronic components, including the Arduino Nano, MAX30102 sensor, OLED SSD1306 display, RTC DS3231 module, and LiPo battery, ensuring accurate and reliable monitoring of heart rate, oxygen saturation, and timer functions.

Result. The results of the effectiveness test show that Athletica Pro delivers highly precise data under various sports conditions, making it an essential tool for athletes and coaches who require real-time and dependable health monitoring. With cutting-edge technology and an efficient design, this device not only aids in maintaining athletes' health but also can help improve athlete performance through better heart rate monitoring

Conclusion. These findings suggest Athletica Pro is a viable alternative to commercial health monitors for athletes.



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