Design Brief: Wearable Device for Badminton Motion Detection

1. Project Background and Objectives

The aim of this project is to design a wearable device focused on badminton motion detection. Utilizing sensors and machine learning technologies, the device will detect and analyze motion data in real-time, providing users with personalized exercise recommendations.

2. Hardware Design

2.1 Core Microcontroller

Arduino Nano 33 BLE Sense

- Integrated 9-axis IMU sensor (accelerometer, gyroscope, magnetometer).
- Built-in Bluetooth Low Energy (BLE) module for wireless data transmission.
- User-friendly and suitable for beginners.

2.2 Heart Rate and SpO_2 Sensor

MAX30102 Sensor

- Provides heart rate and blood oxygen level measurements.
- Compact design suitable for wearable devices.
- Affordable, priced around £10 - £15.

2.3 Power Supply

- **Lithium Polymer (LiPo) Battery**
  - Specifications: 3.7V, 400mAh - 1000mAh.
  - Adequate capacity to ensure device endurance.
- **Battery Charging Module**
  - Micro USB LiPo charging module.

2.4 Enclosure and Wearing Method

- **Wristband or Velcro**
  - Convenient for securing the device on the wrist or racket handle.
- **Enclosure Material**
  - Use 3D-printed casing or small plastic project boxes to protect internal components.

3. Software Design

3.1 Microcontroller Programming

- Use Arduino IDE to write code for reading sensor data.
- Implement data preprocessing and filtering to reduce noise and improve data quality.
- Use BLE communication to transmit processed data wirelessly.

3.2 Data Processing and Machine Learning

- Use Python environment and libraries like scikit-learn for data analysis.
- Perform feature extraction and model training.

4. Project Implementation Steps

1. **Hardware Assembly**
   - Connect the microcontroller, sensors, and power modules.
   - Install the enclosure and wearing device to ensure stability and comfort.
2. **Software Development**
   - Write microcontroller code to read, process, and transmit sensor data via BLE.
   - Write Python programs on the computer to receive and process data.
3. **Data Collection and Model Training**
   - Collect extensive motion data to enrich the dataset.
   - Perform data preprocessing, feature extraction, and model training.
4. **System Integration and Testing**
   - Integrate hardware and software to build a complete system.
   - Conduct functional testing and performance evaluation to ensure system stability and reliability.

5. Budget and Cost Control

5.1 Hardware Cost

Item	**Price (£)**
Arduino Nano 33 BLE Sense	£30
MAX30102 Sensor	£10 - £15
LiPo Battery	£5 - £10
LiPo Charging Module	£5
Wristband/Velcro	£2 - £5
Enclosure Material	£5 - £10
Connecting Wires and Connectors	£5
Total	**£85 - £110**

Table 1: Estimated Hardware Costs

5.2 Cost Optimization Measures

- Use highly integrated hardware to reduce the number of components and complexity.
- Leverage open-source resources to reduce software development costs.
- Simplify functions, focus on core objectives, and reduce development difficulty.

6. Project Features and Advantages

- **Cost-Effective**: Complete the design within budget, suitable for student projects.
- **Comprehensive Functionality**: Integrate motion detection and physiological monitoring to provide comprehensive exercise analysis.
- **Ease of Implementation**: Simple hardware connections and software based on rich open-source libraries reduce development difficulty.
- **High Scalability**: Additional sensors or functions can be added in the future to enhance the device's capabilities.

7. Conclusion

By rational hardware selection and software design, this project successfully designed a wearable device focused on badminton. The device can detect motion status in real-time, monitor physiological indicators, and provide users with personalized exercise recommendations using machine learning models. The entire project fully considers cost control and implementation difficulty, making it suitable for undergraduates to complete and having practical application value and expansion potential.

Wish you great success with your project!