Project Smart Punch Bag

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1. Description

A "Smart Punch Bag" is a modernized version of a traditional punching bag that incorporates technology to provide additional features and benefits for users. It is typically equipped with sensors, accelerometers, a display screen and connectivity to interact with apps or devices.

Some features and benefits of a Smart Punch Bag may include:

1. Tracking and monitoring: The sensors in the punch bag can track and measure the force, speed, and accuracy of punches and kicks. This data can be displayed in real-time on a screen and transmitted to a smartphone app for detailed analysis and feedback.

2. Interactive workouts: Smart Punch Bags can be programmed with pre-set workout routines or connected to apps that offer guided workouts and training sessions. Users can follow along with instructions and challenges, making their workout more engaging and motivating.

3. Gamification: Smart Punch Bags may incorporate gamified elements, such as scoring systems, challenges, and leaderboards, to make training more enjoyable and competitive. Users can compete with friends or other users online, adding a social aspect to their workouts.

4. Personalized feedback and coaching: The data collected from the sensors can be used to provide personalized feedback and coaching to users. By analyzing their performance, the Smart Punch Bag can suggest improvements, correct form, and help users track their progress over time.

5. Connectivity options: Smart Punch Bags may offer connectivity options, such as Bluetooth or Wi-Fi, to sync with other devices or fitness apps. This allows users to store their workout data, share it with others, or integrate it with their overall fitness goals and routines.

Overall, a Smart Punch Bag combines the benefits of a traditional punching bag with modern technology to enhance the workout experience, provide valuable feedback, and help users achieve their fitness goals more effectively. It is a great tool for individuals looking to improve their boxing skills, cardio fitness, or overall strength and conditioning.

2. Previous Developments and Documents

1. github.com/ziatokhi/BoxingTire
2. ESP32/Acel + Web Browser app: github.com/Matt-Stedman/sensai-smart-bag-poc1
3. BBC Micro + Android app: github.com/Matt-Stedman/sensai-smart-bag-poc2

3. Use Cases

3.1. Case 1: One User Alone

Primary Actor: Individual User.

System Components:

Preconditions:

- The Electronic Punch Bag is powered on and calibrated correctly.
- The individual user is positioned correctly in front of the Electronic Punch Bag.

Steps:

1. The individual user selects the desired training mode on the Electronic Punch Bag.
2. The system initiates a countdown for the start of the training session.
3. The individual user begins to execute punches on the Electronic Punch Bag.
4. The system registers and displays in real-time the strength and accuracy of the punches executed by the individual user.
5. Upon completion of the training session, the system presents a summary of the user's performance results.

Postconditions:

- The Electronic Punch Bag stores the data of the training session conducted by the individual user for future reference.
- The user can choose to save or discard the training session results.

3.2. Case 2: Local Competition

Primary Actor: Participants in Local Competition (minimum 2 participants).

System Components:

Preconditions:

- The Electronic Punch Bag is operational and calibrated accurately.

- The participants are positioned correctly in front of the Electronic Punch Bag.
- Each participant is assigned a unique identifier for result tracking.

Steps:

1. The participants select the competition mode on the Electronic Punch Bag.
2. The system initiates a countdown for the beginning of the competition.
3. Participants compete against each other by executing punches on the Electronic Punch Bag.
4. The system records and displays in real-time the scores of each participant, considering the strength and accuracy of their punches.
5. Upon completion of the competition, the system presents a ranking of the participants and declares the winner of the competition.

Postconditions:

- The Electronic Punch Bag stores the competition results, including individual scores and final rankings.
- Participants have the option to review their performances and compare them with other competitors.

3.3. Case 3: Online Competition

Primary Actor: Participants in Online Competition (minimum 2 participants).

System Components:

Preconditions:

- The Electronic Punch Bag is connected to an online platform and calibrated accurately.
- Participants have access to the online platform and are logged into their respective accounts.
- Each participant has a stable internet connection and a compatible device to interact with the online platform.

Steps:

1. Participants log into the online platform and navigate to the Electronic Punch Bag competition section.
2. Participants select the online competition mode and join the competition.
3. The system matches participants with opponents based on designated criteria such as skill level or geographical location.

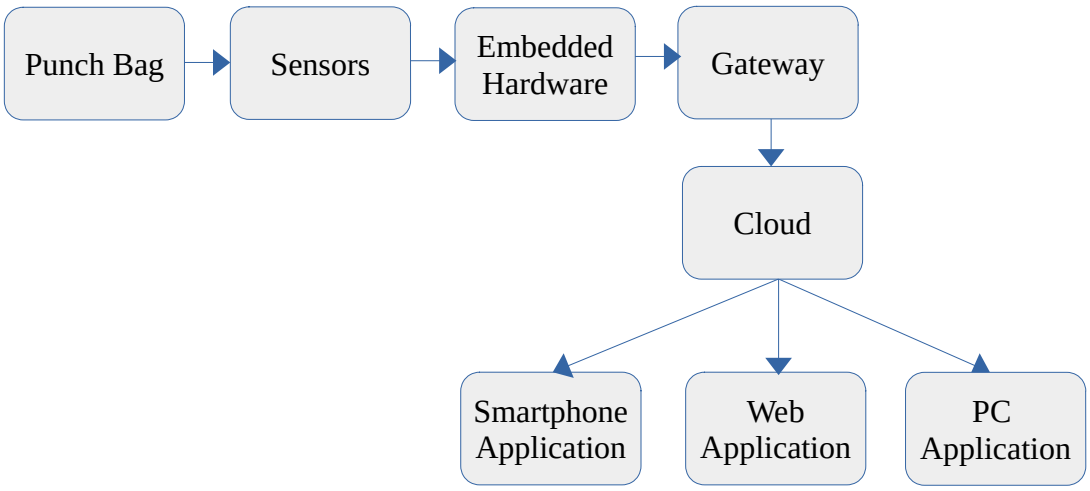
4. Participants compete by executing punches on the Electronic Punch Bag while the system records and evaluates their performance in real-time.
5. The online platform displays the live scores of participants and updates the leaderboard throughout the competition.
6. Upon completion of the competition, the system announces the winner and displays the final rankings on the online platform.

Postconditions:

- The Electronic Punch Bag stores the competition results and updates the online leaderboard accordingly.
- Participants can review their individual performance metrics and compare them to other competitors.
- Participants may receive virtual badges or rewards on the online platform based on their performance in the competition.

4. System Base Archtecture

4.1. Overview



A comprehensive system overview of a "Smart Punch Bag" designed for individuals, physical groups, and online groups would involve the integration of various components to provide a connected and interactive fitness experience. Here is how the punch bag, sensors, hardware, gateway, cloud storage, smartphone application, website application, and PC application can interact within the system for different user scenarios:

1.Punch Bag: The physical punch bag serves as the core component for users to perform boxing and kickboxing workouts. It is equipped with sensors to capture data on force, speed, and accuracy of movements during training sessions.

2.Sensors: The sensors embedded within the punch bag monitor and collect performance metrics from users' punches and kicks. These sensors track variables such as impact force, velocity, and technique accuracy, providing real-time feedback on the user's workout intensity and technique. These sensors may include accelerometers, gyroscopes, and pressure sensors to track movements accurately.

3.Hardware: The hardware components within the Smart Punch Bag process the data collected by the sensors and facilitate communication with the gateway for data transmission and analysis. They ensure the proper functioning and connectivity of the system.

4.Gateway: The gateway device acts as a central hub that aggregates and transfers the workout data from the hardware components to external systems such as cloud storage and applications. It manages the communication flow between the Smart Punch Bag and the connected devices and platforms.

5.Cloud (Data Storage): The cloud storage infrastructure securely stores and processes the workout data collected by the Smart Punch Bag system. It allows for centralized data storage, analysis, and sharing among users, physical groups, and online groups.

6.Smartphone Application: The smartphone application provides a user-friendly interface for individuals and online groups to access their workout data, track progress, set goals, and receive personalized feedback. It connects to the cloud storage to retrieve real-time performance metrics and training insights.

7.Website Application: The website application offers an online platform for users to access their workout data, engage in group fitness challenges, and interact with a broader fitness community. It provides features for workout planning, social sharing, and virtual group training sessions.

8.PC Application: The PC application is used mainly for a competitors panel as an advanced interface to analyze performance metrics, visualize workout data, and customize training routines.

For individuals, the Smart Punch Bag system provides personalized training feedback and goal tracking through the smartphone and website applications. Online groups can participate in virtual training sessions, collaborate with trainers, and share their progress within a supportive community environment. The physical group, such as competition, training or playground, uses the PC application as a panel to analyze the performances with the audience.

By integrating these components, the Smart Punch Bag system offers a versatile and engaging fitness solution that caters to the varying needs and preferences of individuals, physical groups, and online groups, enhancing their workout experience and supporting their fitness goals.

4.1.1. Punch Bag

A home made constructed with tires or a commercial punch bag.

4.1.2. Sensors

Motion sensors and accelerometers used to accurately capture the force, speed, and technique of punches and kicks.

4.1.3. Hardware

An embedded board as “BBC Microbid” with proper connections to gateway.

4.1.4. Gateway

The gateway can be a piece of hardware put directly with hardware for a stand alone punch bag or a independent device when used in a group of smart punch bags.

4.1.5. Cloud

Amazon Web Services (AWS) cloud storage services for reliable, secure and scalable solution for storing and analyzing workout data in the cloud.

4.1.6. Smartphone Application

For the smartphone application will be used Flutter platform for Android and iOS devices that can be used to develop user-friendly interfaces and interactive features for tracking workouts and receiving feedback.

4.1.7. Website Application

Web development frameworks like React.js, Angular, or Vue.js, along with backend technologies like Node.js, Python (Django or Flask), or Ruby on Rails, can be employed to create a responsive and dynamic website application for users to access their workout data online.

4.1.8. PC Application

The PC application will be made by Free Pascal language to compile in Linux and Windows.

5. Punch Bag

5.1. Homemade with tires

5.1.1. Manual

5.1.2. Explaining Videos

https://www.youtube.com/watch?v=A9nFaBPalgY

5. Devices

5.1. Smart Punch Bag

5.1.1. BBC Micro:Bit Board

Website: https://microbit.org/

5.1.2. ESP32-S3-LCD-1.28 development board 1.28inch Round LCD Display Screen / Accelerometer / Gyroscope Sensors

User Guide : https://spotpear.com/index/study/detail/id/1168.html

5.2. Panel

5.2.1. Raspberry Pi Zero W Board

Website: https://www.raspberrypi.com/products/raspberry-pi-zero-w/

6. Softwares

5.1. Arduino for Hardware

5.1.1. ESP32-S3-LCD-1.28

Instalation guide: https://spotpear.com/index/study/detail/id/1168.html

5.2. Flutter for Android and iOS

6. Protocols