Embedded Systems Project Proposal

PUSH-UP EXERCISE COUNTER

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RATIONALE

Push-ups are a physical exercise performed in a prone position by raising and lowering the body using the arms. It is a basic exercise commonly seen in military physical trainings and punishments.

Push-up counters are made in order to accurately record the number of push-ups done by a person and to help a person monitor the progress of his training. Existing push-up counters use infrared technology or compression-based technology to count the number of push-ups done by the user. However, there are some flaws that exist in current push-up counting devices.

Firstly, existing pushup counters lack the ability to measure the posture of the user during pushups. This means that the users may be doing the pushup in the wrong posture, causing harm to the lower back.

Secondly, existing pushup counters are not lightweight or portable, except for mobile applications. This would mean extra effort would be required to set up the existing pushup counters.

ENGINEERING GOALS

Firstly, this project aims to build a pushup counter that can measure the posture of the user when they are doing pushups. This can be done using sensors on the body the track the movement of their back.

Secondly, the pushup counter must be wearable. This suggests that the components of the pushup counter must be lightweight, and small to reduce obstruction to the user. The design of the counter aims to be similar to the design of a safety harness.

Lastly, the pushup counter should be cheaply produced. To ensure the feasibility of mass production, the pushup counter must be made from as little components as possible, to reduce costs.

TARGET AUDIENCE

The pushup counter is intended for physical assessments, such as the Individual Physical Proficiency Test (IPPT). As such, the military would find a use for such technology. Fitness enthusiasts would also find a want for such a product.

LITERATURE REVIEW

Existing pushup counters employ various methods to counter pushups, such as using pressure plates, infrared technology or another person. Flaws arise when such methods are employed.

IPPT/Fist method

This method of counting push-ups requires the tester (person recording the push-ups) to place his fist on the ground below of the center of the participant's (person doing the push-ups) chest when doing push-ups. The participant's chest must touch the tester's fist for a push-up to be considered valid. [1]

As the sizes of a fist varies with testers, inaccuracies in results may arise as the distance the participant has to lower his chest changes.

Furthermore, this method requires 2 people (participant & tester). If a person does push-ups alone and counts his push-ups, his results might not be accurate as he may not have done valid push-ups throughout.

Compression-referenced push-up counter devices

Typically, such a device is placed on the ground parallel below the user's chest. The device will record a push-up count whenever the person's chest compresses the pressure plate of the device. [2]

One shortcoming of this device is that it is not able to validate the posture of the person who is doing the push-ups. Push-ups with unacceptable postures can be counted. For example, a person's back may not be straight when doing push-ups, which makes it easier for the person to do push-ups.

Push-up counter mobile applications

Push-up counters also come in the form of mobile applications. The mobile applications make use of the infrared proximity sensors on the phone to record push-ups. By constantly sensing the light levels of its surrounding, it counts a pushup whenever the user's chest is near the phone. [3]

When placed in different light conditions, its ability to accurately record push-ups is limited as the surrounding light intensity fluctuates and the infrared proximity sensor is unable to pick up push-ups.

METHODOLOGY

Using Arduino and several other components, this project would create a pushup counter that can measure the distance between the user's chest and the ground and the posture of their lower back. Using this information, Arduino can then gauge whether a user has done a pushup and respond to the user, with light and sound signals. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino can be programmed to perform tasks through writing codes using the Arduino Integrated Design Environment.

PROCEDURES

The distance between the user's chest and the ground would be recorded using an ultrasonic sensor. The ultrasonic sensor measures the time it takes for the ultrasound to bounce off the nearest object. We can find the distance between the ultrasonic sensor and the ground using the formula.

$$\text{Distance} = \frac{\text{Speed of sound} \times \text{Time duration between the emitted pulse and reflected pulse}}{2}$$

The posture of the user would be recorded using a flex sensor. The flex sensor is a variable resistor which increases in resistance the more it is bent. By placing the flex sensor on the lower back of the user, we can measure how much the back arcs during a push up.

DATA ANALYSIS

The data obtained from the ultrasonic sensor during the prone position would be used to determine how low the user must go before being in the prone position. This information would be inputted into the Arduino program.

The data obtained from the flex sensor would be used to determine the range of how much the back can arc during a push up. This information would be inputted into the Arduino Program.

RISK AND SAFETY

Doing push ups is a physically strenuous activity, as such, there is a risk of injuring oneself when doing such an activity. To reduce the chances of injuries happening during push ups, participants would stretch before commencing their push ups. Participants would also do push ups in sets of 8-12 to prevent over exertion. [4]

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