

Muscle Strength Endurance Testing Development Based Photo Transistor with Motion Sensor Ultrasonic

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Abstract. The endurance of upper-body muscles is one of the most important physical fitness components. As technology develops, the process of test and assessment is now getting digital; for instance, there are a sensor stuck to the shoe (Foot Pod, Polar, and Sunto), Global Positioning System (GPS) and Differential Global Positioning System (DGPS), radar, photo finish, kinematic analysis, and photocells. Those devices aim to analyze the performances and fitness of athletes particularly the endurance of arm, chest, and shoulder muscles. In relation to that, this study attempt to create a software and a hardware for pull-ups through phototransistor with ultrasonic motion sensor. Components needed to develop this device consist of microcontroller MCS-51, photo transistor, light emitting diode, buzzer, ultrasonic sensor, and infrared sensor. The infrared sensor is put under the buffer while the ultrasonic sensor is stuck on the upper pole. The components are integrated with an LED or a laptop made using Visual Basic 12 software. The results show that pull-ups test using digital device (mean; 9.4 rep) is lower than using manual calculation (mean; 11.3 rep). This is due to the fact that digital test requires the test-takers to do pull-ups perfectly.

1. Introduction

In this modern era, the advancement of technology is one of the undeniable factors. Sport, like the other fields, has no exception. In Indonesia, the development of an instrument or a device testing endurance of upper-body muscle (pull-ups) is relatively limited. Therefore, this study tries to cope with it by involving many technological aspects such as infra-red, phototransistor, and ultrasonic with affordable price and an integration with an LED display as well as laptop. Another component supporting this instrument is a software installed on a laptop or a PC using Visual Basic 12 software. This application functions to perform the results of upper-body muscle endurance strength test sent from every sensor showing the number of movements automatically. Muscular strength is defined as the maximal contractive power of muscles [3,5,6,7]. Pull-ups test, on the other hand, is one of the instruments to measure it (the endurance strength of upper-body muscles) [4]. Making function of this application is to display the results of strength tests muscle endurance upper body sent from each sensor by displaying the number of movements that are automatically calculated. In essence, muscular



strength is defined as the maximal contractive power of muscles. Strength is divided into three types, namely maximum strength, speed strength, and endurance strength. According to [1,2,6,11] describes the test measures the pull ups as follows:

- Ask the client to grasp the bar with an overhand grip.
- Have the client take the beginning position, hanging with the arms straight.
- Ask the client to pull the body superior enough that the chin is over the top of the bar
- Have the client return to the fully extended hanging position with each repetition.
- Instruct the client to minimize movements, including swinging of the body.
- If necessary, you can hold your extended arms on front of the client's thighs to prevent excessive swinging.

Mistakes are often made when the motion pull ups [4,8,9,10]; the chin bar is not to exceed, when returning to the starting position, the arm just dropped by half, when the body to be lifted using the muscles in your arms, your head does not exceed the upper beam, when would lift the body, assisted by the leg swing that other or additional movements, do pull ups with less movement means less than perfect. In conducting the movement of course there is the role of muscles that contract in order to move. When doing pull ups by lifting himself up muscles used are the latissimus dorsi, pectoralis, the posterior deltoid muscle, teres major muscles, lower trapezius, pectoralis minor, biceps, rectus abdominis.



Figure 1. The dominant muscles involved when motion pull ups anatomy

2. Method

The procedure of study in the form of the measures carried out in the study with the flow as follows:

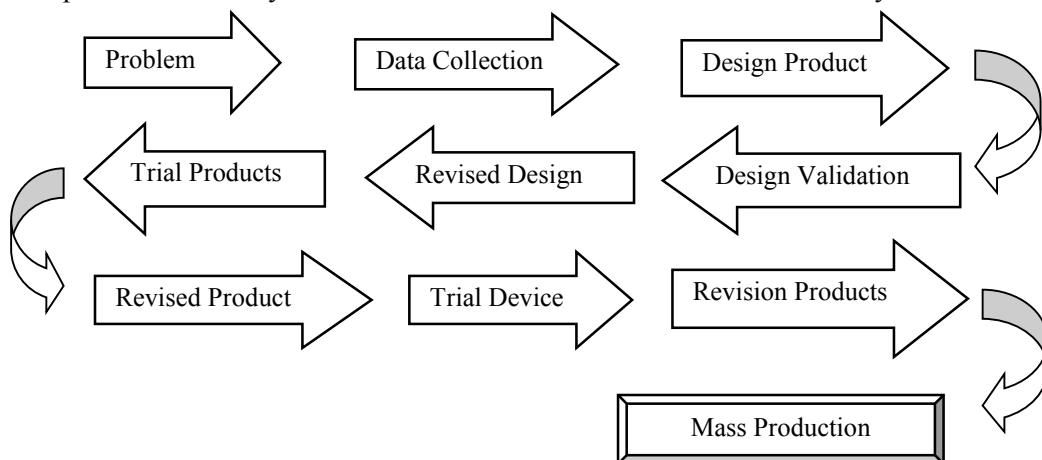


Figure 2. Research procedure

The research methodology employed in this study is the Research and Development (R & D) method used to test the effectiveness of the product. Before products are produced for general use, there is need to test the effectiveness of these products. Results of this study were to be applied in producing a measuring tool for strength endurance muscle upper body testing which is based on microcontroller with personal computer system interfacing.

Components supporting the development of measurement tools pull ups are required in the development of digital measuring devices pull ups consists of microcontroller MCS-51, photo transistors, light emitting diode, buzzer, ultrasonic sensors and infra-red sensors.



Figure 3. Component supporting the development of measurement tools pull ups

3. Result and Discussion

3.1. *Prototype Pull Ups digital*

The development of this measure is to create a measuring tool endurance strength could be pull up the pole equipped with sensors. This tool aims to calculate the number of pull-up movement that occurred during the 60 seconds the results will be displayed on the surface of the box precisely at seven segments. Pull up the pole is designed to be done anywhere (portable). Pull up their poles using this sensor is expected to make a calculation of the movement correctly when pull ups and pull ups can be carried easily anywhere.



Figure 4. Prototype measuring instrument digital motion pull ups

3.2. *The Series of Sensors and LED Display*

Sensors are used there are two infrared light emitting diode (IR LED) and laser. Sensor IR LEDs are placed in the upper beam with the aim of detecting the chin that passes through the upper beam when the pull up, while the laser sensor is placed on the pole bottom with the aim of detecting the lower leg while returning to the starting position when doing pull ups. The laser sensor can be raised and lowered to adjust the height of the sample. If both these sensors detect the motion will be counted. While on the surface the box there are seven segments and switches start and reset. Seven segment used consists of four units, two to display counter and the remaining two for counting down trimmer. Start and reset function to start and return back to the original.



Figure 5. The series of infrared sensors on the bottom of the pole and LED box

3.3. *The Workings of the Pull Ups Digital*

The first step to see how the tool works is necessary to enable the circuit by connecting the power supply with a voltage source alternating current, then push the button on the box then the lamp seven segments will light, the laser will fire a beam, and IR LED dispersive infrared waves. Before starting make sure the LED indicator lights up indicating sensor comparator can detect, if not light up check the laser light beam sure to have shot photo transistor and set the reference voltage for the IR LEDs. If the LED is already lit comparator then the test is ready to be implemented. Make sure the sample is already hanging, and under the laser has hit the lower leg. If you have press start on the green box it will sound of buzzer and counting down from 60 seconds to start, this indicates the test begins. When implementing pull up chin movement must pass through the upper beam and back to the starting position until the return leg was shot by a laser. Sensors detect and count results will be shown on the seven segment on the surface of the box. If there is a movement that does not count, mean when motion is not detected by the sensor, which means the movement is wrong. The test will last for 60 seconds, if the time is up will buzzer resumes indicating the time the test is completed, if it will be continued on the next sample push reset to restore the numbers counter and timer to the original number then press start.

3.4. *Product Test Results*

After validation and design improvements made product trials. For such testing is done with the experiment that compared the effectiveness and efficiency of manual labor with a digital system. Samples in testing this tool involving 30 people who performed in soccer stadiums and laboratory sport science Faculty of Sport and Health Education, Indonesia University of Education.

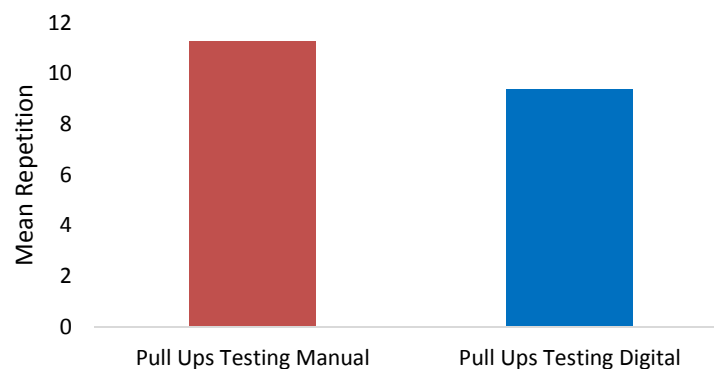


Figure 6. Result of pull ups between manual and digital testing

The above results show that the average value of the test results with a manual pull ups (11.3) and digital (9.4) but not significant differences in the level of 0:05. The average results of the test execution digitally lower compared with the manual, this shows that the implementation of digital test demands perfection movement.

4. Conclusion

Measuring tool strength endurance free standing pull up bar with this sensor successfully designed and developed. Endurance strength measuring instrument developed by researchers is the development of a pole the previous pull up pull free standing bar, the previous development in the form of poles that can be placed anywhere while enabling (portable) but has not been supplemented by an automatic timer. The main components of this tool is a microcontroller MCS 51, infrared sensors, and laser sensors. MCS 51 a simple microcontroller that provides a feature timers and counters that usage on the needs of counter automatically appropriate. In this tool uses two sensors, namely an infrared sensor located on the upper beam and laser sensors on the mast bottom. System tools work essentially is an automatic calculation tool will calculate if two conditions are met and that both sensors obstructed by movement resulting change in voltage in the circuit. The voltage changes which become impulses in the MCS 51 to be processed into the output so that the results will appear on the surface of the box through seven segments. The trial results mention that there is no difference between pull ups using a sensor and without censorship, but when viewed on average from the test group test uncensored visible difference has on average larger. This shows that the pull up with a more controlled sensor for calculating just the right moves.

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