Development of Sit Up Measuring Tools Based on Arduino and Ultrasonic Sensors With Android Applications

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Abstract—This study aims to develop an Arduino-based Sit Up test measuring instrument and an Ultrasonic sensor with an Android application, with the hope of providing effectiveness and efficiency in calculating Sit Up tests with more accurate calculation results. This type of research is Research and development. Research and development methods are research methods used to produce certain products, and test the effectiveness of the products. The development of the Sit Up test measuring instrument was first validated by electrical experts and measurement test experts. After that, it was continued with a small group test of 10 people and a large group test of 20 people. The results of the study obtained validity from electrical experts with an assessment percentage of 88.8% or in the "Good/Decent" category and the validity of test and measurement experts with an assessment percentage of 94% or in the "Good/Decent" category. Furthermore, the reliability test results obtained a small group value of 0.995 or in the "Very Strong" category and a large group of 0.996 or in the "Very Strong" category. Thus, it can be concluded that the Arduino-based Sit Up test measuring instrument and the Ultrasonic sensor with the Android application are declared suitable for use for the Sit Up test in producing more accurate calculations.

Keywords—measuring instruments, Sit Up, Arduino, ultrasonic sensors

1 Introduction

Technology is an inseparable part of human life [1,2]. Technological progress will run and develop along with the development of science [3]. "The development of science and technology capabilities is one of the dominant factors for any country to educate the nation's life, increase the prosperity of the people" [4]. The application of technology in the field of sports aims as an analytical tool and a measuring tool for sports to improve sports performance [5,6]. Achieving sports achievements will not be enough to have physical, technical, tactical and mental abilities. Without the support of technology in sports, it is very fun for athletes to achieve maximum performance [7].

The current phenomenon is that many coaches of physical condition rarely evaluate the level of physical condition of athletes who have been trained so that coaches do not have data to make policies or draw conclusions in training. One of the reasons for this situation is the limitations of supporting test tools for physical conditions, especially digital-based ones [8]. In the world of sports, the application of science and technology (IPTEK) has now produced many products to be used and utilized as a sports analysis tool, so as to improve performance [9]. These products include Force Platform, Ergometer, Ergo Cycle, Polar GPS (Global Positioning System), Gas Analysis, Speed Coordination Time, Speed Reaction Time, Treadmills and others [6]. Sit-ups are one of the many forms of abdominal muscle strength training [10]. In sports tests that are still manual, errors often occur in calculating the number of Sit Ups so that an automatic calculation is needed with the development of an android-based application for Monitoring the number of Sit Up.

Alternative solutions that need to be sought to overcome these problems, Recently devices combined with sensor technology have gained benefits as an effective tool for assessing physical activity in the general population [11]. Some of the sensors that can be used are Arduino and ultrasonic [12,13]. The use of the Arduino device has been designed in the tool to measure muscle fatigue [14]. In addition, the use of ultrasonic sensor technology has been used during the post-injury recovery period [15]. However, until now the effectiveness of sensor technology has never been tested with an android application for measuring instruments in the field of sports.

To answer this question, we will conduct research on the development of an Arduino-based sit-up measuring instrument and an ultrasonic sensor with an android application.

2 Research methods

2.1 Study design

This research uses Research And Development research design. This research involves 2 experts who are competent in their fields, namely electrical engineering, and a test and measurement expert which aims at the validation test stage, knowing the weaknesses and strengths of the products that have been designed. After carrying out the validation test phase, the resulting product will be tested for use in the field.

2.2 Participants

A total of 10 people tested in small groups and 20 people tested in large groups participated in this study. The subjects of this study were men aged 18–25 years.

2.3 Product design

1. Tool name: Arduino and ultrasonic sensor based sit up measurement tool with android application.
2. Materials used: Arduino, Bluetooth HC-05, Ultrasonic sensor HC-SR04.

2.4 Tool design

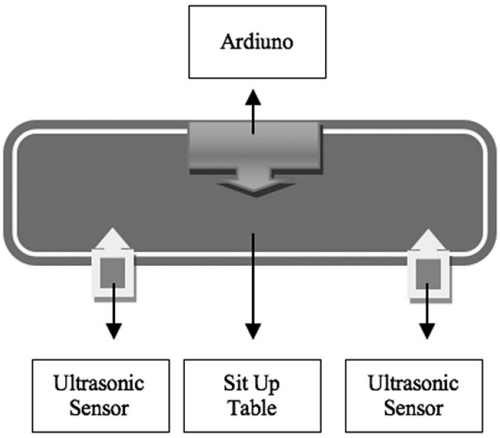

Fig. 1. Sit up measuring device sketch

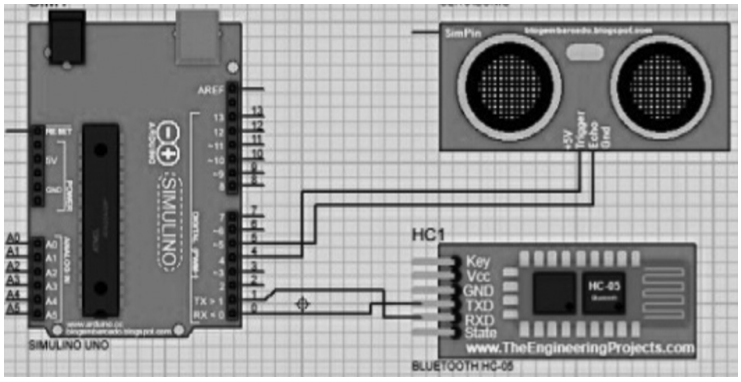

Fig. 2. Measuring instrument circuit design

2.5 Statistical analysis

The data obtained will be tested using the r-correlation method.

3 Results

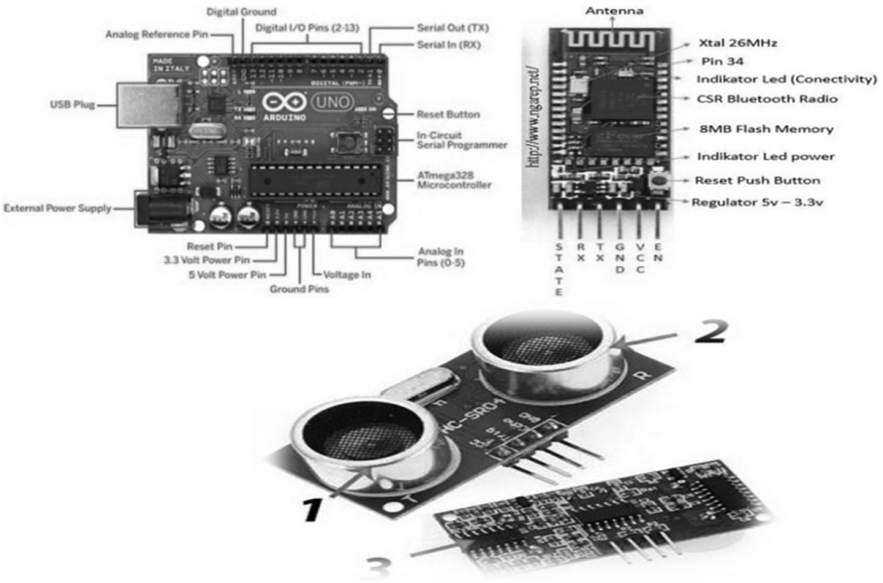

Fig. 3. Arduino, bluetooth HC-05, ultrasonic sensor HC-SR04

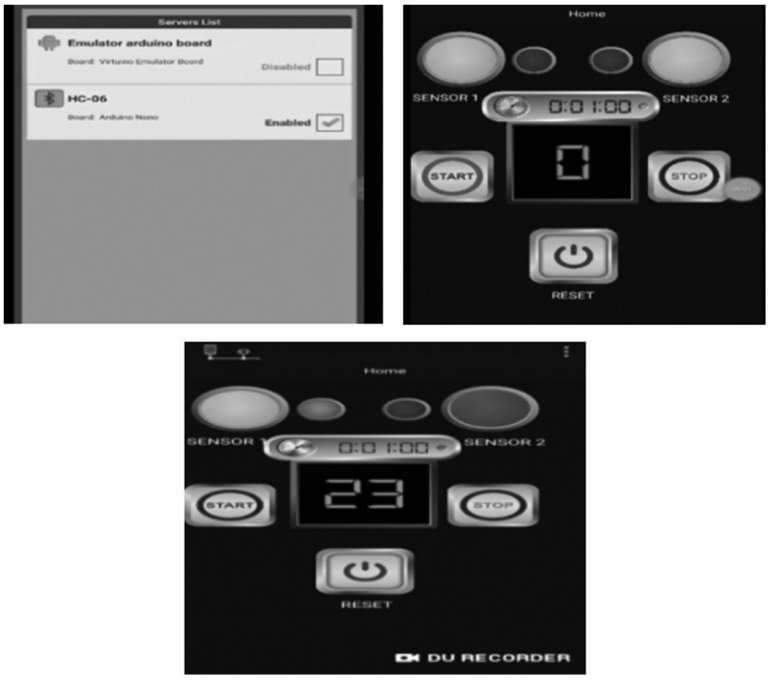

Fig. 4. Sit up measuring tool application on android

Fig. 5. Tool trial

3.1 Expert validation test

Table 1. Questionnaire scores for the validity of isometric therapy devices using Arduino and load cell designs by experts

Expert	Aspect	Score
Electrical Engineering	Suitability	25
	Accuracy	25
	Convenience	23
	Practicality	25
	Amount	88
Measurement Test Expert	Suitability	25
	Accuracy	22
	Convenience	22
	Practicality	25
	Amount	94

Table 2. Percentage and eligibility level of experts

No	Expert	Percentage	Eligibility Level
1	Electrical Engineering	88%	Very good
2	Measurement Test Expert	94%	Very good

Based on the assessment of the two experts, the development of a sit up measuring tool can be used.

3.2 Reliability

Table 3. Analysis of the alpha coefficient of reliability test

Group	n	Alpha Coefficient	Reliability
Small	10	0,995	Very high
Big	20	0,996	Very high

Based on the results of the alpha coefficient reliability test, the sit up measuring instrument based on Arduino and ultrasonic sensors with the android application is said to be reliable and consistent in data collection.

4 Discussion

Results Based on our research, it was explained that the validity test by electrical experts and test and measurement experts met the requirements which were included in the very good category. Validity in research is something that shows the truth or accuracy [16]. The resulting tool with a good level of validity will help in its acceptance in the wider community [17].

The results of the reliability test of the alpha coefficient in the small group and large group have a high correlation, so it can be said that the sit up measuring instrument based on Arduino and ultrasonic sensors with the android application is said to be reliable and consistent in data collection. The product development of the Sit Up measuring instrument was developed to provide more accurate and practical results in the implementation of sit ups. The use of sensor technology in the world of sports has been widely developed. Coupled with research (Qi et al. 2015) [18] reported that a wireless ultrasonic sensor network can be used to track the kinematics of the lower extremity and trunk joints during squat exercises. Research (Jahren et al. 2021) [19] reports that ultrasonic sensors can be used for tracking human movement, it aims to measure relative distances. Research (Hadžić, Germič, & Filipčič, 2021) [20] reported that sensor technology is a valid and reliable tool used to measure the number of strokes in tennis.

The main result of this study was to develop an effective, valid and reliable sit up measuring instrument to measure the number of sit ups performed by a person using ultrasonic sensor technology and controlled by an android smartphone application.

5 Conclusion

Results Based on the research we have done, the Arduino-based Sit Up measuring instrument and the Ultrasonic sensor with the Android application can be used as an effective, valid and reliable digital measurement medium in calculating Sit Up tests.

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7 References

[1] Ghaznavi, M. R., Keikha, A. & Yaghoubi, N.-M. The Impact of Information and Communication Technology (ICT) on Educational Improvement. *Int. Educ. Stud*. (2011). https://doi.org/10.5539/ies.v4n2p116

[2] Lyapina, I., Sotnikova, E., Lebedeva, O., Makarova, T. & Skvortsova, N. Smart Technologies: Perspectives of usage in Higher Education.. *Int. J. Educ. Manag.* (2019). https://doi.org/10.1108/IJEM-08-2018-0257
[3] Garcia-Soto, C. *et al.* Marine Citizen Science: Current State in Europe and New Technological Developments. *Frontiers in Marine Science* (2021). https://doi.org/10.3389/fmars.2021.621472
[4] Hansson, S. O. Technology and Mathematics. *Philos. Technol*. (2020). https://doi.org/10.1007/s13347-019-00348-9
[5] Aroganam, G., Manivannan, N. & Harrison, D. Review on Wearable Technology Sensors Used in Consumer Sport Applications. *Sensors (Basel, Switzerland)* (2019). https://doi.org/10.3390/s19091983
[6] Ratten, V. Sport Technology: A Commentary. *J. High Technol. Manag. Res.* (2020). https://doi.org/10.1016/j.hitech.2020.100383
[7] Luo, D. The Application of Computer Technology in Sports Training and Competition. In *Advances in Intelligent Systems and Computing* (2021). https://doi.org/10.1007/978-3-030-53980-1_80
[8] Komaini, A. *et al.* Motor Learning Measuring Tools: A Design And Implementation Using Sensor Technology For Preschool Education. *Int. J. Interact. Mob. Technol.* (2021). https://doi.org/10.3991/ijim.v15i17.25321
[9] Komaini, A., Gusvominesia, W., Bakhtiar, S. & Ayubi, N. Measurement of Maximal Oxygen Uptake (VO2Max) as a Cardiorespiratory Physiological Fitness Parameter Using Sensor Technology-Based Device Development. *Indian J. Forensic Med. Toxicol.* 16, 244–250 (2022). https://doi.org/10.37506/ijfmt.v16i1.17460
[10] Slater, D., Korakakis, V., O'Sullivan, P., Nolan, D. & O'Sullivan, K. "Sit Up Straight": Time to Re-evaluate. *Journal of Orthopaedic and Sports Physical Therapy* (2019). https://doi.org/10.2519/jospt.2019.0610
[11] Li, R. T. *et al.* Wearable Performance Devices in Sports Medicine. *Sports Health* (2016). https://doi.org/10.1177/1941738115616917
[12] Alaidi, A. H. M., Aljazaery, I. A., AlRikabi, H. T. S., Mahmood, I. N. & Abed, F. T. Design and Implementation of a Smart Traffic Light Management System Controlled Wirelessly by Arduino. *Int. J. Interact. Mob. Technol.* (2020). https://doi.org/10.3991/ijim.v14i07.12823
[13] Yahya, O. H., AlRikabi, H. T. S., Al_Airaji, R. M. & Faezipour, M. Using Internet of Things Application for Disposing of Solid Waste. *Int. J. Interact. Mob. Technol.* (2020). https://doi.org/10.3991/ijim.v14i13.13859
[14] Toro, S. F. Del *et al.* Is the Use of a Low-Cost sEMG Sensor Valid to Measure Muscle Fatigue? *Sensors (Basel)*. (2019). https://doi.org/10.3390/s19143204
[15] Robotti, G., Draghi, F., Bortolotto, C. & Canepa, M. G. Ultrasound of Sports Injuries of the Musculoskeletal System: Gender Differences. *Journal of Ultrasound* (2020). https://doi.org/10.1007/s40477-020-00438-x
[16] Chander, N. G. Study Validity. *Journal of Indian Prosthodontist Society* (2018).
[17] Tunis, S. R., Stryer, D. B. & Clancy, C. M. Practical Clinical Trials: Increasing the Value of Clinical Research for Decision Making in Clinical and Health Policy. *Journal of the American Medical Association* (2003). https://doi.org/10.1001/jama.290.12.1624
[18] Qi, Y., Boon Soh, C., Gunawan, E., Low, K. S. & Thomas, R. Lower Extremity Joint Angle Tracking with Wireless Ultrasonic Sensors During a Squat Exercise. *Sensors (Switzerland)* (2015). https://doi.org/10.3390/s150509610
[19] Jahren, S. E. *et al.* Towards Human Motion Tracking Enhanced by Semi-Continuous Ultrasonic Time-of-Flight Measurements. *Sensors* (2021). https://doi.org/10.3390/s21072259
[20] Hadžić, V., Germič, A. & Filipčič, A. Validity and Reliability of a Novel Monitoring Sensor for the Quantification of the Hitting Load in Tennis. *PLoS One* (2021). https://doi.org/10.1371/journal.pone.0255339

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