

## Microcontroller-Based Digital Body Height Measuring Tool with Display Information

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**Abstract:** This research was conducted to make a digital body height measuring device based on the arduino uno microcontroller with information display using an LCD, this tool is expected to help the process of measuring body height become easier, practical, and obtain more accurate results. The system development method uses research and development which aims to produce products from research. Products produced based on needs analysis. Research procedures and data collection using needs analysis, literature studies, and small-scale research. The testing method uses black box testing which aims to test the specific functions of the designed software. The results of the research and trials of the digital body height measuring tool with the HC-SR04 ultrasonic sensor based on the arduino uno microcontroller can work properly with an accuracy of 99.73% and an error of 0.009%.

**Keywords:** *Microcontroller, arduino uno, body height, digital measuring tool, display information*

### 1. Introduction

Length and height are physical quantities that are often measured for various purposes that require human body height data [1]. Human body height depends on environmental and genetic factors. The average growth for each sex in the population is different, adult males are on average taller than adult females. In addition, human body height also differs according to ethnic groups [2]. Body height is one of the important factors in the stages of human growth. The average body height growth stops when someone is 16 years old for women and 18 years for men [3]. In some professions, body height is a requirement that must be met by a job applicant, for example in the fields of military, banking, aviation, and modeling. If only one or two people want to be measured, it may not be a problem, but if the people to be measured are more than 100 people, as happens in the medical tests conducted by the military in accepting new members, it will be very inconvenient and time-consuming. To find out body height, we need a measuring tool called a body height meter which is usually expressed in cm or inches [4].

Body height measuring tools on the market cannot obtain accurate data, because most of the body height measuring devices on the market are still manual. This means that we still use measurement methods with human assistance

to get body height data. This then has an impact on less efficiency in its use [5]. To measure a person's body height, at least there must be a tool operator who helps, who is in charge of taking measurements and reading the data that appears in the results of these measurements. The results of reading the scale on a manual body height measuring instrument made by humans have a less level of accuracy and precision, and human error can even occur [6].

During this time the tool that is often used to measure human body height is a manual meter (length meter). If you want to measure body height using a manual meter, you must be really careful in doing so, because manual meter readings still use analog and in their readings, there is often a difference of two readings between one person and another. Meanwhile, if you use digital, there will be no difference in numbers in the reading [7]. After paying attention to this and the community's need for a measuring instrument that has a high level of accuracy and is practical.

The rapid development of information and communication technology in the current era has had an impact on globalization, business competition, job demands, and increasing patterns of human life. Advances in technology have caused humans to create many tools that can help lighten a job being done. In line with the times, a body height measurement tool is needed that can work automatically, carry out the measurement process, read the measurement results, and notify the measurement results automatically. Based on the aim to utilize

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electronic technology as a microcontroller-based body height measurement tool. The body height measurement tool that will be made can make it easier for users to measure body height and can provide accurate information. The body height measurement tool utilizes the principle of 20KHz ultrasonic wave reflection with a certain frequency. Ultrasonic waves can travel through liquids, gases, and solids. To measure the distance of objects, a frequency of 40KHz is used with a speed of sound of 344m/s, so it is easy to calculate the delay time and in use, these waves do not interfere with the human hearing system. Data stored on the microcontroller will be processed and output in written form via a Liquid Crystal Display (LCD) that can move up and down for easy reading.

Related to some understanding of body height, measuring instruments, and microcontrollers, this research was conducted to make a digital body height measuring instrument based on the Arduino Uno microcontroller with display information using an LCD, this tool is expected to help the body height measurement process become easier, more practical, and get more accurate results.

## 2. Literature Review

Along with the development of science and technology, many ideas appear in the field of microcontrollers. This development is actually not without reason, because basically, this technology simplifies what actually exists in the world [8]. Microcontrollers develop with Arduino. This Arduino simplifies conventional systems to become automatic and more concise. With the development of technology at this time, controlling electronic devices has become easier and more practical [9]. Therefore, making a body height measuring instrument based on the Arduino Uno microcontroller with display information, this tool is expected to help the body height measurement process become easier, more practical, and obtain more accurate results [10].

### 2.1. Concept of Microcontroller

A microcontroller is a computer system in which all or most of its elements are packaged in a single IC chip, so it is often also called a single-chip microcomputer. The microcontroller circuit is composed of an IC (Integrated Circuit) and several supporting components so that it can work properly [11].

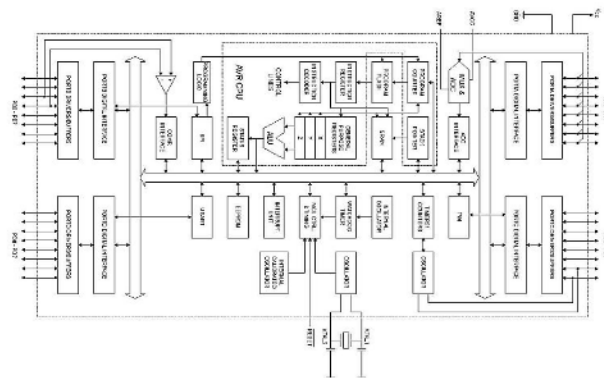


Fig. 1. Microcontroller Architecture

The microcontroller is a breakthrough in the latest microprocessor and microcomputer technology that is here to meet market needs [12]. The latest technology with semiconductor technology contains more transistors but only requires a small space as a container for placement and can be mass-produced so that the price is cheaper and can be reached by almost all people [11], [13]–[16]. Therefore the microcontroller is very suitable to be applied to control a variety of equipment that is more sophisticated than a PC computer, because of its high effectiveness and flexibility [17].

### 2.2. Arduino Uno Microcontroller Module

The Arduino Uno microcontroller module was created by Massimo Banzi, David Cuartilles, Tom Gianluca, David A. Mellis, and Nicholas Zambetti in 2005. The Arduino language is a fork of the wiring platform language and processing language [18]. The wiring platform was created by Hernando Barragan in 2003 and processing was made by Casey Reas and Benjamin Fry in 2001. Arduino uses standard open-source licenses, including hardware (circuit schematic, PCB, or printed circuit board design), bootloader firmware, documents, and software. IDE (Integrated Development Environment) as an Arduino board programmer application [19].

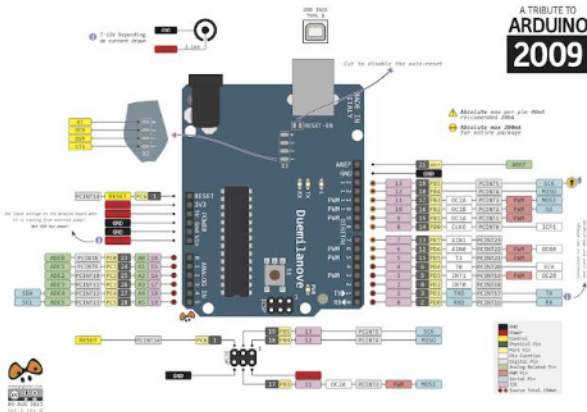


Fig. 2. Arduino Uno Microcontroller Module

The Arduino microcontroller used to make a body height measuring tool is the Arduino Uno. Arduino Uno is a microcontroller board based on ATMega328 [20]. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an



ICSP header, and a reset button. This board uses power connected to the computer with a USB cable or external power with an AC-DC adapter or battery [21]. Arduino Uno and computer communication can be done via the USB serial port (Universal Serial Bus). In this case, Arduino Uno can not only read data from the computer on the serial port but can also send data to the computer. The communication is two-way [22]. Meanwhile, the difference between ATmega85 and 32 lies in the flash memory. If the ATmega8535 flash memory is 8 KB then the ATmega32 flash memory has 32 KB flash memory [23].



**Fig. 3.** Arduino Uno Microcontroller Architecture

It has 14 pins, each of the 14 digital pins on the Uno can be used as an input or output, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. To support Arduino so that it can be used, it is enough just to connect the Arduino Uno Board to a computer using a USB or power cable with an AC-to-DC adapter or battery to run it. Arduino Uno can be powered via USB connection or by one external power (automatic) [24]. The recommended power requirement range for the Uno board is 7 to 12 volts, if it is powered less than 7 volts it is possible that the 5v Uno pin can operate but is unstable then if it is powered more than 12V, the voltage regulator can overheat and can damage the Uno board. For programming language Arduino Uno uses the C language and for programming it uses the Arduino Software (IDE) application, IDE stands for Integrated Development Environment [25].



**Fig. 4.** Arduino IDE Software

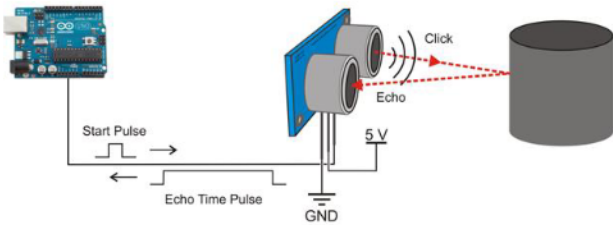
### 2.3. Ultrasonic Sensor Module

The ultrasonic sensor serves to provide feedback information to control the program by detecting the output [26]. An ultrasonic sensor is a sensor that has the function to convert physical quantities, aka sound, into electrical quantities, and vice versa. The working principle of this ultrasonic sensor is quite simple, which is based on the reflection of sound waves so that it can be used to define the existence or distance of an object with a certain frequency. In ultrasonic sensors, ultrasonic waves are generated through a device called a piezoelectric. The waves being compared have a frequency of 40 kHz to 400 kHz. In simple terms, the ultrasonic sensor will shoot ultrasonic waves toward a certain object. After the wave hits the object, the wave will be reflected back to the sensor, then the sensor will calculate the difference between the time of sending and receiving the reflected wave.



**Fig. 5.** Ultrasonic Sensors

The atomic structure of a piezoelectric crystal will contract (bind), expand, or shrink against the polarity of the applied voltage and this is called the piezoelectric effect. The contractions that occur are forwarded to the vibrating diaphragm so that ultrasonic waves are emitted into the air (the surrounding area). Ultrasonic wave reflection will occur when there is a certain object and the ultrasonic wave reflection will be received back by the receiving sensor unit. Furthermore, the receiving sensor unit will cause the vibrating diaphragm to vibrate and the piezoelectric effect produces an alternating voltage with the same frequency.



**Fig. 6.** Ultrasonic Sensor Working Principle

The amplitude of the electrical signal generated by the receiving sensor depends on how far the detected object is and the quality of the transmitter and receiver sensors. The process carried out on this sensor uses the reflection method to calculate the distance between the sensor and the target object. The distance between the sensors is calculated by multiplying half the time used by the ultrasonic signal on its way from the sending circuit to being received by the receiving circuit, with the propagation speed of the ultrasonic signal on the propagation medium it uses, namely air. The reflected ultrasonic waves can be used to measure the distance between the sensor and an object which can ideally be calculated using the formula.

$$s = 0,5.v.t$$

Information:

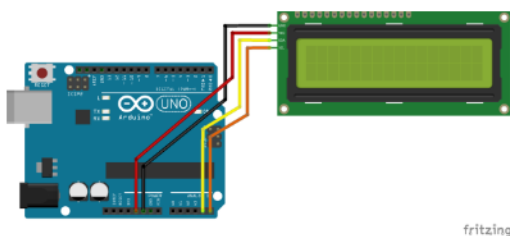
$s$  = distance between the object and the sensor (m)

$v$  = speed of sound in the medium is 344 m/s

$t$  = travel time (seconds)

#### 2.4. Liquid Crystal Display (LCD) Modules

Liquid Cristal Display (LCD) is one type of electronic display made with CMOS logic technology that works by not producing light but reflecting the light around it to the front-lit or transmitting light from the back-lit. LCD (Liquid Cristal Display) functions as a data viewer in the form of characters, letters [27].



**Fig. 7.** Liquid Crystal Display (LCD)

The LCD material is a layer of organic mixture between a layer of clear glass with transparent indium oxide electrodes in the form of a seven-segment display and a layer of electrodes on the glass back. When the electrodes are activated by an electric field (voltage), the long,

cylindrical organic molecules align themselves with the electrodes from the segments. The sandwich layer has a front vertical light polarizer and a rear horizontal light polarizer followed by a reflector layer. The reflected light cannot pass through the aligning molecules and the activated segment appears to darken and forms the character of the data to be displayed.

In the LCD module, there is a microcontroller that functions as a controller for the LCD character display. The microcontroller on an LCD is equipped with memory and registers. The memory used by the internal LCD microcontroller is Display Data Random Access Memory (DDRAM), Character Generator Random Access Memory (CGRAM), Character Generator Read Only Memory (CGROM), Command Register, and Data Register. [28]. Pins, pins or input and control lines in an LCD (Liquid Cristal Display) include; The data pin is a path to provide character data that you want to display using an LCD (Liquid Cristal Display) which can be connected to a data bus from another circuit such as a microcontroller with an 8-bit data width. The RS (Register Select) pin functions as an indicator or determines the type of incoming data, whether data or commands. Logic low shows that the input is a command, while logic high shows data. The R/W (Read Write) pin functions as an instruction to the module if low writes data, while high reads data. Pin E (Enable) is used to hold data either in or out. The VLCD pin functions to adjust the display brightness (contrast) where this pin is connected to a 5 Kohm trimpot, when not in use it is connected to ground, while the power supply voltage to the LCD is 5 Volts.

#### 3. Literature Review

The research was carried out using the research and development system development method which aims to produce products from the research [29]. Products are produced based on needs analysis. Research procedures and data collection using needs analysis, literature studies, and small-scale research. Research planning formulates research objectives, and estimates the things needed in research. Develop preliminary products, make product designs to be developed, and determine facilities, infrastructure, and testing. Operational field testing is related to testing the effectiveness and adaptability of product designs involving product users. The testing method uses black box testing which aims to test the specific functions of the designed software [30]. The correctness of the software being tested is only seen based on the output generated from the data or input conditions given for existing functions without looking at how the process is for getting that output. From the output produced, the program's ability to meet user needs can be measured as well as known errors.

### 3.1. Body Height Measuring Tool Block Diagram

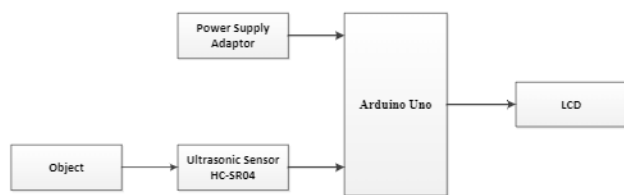


Fig. 8. Schematic Block Diagram

The working principle of a body height measuring tool is to measure body height using a sensor. The following is a block schematic of the hardware design of the tool.

The system of this tool has an input in the form of an ultrasonic sensor HC-SR04. The input received is in the form of sensor measurement data, which will be processed by the Arduino Uno microcontroller. At the output, there is a Liquid Crystal Display (LCD) to display the measurement results obtained.

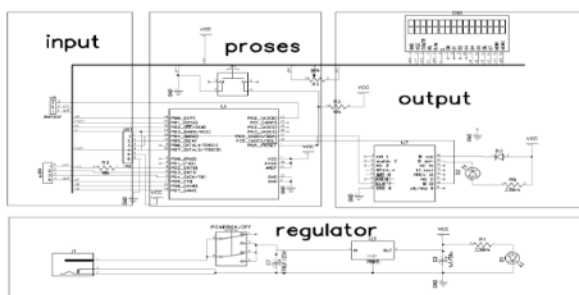


Fig. 9. Architectural Schematic Block Diagram

## 4. Results and Discussion

### 4.1. Results of System Analysis

Measurement of body height in general is still done manually with various materials and shapes. Body height measurement tools that are used by most people are still manual. There are various ways to measure body height, some are drawn like a tape measure, and some are shaped like a ruler attached to the wall. Several models or types of body height measurement tools that are often found around us include wall stickers, plan toys jungle height charts, nordic growth charts, and stature meters.

### 4.2. Results of Analysis of Research Tools and Materials

Before starting the research process, it is better to collect and prepare the tools and materials to be used in the research. This is done so that the research process to be carried out can run well in accordance with what is expected by the researcher. Making a body height measuring device requires electronic modules, such as a 16x4 Liquid Crystal Display (LCD), potentiometer,

Arduino Uno microcontroller, and HC-SR04 Ultrasonic Sensor. Analysis of the needs for tools and materials consists of hardware and software requirements which can be explained as follows; A computer tool for uploading program code results to the Arduino Uno microcontroller.

Arduino Uno Microcontroller Module, functions as the main controller for the system circuit of all electronic equipment used. The Arduino Uno microcontroller is equipped with ports that function to connect the HC-SR04 Ultrasonic sensor module and Liquid Crystal Display (LCD) using jumper cables. HC-SR04 Ultrasonic Sensor Module, functions as a distance sensor in measuring water in the evaporimeter. The HC-SR04 ultrasonic sensor module consists of YX (transmitter) and RX (receiver). TX functions as a transmitter of signals that hit obstacles while RX functions as a receiver of reflected signals from TX. The Liquid Crystal Display (LCD) module is an electronic module that functions as an output or display of data from measurement results that have been processed by the microcontroller.

Potentiometer, serves to adjust the voltage and intensity of the way on the LCD. Adapter, for Arduino Uno Microcontroller power supply. Arduino IDE software, which functions as a text editor, verifies coding to find out if the coding has errors and at the same time the compiler will be uploaded into the Arduino Uno microcontroller memory. In addition, the Arduino IDE software also functions to connect a computer to the Arduino Uno microcontroller board using a USB cable connection.

### 4.3. Results of Body Height Measuring Tool Design

The design of the tool is a series of prototype Body height measurement tools that are used to implement the tool later. The design was made to facilitate the process of working on the tool to be made. From this design, it can be seen the materials and tools that will be used in the body height measuring tool.

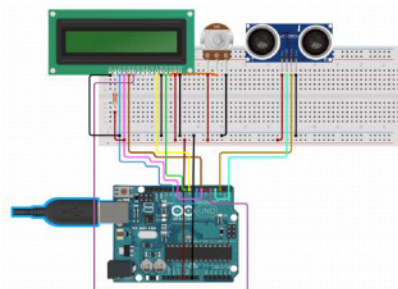


Fig. 10. Body Height Measuring Tool Design

In the design of the body height measuring tool which can be seen in figure 6, the equipment used is a 16x4 LCD,



Potentiometer, Arduino Uno microcontroller, HC-SR04 Ultrasonic Sensor, and Breadboard.

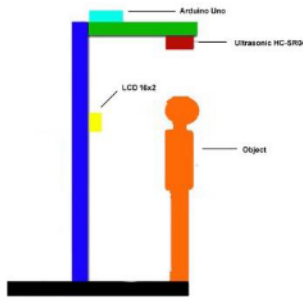


Fig. 11. Body Height Measuring Tool Prototype Design

#### 4.4. Results of Installation of Materials and Tools to the Arduino Uno Microcontroller

Installation of materials and tools to the Arduino Uno microcontroller using jumper cables as a link. The +5V (VCC) pin on the Arduino Uno microcontroller is connected to Terminal 1 on the Potentiometer which functions to regulate the positive voltage, while the Ground pin on the Arduino Uno microcontroller is connected to Terminal 3 on the Potentiometer which functions to regulate the Negative voltage. The VEE pin on the LCD is connected to terminal 2 on the Potentiometer which functions to adjust the light intensity on the LCD. Next, install the HC-SR04 Ultrasonic Sensor module on the Arduino Uno microcontroller using a jumper cable as a link. The HC-SR04 Ultrasonic Sensor has 4 pins namely VCC, ECHO, TRIG, and GND.

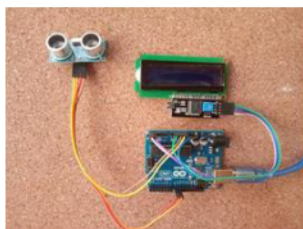


Fig. 12. Results of Installation of Tools and Materials

#### 4.5. Results of Body Height Measuring Tool Test

Tool testing uses the Blackbox testing method, which aims to observe the results of execution through test data and check the functionality of the software. This test needs to be done to find out whether there are still differences in results or errors, if there are errors from these results it will be known how much error there is in the body height measuring tool that is made. Testing the tool itself was carried out directly on 10 people. The results of testing the body height measuring device on 20 people obtained the results which can be seen in table 1.

Table 1. Tool Testing Results Against Object

No	Body Height Manual (cm)	Gender	Body Height On Tool (cm)	Error (cm)	
				cm	%
1	172	Man	174	+2	0,012
2	155	Woman	156	+1	0,006
3	165	Woman	167	+2	0,012
4	164	Woman	165	+1	0,006
5	169	Man	170	+1	0,006
6	175	Man	176	+1	0,006
7	170	Woman	172	+2	0,012
8	167	Man	168	+1	0,006
9	150	Woman	152	+2	0,013
10	173	Man	175	+2	0,012
Average				+1,5	0,009

#### 5. Conclusion

Based on the results and discussion of the Arduino Uno microcontroller-based digital body height measuring tool with display information, it can be concluded that the digital body height measuring instrument with the Arduino Uno-based HC-SR04 ultrasonic sensor designed and made to detect body height is proven to be used as a substitute manual body height measurement tool. The results of research and testing of a Digital Body Height Measuring tool with an Ultrasonic Sensor HC-SR04 Based on the Arduino Uno microcontroller can work properly with an accuracy of 99.73% and an error of 0.009%.

A conclusion might elaborate on the importance of the work or suggest applications and extensions. Regarding the application of automatic clotheslines designed by this author are as follows this height measurement tool can be developed for further research by using voice, this body height measurement tool can be developed for further research so that data can be received via smartphones, and this height measurement tool can be developed for further research so that data can be received via a smartphone or computer and the data is stored in a database.

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interpretations/conclusions of this paper.

### Author contributions

**Dadang1 Haryanto1:** Conceptualization, Methodology, Software, Field study **Aneu2 Yulianeu2:** Data curation, Writing-Original draft preparation,

Field study **Andri3 Sukmaindrayana3:** Software, Validation Visualization, Field study **Agus4 Ramdhani4 Nugraha4:** Investigation, Writing-Reviewing, and Editing.

### Conflicts of interest

The authors declare no conflicts of interest.

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