Ultrasonic Sensors Height and BMI Device

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Abstract- This project is based on developing and creating a device that utilizes ultrasonic sensors to determine height. The device is intended to be used as an alternative to the other more bulky and expensive models found either at home or at your doctor's office. The device will be created for people to use it on their own with ease without requiring help. The objective is to make it both aesthetically pleasing, easy to use, and as cost effective as possible. The design includes two ultrasonic sensors, composite framework, a PIC controller, wiring, and C++ coding in its design.

Keywords—Ultrasonic; Height Measuring; BMI

I. INTRODUCTION

Height and weight are important indicators of human health.. Most people likely know their height up to a certain point. But even being half an inch to an inch shorter could be a very important indicator to your health. For children, it is important to monitor that they are growing at a healthy rate, and for the elderly it is important to monitor whether or not their height decreases. This could be an indicator of osteoporosis. If this technology is paired with a scale, a person's Body Mass Index (BMI) can easily be calculated. Doctors commonly use BMI as important indicators for diabetes and heart disease.

Currently, methods to measure height and weight are archaic, take too much time, and usually required more than one person. These measurements, especially when directly linked to health, need to be as accurate as possible, and in a way that isn't time consuming. Ultrasonic sensors provide a solution to this problem. They work similar to echolocation in bats by sending out a sound wave and then determining the distance of something by listening for the return echo.. Based off of that information the device is able to determine distance to an object, which is in this case the floor. Having two ultrasonic sensors allows for two separate measurements, and by averaging both the design team was able to attain more accurate readings, while also compensation for non-level orientations.

This Project aims to make it easy for any person to take their measurements at home, while maintaining accuracy. When designing the prototype the team kept in mind how effective the device is, the cost of the materials, how easy it is to assemble and manufacture, and finally how consumer friendly it is. The team has done extensive research on the market for such an item, and has found quite a lucrative spot for such a device. Upon careful inspection there are a few products that are similar in theory, but in design could not be more different. These items cost anywhere from six hundred dollars to one thousand dollars. The design only cost around forty dollars to create. With this in mind the team has created a prototype that is pleasing to use for the consumer, but more importantly is accurate in determining height measurements.

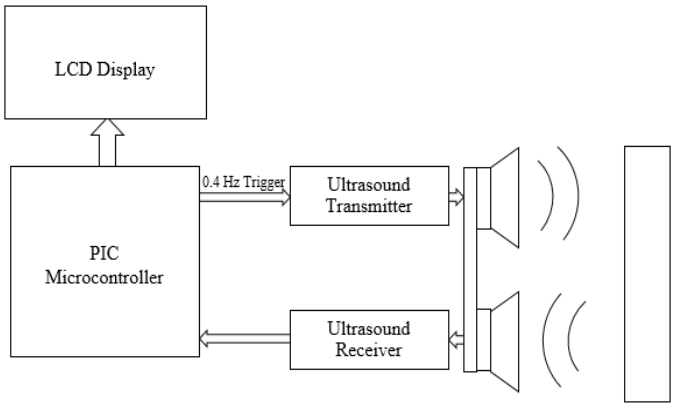

Figure 1. Block Diagram

II. METHODS

A. Design Process

The design process began with the programing and implementation of the HC-SR04 ultrasonic sensor. This was first implemented onto a breadboard to first ensure that the idea would work before implementing it in the final design. The circuit includes a PIC18F4525 microcontroller, 4 MHz resonator, ultrasonic sensors, a 9 to 5 V converter, and one resistor. Initially before building the prototype the team needed to check to see if the ultrasonic sensors were functioning and how accurate they were. After this information was found the team began the design phase. Some things that the design team kept in mind while the prototype was created are the following:

1. The device should reach the ground, unobstructed by any obstacles.
2. The design should include two ultrasonic sensors at opposite sides so the average of the two can be taken.
3. The breadboard, wiring, and other components should be covered in a housing unit.
4. The prototype should be built so that it is kept stable at the top of your head with very minimal movement.

All of this was kept in mind when the team designed the functioning prototype.

B. The Prototype Build

The Software

Designing began with coding the PIC microcontroller using MPLab and C++ coding. The team programmed the microcontroller so that a trigger signal is sent to the ultrasound

and that length of the return signal would be measured upon returning to give us a certain distance. This was recorded using a counter, which we then converted to feet, inches, and tenths of inches. The accuracy was improved with the second ultrasound, and a simple average command in the code to implement the addition. The information that was gained from the ultrasound was then coded to display on the LCD screen.

The Hardware

The hardware for our design included the PIC18F4525 microprocessor, a 4 MHz resonator, and 9 to 5 V converter, a 9 and 5 V battery, the two ultrasonic sensors, a resistor, the wiring, and the LCD to display the height. The final step was to build something that would house and encase the board and sensors. To do this wood composite board was cut so that the board and sensor can lay on them. Then two holes were cut at each end so the sensors could fit in there snugly. The breadboard lays on top of the wood composite plank in the center, and is encased in a housing of the same material. The LCD screen is mounted through a hole cut in the front of the housing, for easy viewing. The sensors are on each end of the plank to provide a large distance between them.

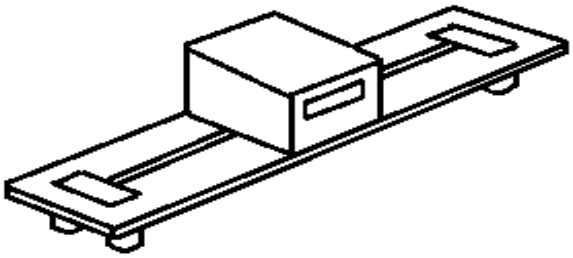

Figure 2. Sketch of basic prototype.

III. Results

Upon testing our prototype we found that it was functioning correctly and is very accurate. After measuring the same value 10 times, at most the average measurement was 0.4 inches off. The materials used to create our prototype are both cheap and lightweight. The device's weight is hardly noticeable when upon the subject's head and is very easy to hold in place.

IV. Discussion

This project was started this school year and developed in hopes of easing the process of measuring height, without sacrificing accuracy. A prototype was designed so a person alone at home could do this by themselves without spending a significant amount of money. The market for health and fitness is large and growing, and the need for new age products is very prevalent. It is the team's' belief that this device has great potential on such markets, with the only competitors being way too out of budget that only doctor's offices can afford them.

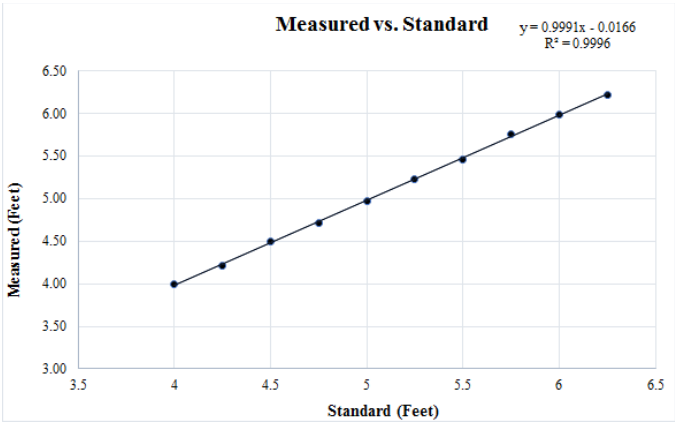

Figure 3. Graph of actual height compared to measured height.

Std	4	4.25	4.5	4.75	5	5.25	5.5	5.75	6	6.25
Avg	4	4.21	4.5	4.71	4.98	5.23	5.46	5.75	5.99	6.22
Std Dev	0.05	0.04	0.04	0.02	0.06	0.03	0.02	0.05	0.04	0.01
% E	0.10	0.84	0.11	0.77	0.48	0.48	0.76	0.06	0.21	0.47

Figure 4. Table of Actual height vs. the Average of 10 readings on our device, along with standard deviation and percent error.

In the future, we hope to add Bluetooth technology which will link the height measurement to an app and a Bluetooth scale. The app would be configured to determine a BMI calculations and notify you on your current health status. The group hopes in the future that they can make the design more easily manufacturable and aesthetically pleasing, so the user feels more comfortable using such device. Thus the device should be very marketable

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