Ultrasonic Imbedded System for Visually Impaired Persons to Enhance Situational Awareness

for
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Northeastern State University
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by
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September 23, 2018

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Abstract

The Abstract will be on this page and will be a summary of the outcome of the project.

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Introduction

Background. Imbedded systems are becoming a part of everyday life, from front door locks that can be opened with a cell phone to refrigerators that can notify owners when the milk is low. While the Internet-of-Things (IoT) offers conveniences to the masses and is therefore the most commonly thought of application of imbedded systems, similar imbedded systems also have the potential to be used for much more serious purposes such as human sensory replacement.

Replacement human sensory input research and development is ongoing at a very technical level. For example, cochlear implants are already used to directly stimulate nerves related to audio signaling to the brain and allow deaf users to be more aware of sound-producing events. Unfortunately, the cost for a cochlear implant can run close to $100,000.00, making it difficult for persons to access this technology. Even worse, there is currently no standard medical technology to assist persons with severe vision loss, leaving no help for people who need visual assistance.

This all-or-nothing situation does not have to be the only solution, though. Commonly available electronics can be used to fill these sensory gaps very inexpensively. In addition, once sensory enhancement projects are created and published to public repositories, the devices can be re-created by novice users. In this way, the community can join forces to provide assistance to persons around the globe.

Project Goals. This project will devise a portable imbedded system for use by persons with extremely limited vision to augment the use of a cane. It will use between one and three ultrasonic sensors and multiple haptic feedback motors to guide users away from obstacles which are not yet in the range of a cane and would otherwise be undetectable.

The specific goals are:

- Design imbedded hardware system utilizing the arduino platform.
- Use multiple ultrasonic sensors and multiple haptic feedback motors as input and output to provide control of the system and feedback.
- Develop software to analyze sensor inputs and determine required hardware action and give appropriate haptic feedback.
- Test system to determine if it provides assistance to test subjects who are not allowed to use their sight.

Platform Choice. The choice of Arduino as the platform for development of this project was based on many factors. Top considerations were that it is extremely cost effective, extensively documented, readily available, and open source. Programs which are written to the microchip controllers on an Arduino board are run automatically on power-up, removing any need for the extra resource overhead and possible complications of an operating system.

Extensive libraries have been developed to support auxiliary sensors and peripheral devices in order to make communication between them and the Arduino quick and easy. When needed, though, it is also possible to create custom drivers because access to registers and specific bits is allowed.

The ‘about’ page of Arduino.cc states that “Arduino is the first widespread Open Source Hardware project and was set up to build a community that could help spread the use of the tool and benefit from contributions from hundreds of people who helped debug the code, write examples, create tutorials, supports other users on the forums and build thousands of groups around the globe.” It goes on to say “Arduino has become the number one choice for electronics makers, especially for developing solutions for the IoT marketplace, which has been predicted to become a $6 trillion market by 2021.”

Hardware Components Section

Arduino

Arduino Mega Specifications. The Seeedstudio Mega used for prototyping this project consists of:

Microcontroller	ATmega2560
Clock Speed	16 MHz
Flash Memory	256 KB (8 KB bootloader)
SRAM	8 KB
EEPROM	4 KB
Recommended Input Voltage	7-12V
Min-Max Input Voltage	6-20V
Operating Voltage	5V
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Total Number of Digital I/O Pins	54
Number of PWM Capable Digital I/O Pins	14
Analog Input Pins	16

Operating voltage of 5V is required to safely receive the signal from the ultrasonic device's echo pin without damaging the microcontroller, and also to drive the ultrasonic sensor's transmitters. Although this particular prototyping board has capabilities to interface with Android devices, that feature was not utilized for this project. In all other respects it is functionally equivalent to an Arduino Mega.

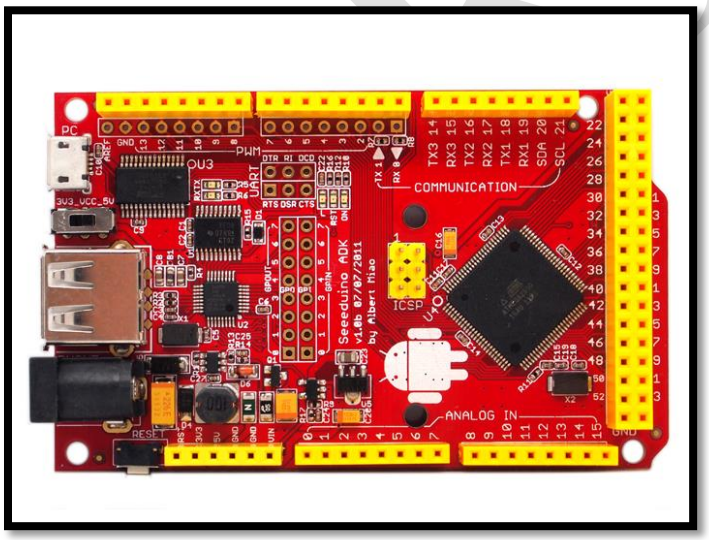

Figure 1 – Arduino Mega style board. *Source:* https://www.seeedstudio.com/Seeeduino-ADK-Main-Board-p-846.html

Arduino IDE. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci. Phasellus interdum arcu id nisl tempor fermentum quis ut dui. Sed pellentesque eget orci sit amet mattis. Nunc blandit massa sed nisi eleifend, et bibendum turpis aliquet.

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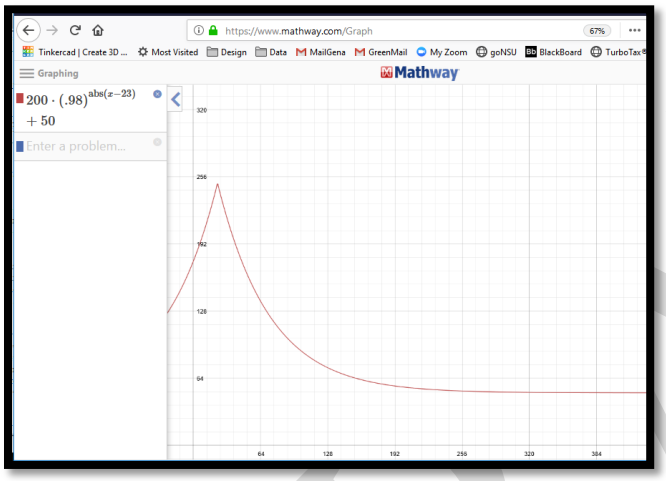

Figure 2 – Explanation of Figure 2.

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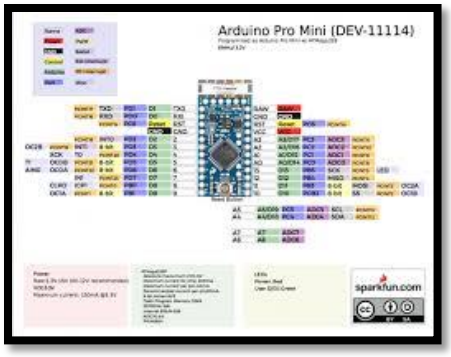

Figure 3 – Description of Figure 3.

Ultrasonic Sensors

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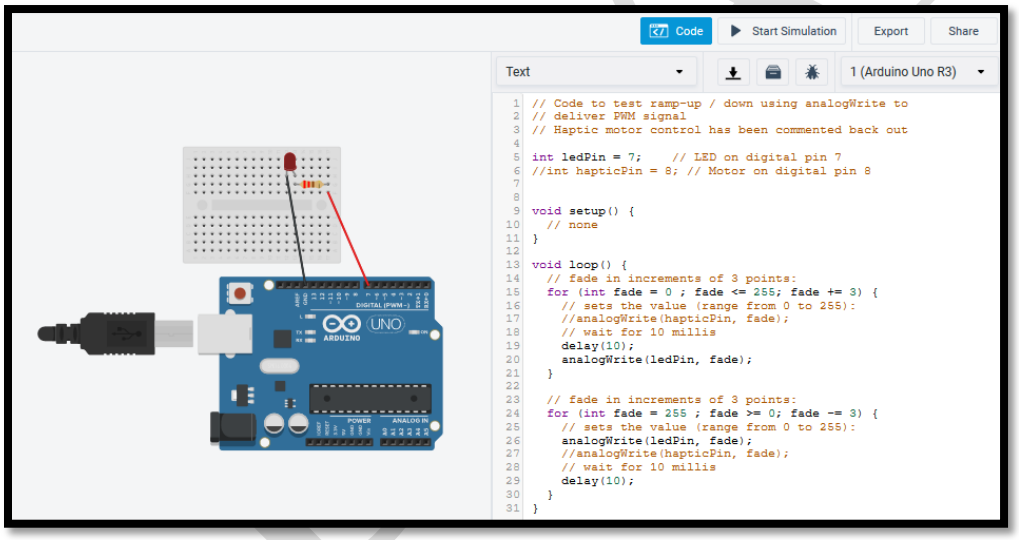

Figure 4 – Name Goes Here. *Source:* Site source. *"*Article Name*"*. Apr. 2014.

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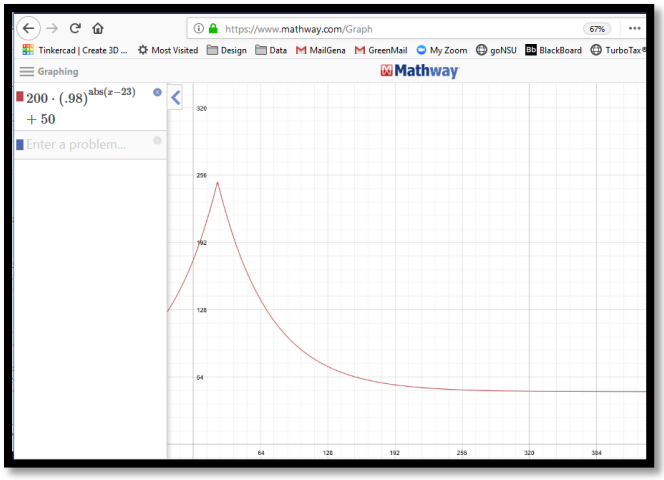

Figure 5 – Explanation of Figure 2.

HC-SR04 Operation. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci. Phasellus interdum arcu id nisl tempor fermentum quis ut dui. Sed pellentesque eget orci sit amet mattis. Nunc blandit massa sed nisi eleifend, et bibendum turpis aliquet.

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Micro Vibration Motor

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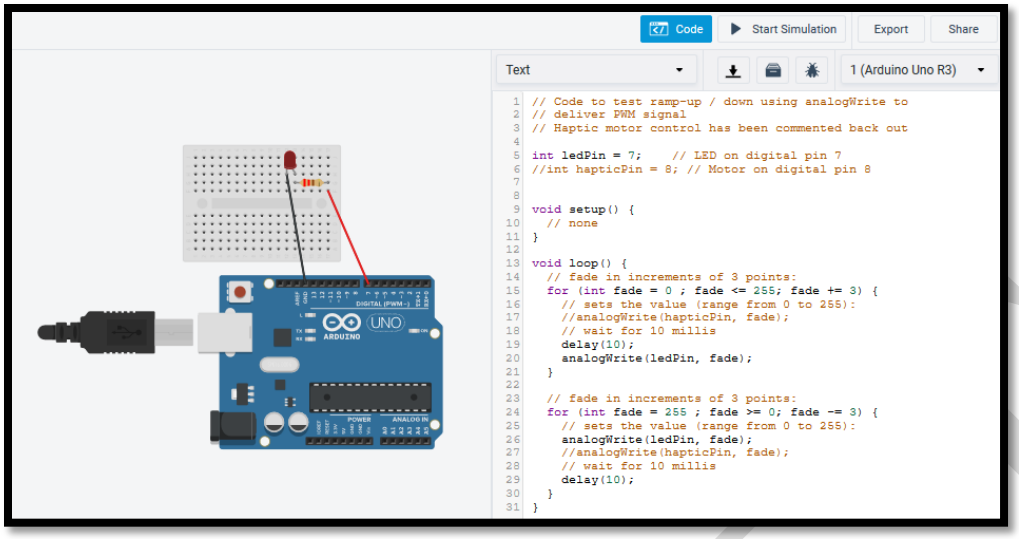

Figure 6 – Name Goes Here. *Source:* Site source. *"*Article Name*"*. Apr. 2014.

Micro Vibration Motor Operation. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci. Phasellus interdum arcu id nisl tempor fermentum quis ut dui. Sed pellentesque eget orci sit amet mattis. Nunc blandit massa sed nisi eleifend, et bibendum turpis aliquet.

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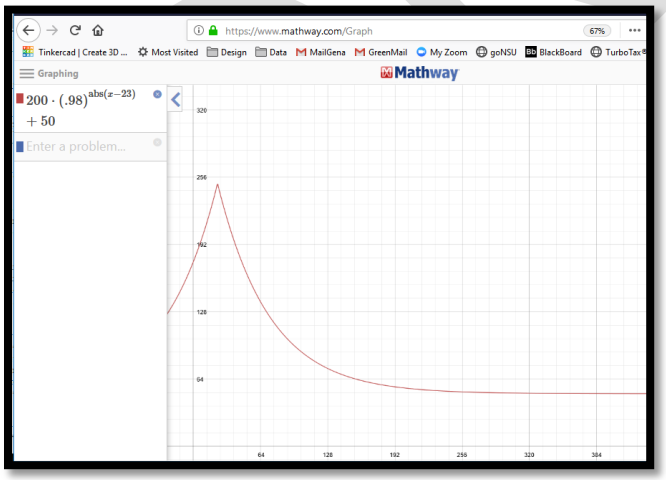

Figure 7 – Explanation of Figure 2.

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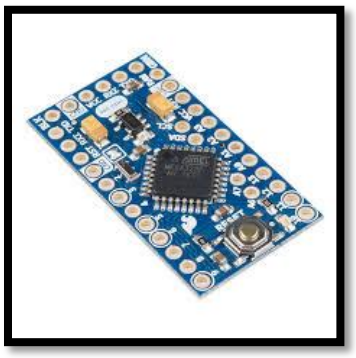

Figure 8 – Description of Figure 3.

Software Development Section

User Experience

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Intuitive Haptic Feedback. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci.

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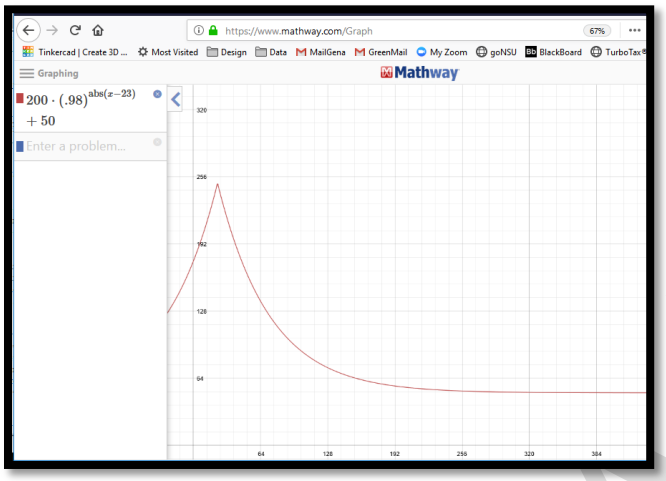

Figure 9 – Explanation of Figure 2.

Coding of Ultrasonic Sensors

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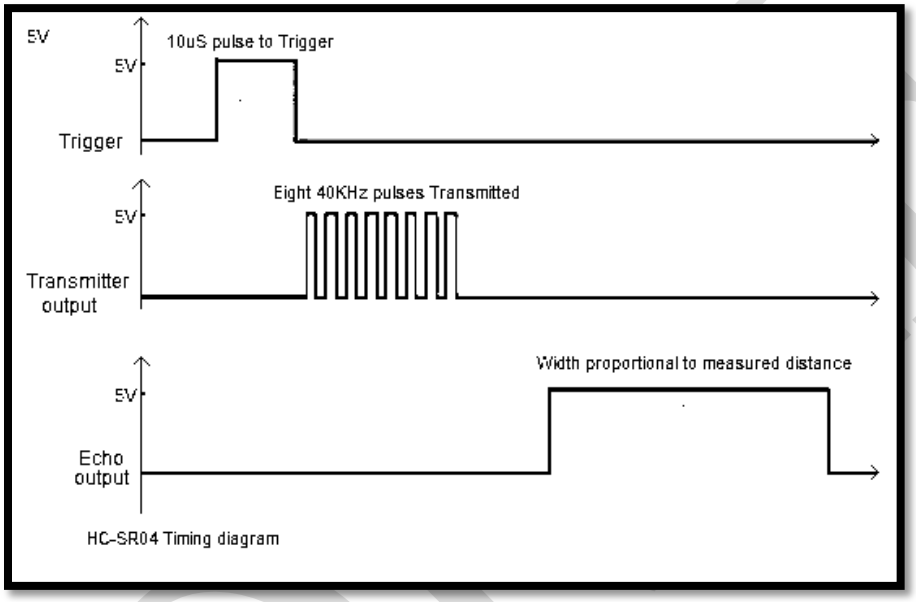

Figure 10 – Description of Figure 3.

Design of Software. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci. Phasellus interdum arcu id nisl tempor fermentum quis ut dui. Sed pellentesque eget orci sit amet mattis. Nunc blandit massa sed nisi eleifend, et bibendum turpis aliquet.

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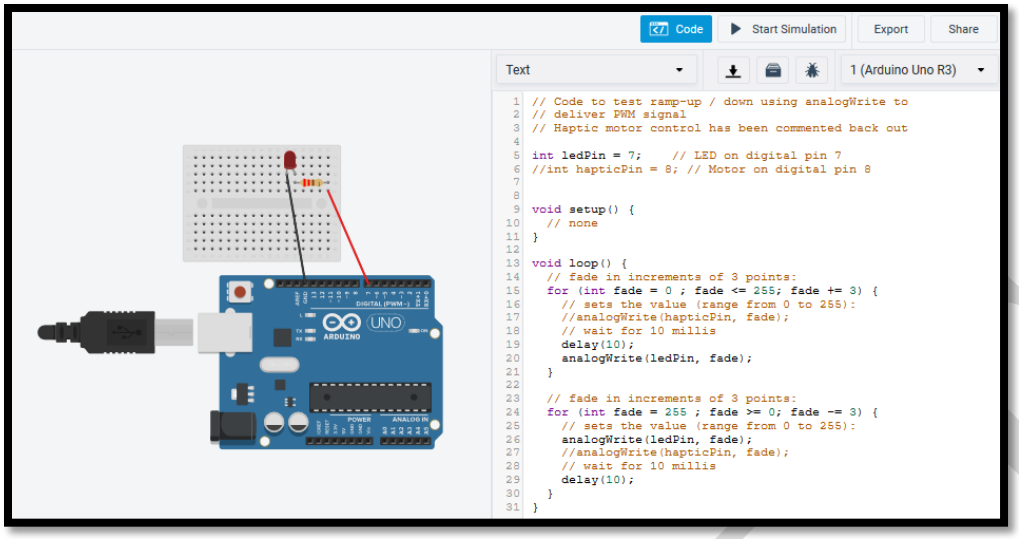

Figure 11 – Name Goes Here. *Source:* Site source. *"*Article Name*"*. Apr. 2014.

Software Improvement of Detection Accuracy. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Cras a gravida lectus. Praesent dapibus ante arcu, non laoreet dui imperdiet ac. Donec velit sapien, molestie et vestibulum at, molestie eu lacus. Praesent accumsan blandit efficitur. Sed suscipit maximus volutpat. Aliquam erat volutpat. Suspendisse scelerisque non lacus at consequat. Nunc ullamcorper convallis enim vitae faucibus. Maecenas id tincidunt orci. Phasellus interdum arcu id nisl tempor fermentum quis ut dui. Sed pellentesque eget orci sit amet mattis. Nunc blandit massa sed nisi eleifend, et bibendum turpis aliquet.

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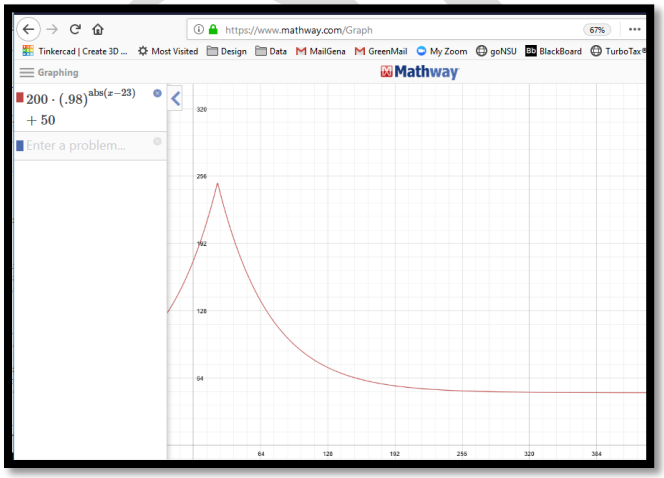

Figure 12 – Explanation of Figure 2.

Coding of Micro Vibration Motor

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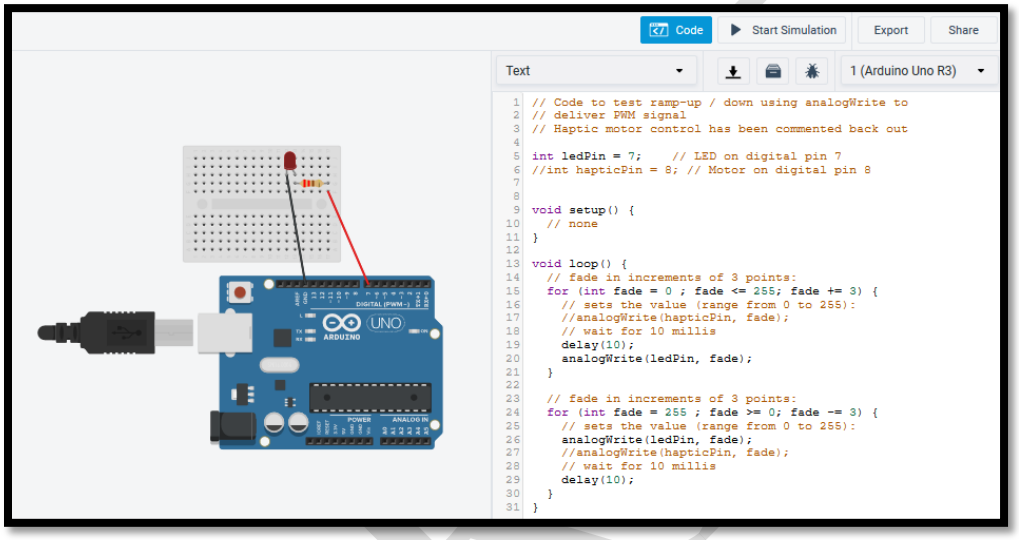

Figure 13 – Name Goes Here. *Source:* Site source. *"Article Name".* Apr. 2014.

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Figure 2 below is a demonstration of this concept. Sed suscipit leo ut purus interdum consequat. Maecenas at efficitur lectus. Ut mollis molestie scelerisque. Nulla commodo posuere eleifend. In a nisl sodales, mattis nulla a, venenatis odio. Etiam augue augue, malesuada vitae metus.

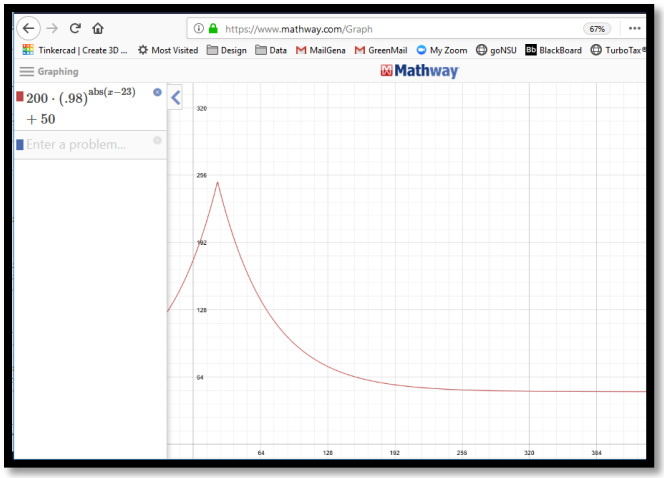

Figure 14 – Explanation of Figure 2.

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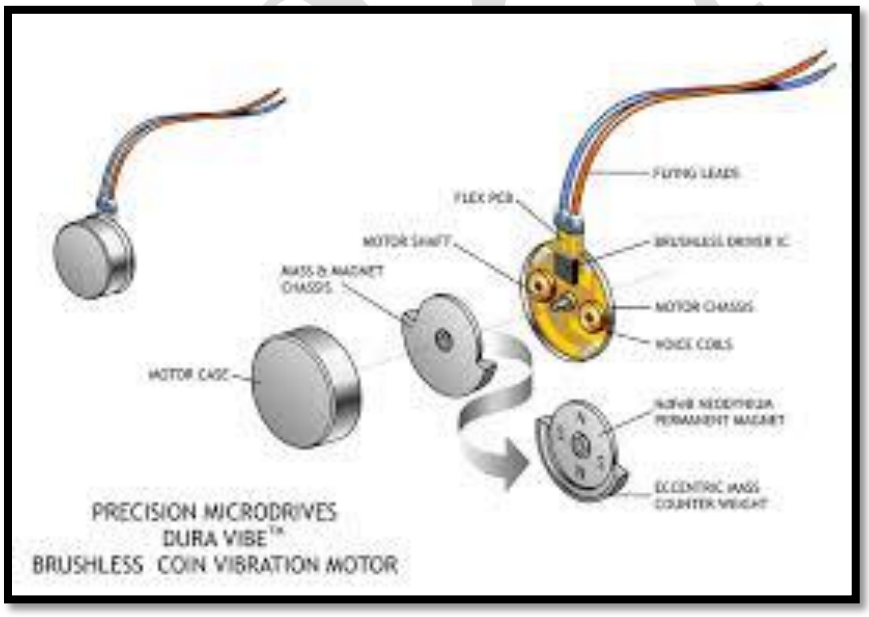

Figure 15 – Description of Figure 3.

Conclusion

Summary and Interpretation of Findings

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Recommendations

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