# Computer Science Research Project Final Paper: Signal: An American Sign Language-to-Text Application with Leap Motion Integration

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**Abstract**

We created a web application that integrates Leap Motion Technology. Leap Motion is a small, portable device that can be connected to computers via USB and are capable of tracking hand positions, and can feed the computer the numerical information (such as 3D coordinates). We used HTML and CSS for front-end development, and JavaScript, jQuery, and Leap Motion API for functionality. We also used Git to track and store our code on Github, an open-source platform for code collaboration. In the end, we have created a functional project that is able to translate half the alphabet from American Sign Language (as of now - more letters will be added later) to English text and display it on the screen.

# Contents

# 1 Introduction

Virtual reality is an ever evolving aspect of computer science and it has real-world applications. One motion-sensing technology companing called Leap Motion, Inc. has created a computer hardware sensor device that allows hand and finger motions to act as computer input. This Leap Motion technology has major implications for the world of computer science; already, it has been implemented in gaming systems, learning tools, among other things.

The focus of this computer science research project is to use Leap Motion technology to facilitate communication between American Sign Language users and non-users. The program used Leap Motion technology to extract hand signal input, and then translate that input into readable, English letters and sentences. As of now, only half the alphabet has been cataloged inside our program - however, in the future, we hope to also allow text input and will translate the text into hand symbol images on the screen for communication in the opposite direction. Furthermore, as program progresses, we hope to use text-to-voice API integration to further capability.

# 2 Previous Work

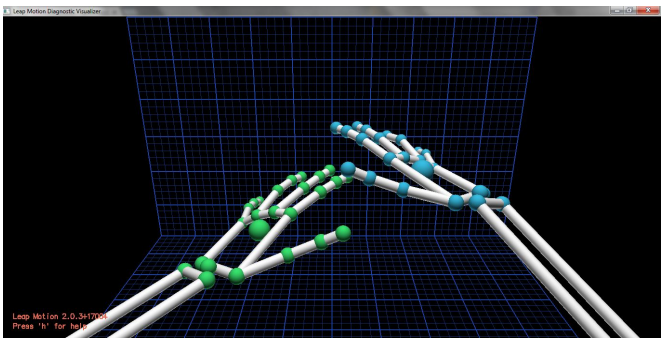
In the past, during TrinHacks 2015, we worked with a Leap Motion controller and Leap Motion technology to create a completely- hands free program with the purpose of helping students study for their classes. This application, titled “Trivia Leap”, was created over the course of 10 hours. While the process of coding the program helped us further our knowledge on working with the Leap Motion controller, the program itself did not incorporate it in a way that was vital in its execution. In other words, the Leap Motion controller was not necessary for the program to run. Because of this, we wanted to find a way that would completely integrate the controller into our project. After brainstorming, we came up with the idea of a sign language translator.

This idea came up when we saw a product by a company called MotionSavvy. The company says that it has developed a completely offline tablet that is able to translate from sign language to a spoken language, and vice versa. MotionSavvy plans to deploy its product in the fall of 2015. Due to the fact that MotionSavvy has not released its product as of when this paper was written, the code behind its main product is not open-sourced. For this obvious reason, we will be unable to access their code and similarly implement it in ours. Inspired by their motives, we hope to create a similar project with a translator of our own, through the use of the Leap Motion controller. Because of the nature of this venture, the Leap Motion will be an essential component of the program.

In addition, there has been extensive documentation done on Leap Motion technology and its integration with different programming languages; Java, Python, C++, Javascript, just to name a few. We plan to use this documentation as a reference during the construction of our proposed application.

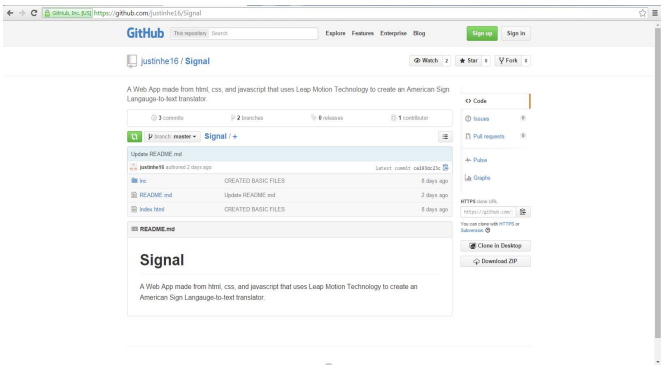
# 3 Statement of Work

Our proposed work was to create an American Sign Language-to-Text web application with Leap Motion Integration. Leap Motion is a specially-designed controller that connects to any computer or laptop via USB cable. The controller is a light sensor that is designed to detect the various patterns of shadows created by hands above it, and translates the hand positioning into 3D coordinates. We used Leap Motion API in our JavaScript code to use the tracking data from the Leap Motion Sensor to create a user interface. Furthermore, we used the tracking data to assign specific 3D coordinate combinations to different hand symbols. This allowed us to translate the different hand symbols in the American Sign Language alphabet into plain, old English text.




*A screenshot of the Leap Motion Visualizer*

We used HTML, CSS, and JavaScript, and jQuery as a means to decorate the front-end version of the application. In order to learn and refine our skills in these languages, we used various online resources such as Codecademy.com, W3Schools, and Google. Furthermore, we used Git and Github to share, publish, and keep track of code. To edit and view our code, we used Sublime Text as our coding environment/text editor. Through Git and Github, we were able to keep tabs and create checkpoints for progress made on the project. Furthermore, we used Github Pages to host our creation on the Internet.




*A screenshot displaying Github interface*

Starting this project, both of us have little-to-no prior experience with JavaScript. This by itself is a great uncertainty, but we were confident that we would be able to accomplish the goal in mind. Even though we have had some experience with the Leap Motion controller, it has been quite limited, as we have only been exposed to it during a single, 10-hour hackathon. Also, our experience with the technology involved Leap Motion integration in a Processing application, something that is notably different compared to web-based applications. Because of this, our coding ability was more limited than usual, as it took some time to get adjusted to the new tools at hand. Looking back at the goals we set for ourselves, we are proud of the completed project!

# 4 Results

After working on the project for the period of time we were given, we were able to accomplish several of the objectives we had set for ourselves. We were able to create a program that could successfully successfully print out half of the letters of the English Alphabet, and implement a hand sign that would print a space. We also were able implement HTML, CSS, and JavaScript, and jQuery in order to make the front end of the program more aesthetically pleasing, and use Git and Github to share and edit our code efficiently. A problem we did not anticipate was the accuracy of the Leap Motion controller. Unfortunately, because of the way that the controller detects separate parts of each finger in one hand, by nature it could only detect rigid hand gestures. This proved to be an obstacle for letters such as “o” and “c”, where the signers need to use their hands to make a curved shape. Given that the only other solution to this problem was to use vectors of the fingers as defined by the Leap Motion controller and the time we had left when we identified this problem, we were not able to incorporate those letters into the translator. Another issue was that of letters “m” and “n”, where signers were required to put there thumb in between their other fingers. An issue rose when we realized that because the Leap Motion controller operated through the detection of shadows, small discrepancies in the hand gestures would be hard to detect. However, given the time that we were allotted for the project, we are satisfied with the product and hope to continue working on it in the summer.

# 5 Evaluation Plan

In order to evaluate our success at the end of this journey, we decided to assess our project by looking at its functionality. Functionality is vital to our project, and appearance and other aspects of the program will have a 2nd-tier importance. We measured functionality based upon 3 metrics: Accuracy, Speed, and Volatility. For accuracy, we measured how well the web application can tell which hand symbol we are using. For example, if one were to create an A symbol in sign language and the program understands it half the time, Accuracy scores a 5 out of

10. For Speed, we looked at how quickly the program identifies each symbol. For Volatility, we looked at any negative functionality aspects the web application has - any glitches with hand symbol reading and what not. Any points in Volatility will be negative. Appearance was evaluated with less weight -- appearance will only score us “bonus” points. In the end, we were impressed with the functionality of the program. After implementing code that allowed for us to take a “snapshot” of the hand positioning, the Accuracy of the program came out to a strong 9 out of 10, since sometimes the Leap Motion Controller would interpret the hand gesture incorrectly, a factor that was not attributed to our actual code. The Speed of the program was also notable: the code functioned with little to no lag. In terms of Volatility, the code functioned flawlessly: when giving the correct hand gesture, the code functioned the way it was intended, much to our contentment. While the Appearance of the program was a bit bland, the title page with interactive design made up for it. In the end, we are proud to say that our program had nearly perfect functionality, and hope to incorporate the rest of the alphabet with the same standard we set for ourselves for the current version of the code.

# 6 Conclusion

After hard work and determination, we were able to create an American Sign Language translator that was able to function the same way we envisioned it to. We are impressed on what we were able to accomplish: at the project’s inception, we knew how much we would have to learn in order to make the project work. While the task was daunting, we were able to persevere and succeed in the end. Even though there are letters missing from the translator, we are confident that we will be able to utilize the same determination we had for this project in order to complete the rest of the more difficult letters. Looking back at how much we have grown by working through this project, we are honored to be the creators of Signal!

# 7 References

http://www.motionsavvy.com/

https://github.com/justinhe16/Signal

https://developer.leapmotion.com/

http://www.w3schools.com/js/default.asp