Project Team 5
Sign Language Detection

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Team Members

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References

1. Bhuyan, M. K., Ghosh, D., & Bora, P. K. (2006). Hand motion tracking and trajectory matching for dynamic hand gesture recognition. Journal of Experimental & Theoretical Artificial Intelligence, 18(4), 435–447. doi:10.1080/09528130600975931
2. Abid, M. R., Petriu, E. M., & Amjadian, E. (2015). Dynamic Sign Language Recognition for Smart Home Interactive Application Using Stochastic Linear Formal Grammar. IEEE Transactions on Instrumentation and Measurement, 64(3), 596–605. doi:10.1109/tim.2014.2351331

Business Case

I. Description

This project is a camera-based hand gesture detection system that can translate said gestures into symbolic outputs, which could potentially be passed to a smart-home system in order to perform common tasks. There are three main parts to this project: the visual input system, the gesture interpretation, and the command output system.

First, the visual input system will use any basic camera in order to read frames from a video feed. We expect this part of the system to be able to read hand gestures in any well-lit room that is about the size of an average bedroom or living room. These frames of gesture images will be compressed or have basic data extracted, and then be sent to the gesture interpretation system. This gesture interpretation system will most likely initially live on a personal computer linked directly to the visual input system, but may eventually work on a server computer that is separate from the visual input system, which would work better for smart home integration with lower processing power. It will use machine learning to detect hand signals from the input frames.

The current plan for the gestures that can be detected are American Sign Language letters A through Z and numbers 0 to 9. An additional goal of this gesture interpretation system would not only be interpreting the correct hand gestures as individual characters, but also being able to correctly guess certain common command phrases, possibly using a phrase detection algorithm common in web search systems, that would be given to the final output system. This system will initially output to a command line with the characters and phrases it detects and guesses at, with an additional goal to be integration with a smart-home system in order to have these commands turn into actions.

II. Motivation and Prior Research

Our primary motivation for this project is the lack of a reliable hand gesture detection system that can be used with simple cameras whose outputs are interpreted and can be used in combination with any smart-home system API. This system could be used in a variety of situations including benefiting the bed-ridden or disabled by allowing an avenue to easily access smart-home systems without having to speak, which could help perform basic tasks like controlling various electronic devices, using the phone or other communication system, or browsing the internet.

Although the field of hand gesture detection systems has been growing due to the recent growth in interest in machine learning, which is useful for such systems with enough processing power, there currently are not any prominent systems available that allow hand gesture detection for smart-home devices. For example, in a paper on hand motion tracking and dynamic hand gestures, Bhuyan, Ghosh, and Bora were able to create a gesture detection system with 95.6% accuracy by mapping a sequence of hand gestures to a series of visual object planes, which are then interpreted as gestures if they match a set of finite states within a certain threshold, otherwise they are left as insignificant hand movements [1]. Abid, Petriu, and Amjadian were also able to make an even better hand gesture recognition system, with a success rate of 97%, that used several methods to override system failure by categorizing unrecognized frames, in addition to modularity by introducing a bag-of-features approach that allows features of the body beyond the basics of hands to be added and recognized in a gesture [2]. Overall, these other projects show a large potential for simple hand gesture recognition systems with

high accuracy, which motivates our project to move forward in using this technology to create a system that can integrate with modern smart devices.

III. Objective

Our goal is to develop software that can detect hand gestures done in front of a camera such as a web cam. Given a video stream, the software will map these gestures and detected hand movements to commands for a smart home device, allowing a user full control of the device with sign language. This software will be optimized for real time operations and over 90% accurate. It will also allow the user to customize gestures and their commands.

IV. Benefits

This project will benefit people with disabilities or temporary injuries who cannot use a smart home system with voice commands by allowing them to use hand gesture control instead. It will also benefit companies who produce smart home devices, as it will slightly expand their market to include more people that can use these devices.

Project Scope

V. Tentative Functionalities

Function	Description
Phrase Customization	The ability to allow users to customize what command a gesture will activate.
Versatile Integration	Effortlessly integration into any system with a camera and access to the internet. (smart home, smart home, laptop, etc.)
Intuitive Interaction	Anyone capable of producing sign language should be able to use this software without any additional knowledge.

VI. Environment and Technology Used

Technology	Description	Development/Deployment
GitHub	Development platform for source code and version control.	Development
Trello	Task manager and organization.	Development
Docker	Development platform for building, testing, and deploying software in standardized units.	Development and Deployment
Amazon Web Service	Host for cloud computing.	Deployment

VII. Expected Deliverables

Deliverable	Description

High Accuracy Gesture Detection	The hand gesture detection in this project is expected to correctly identify gestures with an accuracy of greater than 90%.
Realtime Command Actions	Quickly activate commands to make this a more convenient option than the user doing the action themself.

VIII. Acceptance Criteria

Criteria Category	Acceptance Level
Recognition Accuracy	90% or greater
Device Deployment	Raspberry Pi
User Interface	Minimal for demonstration purposes only

IX. Assumptions, Constraints, and Risks

1. Assumptions

- The system will be used without a visual interface.
- The user knows the recognized gestures.
- The recognized gesture set will be comprised of American Sign Language.
- The user will have a strong internet connection.
- The environment of the system will have adequate lighting.

2. Constraints

- The system should meet or exceed minimum acceptance level by 12/14/20.
- The system should detect a specific set of hand gestures that can be used to control smart home devices.
- The system should be developed with no budget using free tools and resources provided by the university.
- The system should, at a minimum, be able to recognize a specific set of hand gestures with 90% accuracy.
- The system will be developed by a five member team of developers achieving a total time commitment of working 40 hours collectively per week.
- The system will be developed with minimal physical interactions from the Developers and Stakeholders for safety from the current Covid-19 pandemic.

Organization and Communication

X. Duration and Tentative Deadlines

Project Assignment	Tentative Deadline
SRS Document	September 6, 2020
System Model	September 27, 2020
Development Phase	September 27 – November 1, 2020
QA Testing	November 1, 2020
Final Report	November 22, 2020
Completed Project	November 30, 2020
Client Demo	December 7, 2020

XI. Budget Estimate

For the purposes of this project, there will not need to be a set budget. However, in the event of utilizing a smart home camera for testing, there are plenty of devices that fall within the price range of 25-75$. Using a Raspberry Pi or utilizing cloud services are currently tentative aspects of development, however if need be, utilizing AWS for cloud services would be free up to 12 months or for the usage of 750 hours per month. AWS EC2 offers many different pricing options, an on-demand general purpose 16-bit CPU would come to roughly 0.20$ per hour of usage, however the most expensive general-purpose option would be 6.53$ per hour. However, the team cannot imagine going over the constraints of utilizing the free 750 hours per month during development.

XII. Internal and External Roles

Project Role	Name & Organization	Responsibility
Project Manager & Customer	Dr. Razib Iqbal *Missouri State University*	Responsible for guiding the project to its final state, keeping the team on task and ensuring a successful end demonstration of functioning software. He will also provide the team with whatever it needs to succeed and will be the team's contact regarding the requirements and fulfillment of those requirements.
Software Developers	David Gray, William R. Hughes, Robert Stoner, Braden Bagby, Zachary Langford, *Missouri State University*	The full team responsible for the creation and implementation of a software that meets the specific requirements. Meeting the requirements in a timely manner and communicating effectively to the Project Manager/Customer about any

		details that arise during development.

XIII. Stakeholders

- Dr. Razib Iqbal
- Disabled individuals, more specifically deaf or speech disabilities
- Workers associated with Missouri State's Disability Resource Center
- David Gray
- William R. Hughes
- Robert Stonner
- Braden Bagby
- Zachary Langford

XIV. Communication Methods

Stakeholder/Project Role	Communication Medium	Communication Methods	Meeting Frequency
Development Team	Microsoft Teams, Trello, GitHub (tentative)	Team members will be using Microsoft Teams for most communication methods, conducting online meetings, and sharing any files used on or for the project. Trello will be used exclusively for project management methods. GitHub may be used for version control, and source code.	Weekly
Customer/Project Manager	Microsoft Teams, Zoom, or Email	The development team will be using email to contact the customer/project manager which if need be, may escalate to a Zoom or Microsoft Teams meeting. Demos will need to be held remotely via Zoom or Microsoft Teams.	Bi-Weekly
Stakeholder (more specifically MSU's Disability Resource Center)	Email, in-person or remote demos/meetings	Development team will communicate to the Disability Resource Center to perform demos with individuals proficient in sign-	Monthly

		language. Demos may need to be performed remotely via Zoom; however in-person demo would be preferred.	