Team 16

Knuckles, Assistive Robotic Arm

Fall 2018 – Spring 2019

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# COVER LETTER

September 17, 2018

Greetings Dr. Roysam,

We are a senior design team of four motivated students and we would like the opportunity to attend and showcase a competitive project at the IEEE National Conference. Our main goal is to promote the innovated image of our growing university and more precisely the Electrical and Computer Engineering Department. We believe our participation will be valuable to the department’s reputation and this is what we had in mind.

The negative consequences of multitasking came to our attention and our team decided to find a solution. According to the scientific journal, *Current Biology*, shifting focus to multitask reduces productivity by around 40%. As a result, multitasking wastes time, efficiency and may lead to incidents. As a solution, our team started developing Knuckles, the assistive robotic arm. The purpose of our project is to have Knuckles help hand objects to a user performing hands-on work. The user will no longer need to waste time pausing work to search for tools; Knuckles will retrieve the requested object through voice commands. The user will therefore maintain focus and be more efficient.

We have a detailed approach and promise to have a full functioning product by March 19th, 2019. In terms of current progress, we are 3D printing an open source robotic arm called the BCN3D Moveo and are procuring the necessary equipment to fully build and control the robotic arm. We are also modifying an IEEE open source gripper to replace the original one. We have a simulation of the original Moveo robot arm, and an object detection program that works on laptop webcams. Our dedicated team will have a controllable, physical robotic arm built and a working mechanical simulation by the end of the Fall semester. At the end of the Spring semester, we will have a working object detection and voice recognition software integrated with Knuckles.

Please feel free to contact us if you are interested in learning more about Knuckles. We are looking forward to your consideration. We are grateful for your time.

Sincerely,

Andrew Blanchard, Rym Benchaabane, Paola Hernandez, & Matthew van Zuilekom

# REPORT

**Knuckles, an Assistive Robotic Arm**

**Sponsored by Makerspace**

**Fall 2018**

**Purpose**

Knuckles is an assistive robotic arm that will hand the user requested objects and tools. It will serve as a convenient assistant that will increase the user’s productivity and decrease the risk of dexterity incidents.

**Background Information and Research**

In today’s society, people are rushed and tend to multitask. According to research from the scientific journal, *Current Biology*, shifting focus and attempting to multitask reduces productivity by around 40%. *SMF Mutual Insurance* adds that multitasking can lead to dexterity incidents while performing hands-on work.

**Problem and Need**

The problem is that multitasking causes a lack of focus on a task which results to a waste time, money, and can also lead to serious injury. What is needed is a solution that allows the user to continue with their task without distractions, and can assist the user as needed. The extra hand will allow one to focus on the work without having to get up and grab another tool, which saves one time and effort in completing the current task.

**Deliverables**

At the end of the Fall semester, our team will provide the hardware part of the project, which will be the physical robotic arm. The user will be able to use a developed simulation on the computer to manually control the robot through text commands. The simulation will be done through Rviz on the Robotic Operating System (ROS). At the end of the Spring semester, our team will provide the software portion of Knuckles, which will include the object detection and voice recognition portion of the project. With the additional help of the software packages, the user will be able to give voice commands to receive requested objects from Knuckles.

**User Analysis**

Knuckles is currently being developed with lab researchers, mechanics and people with disabilities all in mind. In addition, Knuckles can be used for residential purposes. Indeed, users will not require much training, as Knuckles will be controlled through voice commands. Knuckles will be plugged into a power plug. The user needs a computer where they run the application for Knuckles. Finally, the user will need to know the keywords to activate Knuckles and give voice commands retrieve to requested objects.

**Significance**

Anyone willing to use an extra hand would care about our project. For instance technicians, people with disabilities, open-source robotics community, and researchers are all potential users. The robotic arm will be best applied when the user is conducting hands-on work and is not able to get up from their work. The three main reasons why this project is meaningful are convenience, productivity and cost effectiveness. The user will not only save time and production costs but will also avoid injuries, as well as effectively find objects. Therefore, the user will be more productive thanks to a very convenient tool, Knuckles.

**Division of Labor**

This is the summary of the overall design to understand the different assigned tasks to each team member. Knuckles will operate using high-end technology on a desk or in a lab space. Knuckles is being designed to identify, acquire, and provide an item to an user, with the use of object and voice recognition. The arm scans the environment periodically to create a 3D map, where it identifies its surroundings. Our team is manipulating object and voice detection software to control the robot with voice recognition and provide commands.

Andrew Blanchard, the team captain, is majoring in Computer Engineering and is currently enrolled in a *Introduction to Robotics* class which will expand his knowledge on the mechanical part of our project. He also has experience with facial recognition software using *OpenCV* (a software package that is used in the *Robotic Operating System*) thanks to a project he worked on during his Freshman year. Matthew van Zuilekom, majoring in Electrical Engineering (concentration in Computers and Embedded Systems), is currently attending the *Introduction to Robotics* class and plans on taking a *Introduction to Machine Learning* class next semester to enhance his skills in software, more specifically C and Python. Therefore, Andrew and Matthew will focus on developing the ROS (Robotic Operating System) motion simulation of the robot including the 3D mapping and building the physical arm hardware design. Paola Hernandez is majoring in Computer Engineering and made a B+ in her *Microprocessor* class. She has experience with programming languages such as C/C++/Java and Python. Paola’s role is to study and implement the object recognition software of Knuckles as well as the simulation of that feature on ROS. Finally, Rym Benchaabane’s concentration is Signals, Controls and Communications. She has worked on signal processing software projects. Rym will help with the development of the voice recognition feature of Knuckles as well as its simulation on ROS. Rym also has good intuition with algorithms. Paola and Rym will also be involved in building the robot to understand the functionalities of the hardware components we are using for Knuckles. All four of us are currently taking courses in ROS with the Robotic Committee of IEEE. In case of conflict, all four members share similar skills and therefore supporting each other would not be an issue.

**Project Summary**

To summarize, multitasking can be dangerous and time consuming. Knuckles is a robotic arm that will assist the user with handing requested tools through voice commands to make the task more convenient and accomplish work goals more efficiently.