**Team 3 “Knuckles” Project Description**

Introduction

The Makerspace robotics team aims to design an assistive robotic arm that will operate on a desk or lab space.

On startup, the robot will map the space around it. The robotic arm will be able to pick up object after a given voice command using the scanned map.

When given a voice command to pick up an object, it will use that map data to pick up the object and give it to the requester.

Potential Applications

The robotic arm can be used as an assistant in a laboratory, an office or for people with disabilities.

It can operate in low light settings and respond to voice commands, making it versatile in different environments.

Mechanical Specifications

The mechanical objectives of this project are 6 degrees of rotational freedom, tactile sensing, and dexterity.

6 degrees of freedom give the robot the greatest range so that it can access anything in its surroundings.

The rotational axis will be designed with Autocad.

The gripper will be located at the tip of the robotic arm also representing the robot’s “head”.

The gripper will be prototyped with AutoDesk and a 3D printer.

Tactile sensing gives the robot feedback on objects it picks up or feedback when it is touched, allowing it to react accordingly.

Dexterity lets the robot reliably pick up an object and hand it to someone.

Hardware Specifications

Programming Specifications

The programming objectives of this project are machine learning, visual processing (such as mapping and object detection), voice recognition, speech recognition, and autonomous motion. Visual processing will be handled using OpenCV and TensorFlow. These libraries will allow us to access and process images, while building a neural network to improve recognition. In addition, a radar sensor will also be equipped to the arm to form a 3D map of the environment. Machine learning will connect to visual processing as the robot learns to detect objects and find the best path to grab them. Voice recognition will let the robot process commands that require a chain of steps such as “Give me a pencil.” It will also process movement commands such as “open hand.” Voice recognition and response is likely to be processed using an Arduino. Autonomous motion lets the robot move without external input beyond voice commands. 6-axis movement and mechanics will be developed using Robot Operating System (ROS) on Ubuntu. The gripper will be created in AutoCAD and prototyped with a 3D printer.

Learning Objectives

A major part of Makerspace is giving people experience in new skills or developing existing skills.

Through this project, the team members will gain a working knowledge of Python, C, and C++ for use in Object Detection, Facial Recognition, Speech Recognition, Machine Learning, Neural Networks, and Artificial Intelligence.

The programming languages allow the use of the OpenCV and TensorFlow libraries for visual processing and machine learning, respectively.

Other major software that will be used for this project are ROS, which runs on Linux, AutoCAD, and Arduino.

Milestone Table

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| **Milestones** | **Due Date** | **Minimum** | **Target** | **Stretch** |
| 1 | Summer | -Functional gripper prototype with functional camera & tactile sensing | -Working object and voice recognition program | -Facial recognition software implemented  -6 Axis Arm prototype  -NeoPixel ring light around the camera is able to light up dark areas and provide light for the user |
| 2 | Fall | -Physical arm completed & controlled by controller (ex. Xbox)  -Syncing voice, object, and facial recognition program | -Implementing ROS and TensorFlow for object manipulation  -ROS works with a LIDAR to map the room | -Arm completely functional with Voice, Object and Facial Recognition implemented |
| 3 | Winter [Mini Semester] | -Differentiates between faces and objects | -Arm is able to pick up object asked for without difficulty. For example, will not give wrong object  -Robot can do handshakes and multiple responses to user commands (“open hand”, “close hand”, etc.) | -The robot is working as smoothly as possible. Efficient mechanical movement |
| 4 | Makerspace Due Date  (last week February) | Arm meets all specified goals and performs as expected/well | Robot is able to move more quickly than a human assistant without sacrificing control | Touch sensors on the robotic arm to have arm respond when touched. Pet-like animations |
| 5 | Chili cook-off | Resolve issues brought up at Makerspace presentation/by sponsors | Arm is ready to take part in presentation, responds to new users and random people | Create outside cover for the arm. Protection and aesthetics |

Team 3 “Knuckles” Project Description (full outline below)

Our team aims to create a robotic arm that can detect its surroundings, pick up objects, and interact with people using AI.

The mechanical objectives of the arm are 6 degrees of rotational freedom, capacitive touch sensing, and dexterity.

* Rotational freedom allows the robot to access anything in its surroundings without any assistance
* Capacitive touch gives the robot feedback on objects it contacts
  + Sensors in hand when it pick up objects
  + Sensors on arm itself so it can react to being pet
* Dexterity
  + Robot should be able to reliably pick up an object and hand it to someone

The programming objectives of the arm include voice and face recognition, machine learning, and visual mapping.

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The Makerspace robotics team aims to design an assistive robotic arm that will operate on a desk or lab space.

Object and facial recognition will be handled using OpenCV and TensorFlow. These libraries will allow us to access and process images, while building a neural network to improve recognition. In addition, radar sensor will also be equipped to the arm to form a 3D map of the environment.

The arm’s 6-axis movement and mechanics will be developed using Robot Operating System, ROS, on Ubuntu. The gripper will be created in AutoCAD and 3D printed as we prototype.

Voice recognition and response is likely to be processed using an Arduino. When users make requests of the arm, it should …..

Technical skills, languages and capabilities learned by this project include: Python, C, C++, OpenCV, TensorFlow, ROS, Linux, ….. , Object Recognition, Facial Recognition, Speech Recognition, Machine Learning, Neural Networks, Artificial Intelligence, Robotics, ...

Additional objectives include: pet-like animations to create an organic response to users and environment.

* Overall Idea
  + The Makerspace robotics team aims to design an assistive robotic arm that will operate on a desk or lab space.
  + it can detect its surroundings, pick up objects, and interact with people using AI.
* List of Possible Applications
  + Assistive arm for
    - Lab use
    - People with disabilities
* More in-depth info
  + Mechanical objectives
    - 6 degrees of rotational freedom
      * allows the robot to access anything in its surroundings without any assistance
    - Capacitive touch gives the robot feedback on objects it contacts
      * Sensors in hand when it pick up objects
      * Sensors on arm itself so it can react to being pet
    - Dexterity
      * Robot should be able to reliably pick up an object and hand it to someone
  + Programming objectives
    - Visual Processing
      * will be handled using OpenCV and TensorFlow. These libraries will allow us to access and process images, while building a neural network to improve recognition. In addition, radar sensor will also be equipped to the arm to form a 3D map of the environment.
    - Machine learning
      * In connection with visual processing, robot will learn to recognize objects and how to find the best path to grab it
    - Voice recognition
      * Voice recognition and response is likely to be processed using an Arduino.
      * Recognizes different users’ voice
      * Robot can process commands that require a chain of steps e.g. “Give me a pencil”
      * Can also process movement commands e.g. “open hand”
    - Autonomous motion
      * 6-axis movement and mechanics will be developed using Robot Operating System, ROS, on Ubuntu. The gripper will be created in AutoCAD and 3D printed as we prototype.
* Learning objectives
  + Programming languages
    - Python
    - C
    - C++
  + Programs/Software
    - OpenCV
    - TensorFlow
    - ROS
    - Linux
    - AutoCAD
    - Arduino
  + Programming Concepts
    - Object Recognition
    - Facial Recognition
    - Speech Recognition
    - Machine Learning
    - Neural Networks
    - Artificial Intelligence
* Milestones
  + By the end of summer:
    - Prototype of arm
    - Working program for object recognition
    - Working program for voice recognition
    - Functional Gripper
  + End of Fall semester: