

1 Materials and Methods

1.1 Materials

PIC32MX795F512L: A 32 bit micro-controller for performing the control algorithms of the robot. The PIC32MX795F512L comes from SparkFun electronics as part of the UBW32 board, which comes preloaded with a bootloader for programming the board. The PIC32MX795F512L is programmed in C/C++. To make the device easier to use, we loaded an avrdude bootloader onto the device to use the MPIDE software. The MPIDE framework allows us to use Arduino libraries on the PIC32MX795F512L which helps to accelerate development of basic I/O software for the board[3].

MPU6050: A gyro and accelerometer for obtaining information about the kinematics of the arm and the leg. Uses I2C connection to the PIC32MX795F512L for communication.

Computer vision technology has many tools for object detection and recognition. There are many machine learning paradigms that can be applied to the task of object detection. Neural Networks and Support Vector Machines(SVM) are two technologies that are commonly used in this area. Neural Networks are very complex to tweak and configure, but can achieve great accuracy while being light weight at run time. SVM is a well understood mathematically and configuration of such systems is also well understood. They are light weight if used with simple linear kernels, but more complex kernels would be difficult to implement on a robot[1]. However, all these technologies can be difficult to implement on an embedded system such as a robot, so we will attempt to do develop new techniques that will be lighter on computational power.

The other component of our robot is the robotic hand. There are many different companies and research groups constructing robotic hands for many different applications. There are hands designed to be prosthetics, as well as hands designed to be integrated into robotic systems. One of the most complex is the UB Hand IV, this hand is nearly the same as a human hand in terms of capabilities. However, the hand is very heavy and very power hungry, so it is not very suitable for most applications[2]. We want to leverage some modern technology to make a robotic hand that is smaller and light weight.

1.2 Capstone Technology

We will be attempting to produce a cheap and simple computer vision technology for object detection. Accomplish this, we will be utilizing lasers to make the image processing challenges simpler. Processing live video using common machine learning based computer vision algorithms may prove to be challenging for the smaller computers we will be utilizing for the robot. To help make the task simpler, we will utilize a laser on the head to scan the space. By using the laser to scan the image, and utilizing the live video of the laser motion, we can easily detect edges without using complex algorithms. Using these edges we can find objects. We will also have another laser on the arm. Once we have an object detected, we can use the laser on the head to point at the object, and try to line up the arm using it's own laser. By using the two lasers we can try to guide the arm towards the object.

To make the robotic hand, we will be trying to use small components as much as possible to reduce the size and weight. By using smaller motors, we can make the hand small and still have many degrees of freedom. We cannot make the hand as complex as a human hand, so we will need to sacrifice some capabilities to make the hand small and low power. A major technology that we plan to implement is Shape Memory Alloy(SMA). SMA is a new material that can contract when heated this allows us to use it as an actuator. We can utilize wires of SMA to control joints and other areas of the hand where space is very limited. Combining these various technologies, we can make a hand that is very human-like.

References

- [1] Peter O. ([http://stackoverflow.com/users/815724/peter o](http://stackoverflow.com/users/815724/peter-o)). What are advantages of artificial neural networks over support vector machines? Stack Overflow. URL:<http://stackoverflow.com/q/11632516> (version: 2014-03-03).
- [2] C. Melchiorri, G. Palli, G. Berselli, and G. Vassura. Development of the ub hand iv: Overview of design solutions and enabling technologies. *IEEE Robot Autom Mag*, 20(3):72–81, 2013.
- [3] Microchip. *PIC32MX5XX/6XX/7XX Datasheet*, 11 2012.