



# Project Proposal

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# PROJECT SUMMARY

### Objective

This project will serve as an apparatus that is capable of picking up and moving objects, possibly on an assembly line. The problem that exists is the risk of injury to workers who work with dangerous equipment. Replacing workers in these dangerous situations will eliminate injuries and workers compensation claims, and improve performance efficiency. The service it will provide will be picking up an object, and orienting it correctly, and placing it in a decided location, either a stationary machine or onto a conveyer belt.

### Motivation

This project has the potential to replace a worker that operates machinery. Fabrication shops utilize machinery that have the potential to be dangerous when an error occurs. For example, A machine that carves treads into a screw or a hose bib utilizes a clamp that applies a tremendous amount of force in order to keep the parts oriented correctly. Inserting the parts into the clamp by hand can be dangerous, as part of a finger could get caught in the clamp and cause injury. When workers repeat this task multiple of times a day, alertness decreases as repetition increases, thus increasing the chance of human error and subsequently, injury. Having a robotic arm that can pick up a part, and place into the clamps flawlessly will eliminate the possibility of injury and increase efficiency and production.

### Technical Features

This project will consist of three main parts. The first part is the construction of the robotic arm, its electronics and its controller. This will be the most time consuming portion of the project, and possibly the most difficult to accomplish in under 10 weeks. If this project in to be completed in time, then I will consider purchasing a robotic arm and controller that has already been designed and constructed. This allows me to focus more on the software part of the project, while still getting some experience of working with electronics and hardware. If this path were to be taken, then the next step after purchasing the robotic arm, would be discovering how to send and receive signals to the controller from a computer. Once control of the robot is established, then the next step would be to program a control interface for operation from a computer. The interface will include initial programing of the arm movements (kind of like a 'learn' ability), then an execution loop that will continually run the learned movements at some specified rate. The last part of the project will prove to me the most challenging. It involves equipping the robotic arm with an on-board camera that will be used in the 'picking up' part of the movement (that is, when the arm picks up the desired object). The camera will capture an image of the object from a pre-set home position. From there, it will analyze the orientation the object, identify the key points on that object where the arm desires to grab the object by, and compute a movement scheme to go about picking up the object without colliding with its surroundings.

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In order to make the most of my time, I am going to complete this project in reverse order. I will begin with the computer vision. In order to get familiar with computer vision, I am going to begin with some simple webcams. Microsoft has created a camera called the Kinect that can do object recognition and depth calculation, however I wish to learn about the operations behind these kinds of capabilities, and the Kinect is 200\$. To begin, I will use a series of camera to be able to observe a human arm, calculate edges and key points along the arm, and the display on the screen a virtual representation of a robotic arm that mimics the motion of the human arm in real time. This is something that seems cool to me to create. If I get far enough in this project to invest in a robotic arm or build one, then I will move onto implementing the control of a physical arm, which will be easier once its understood virtually.

Once I have developed a grasp on how to work with camera feeds, and the capabilities I will have, then I will move onto having the computer learn the shapes and orientation of objects. I will start with simple objects, perhaps symmetrical. To begin, I will have to develop a way for the program to store a 3D representation of the object it is trying to view, in order to compare what it is seeing and what it knows (1). I will also I have to create a way for the computer to observe and understand a 3D representation of the object it is viewing. This might require a 3d camera, or perhaps there is a way to do it with two cameras (2). Once a 3D model of the object has been viewed, It will have to determine the current orientation of the object and then locate the predetermined key points by which the object is to be grabbed by. Once all this is achieved, then will I proceed to buying or building a robotic arm and controller.

## Risks

Although this project as a whole is a risk, the parts listed above as (1) and (2) will seem most challenging to me. The biggest risk is getting everything done in time, Especially the difficult parts:

- Developing a virtual robotic arm.
- Being able to generate a 3D models of the object in view.
- Creating a way for a program to store a 3D model of an object, and comparing it to the object in view.
- Buying/making the physical robotic arm and controller
- Getting the computer to communicate with the program to control the arm movements.

My hope is to at least get the first part of the project conquered (virtually mimicking arm movements). Once that is complete, I will then move onto the object recognition, but will not proceed with the physical arm until I have completed the first two steps. I might consider abandoning the object recognition if I find it too difficult after attempting to create it. I will be using Matlab 2014a, as I have a student license, and used it at JPL and am familiar with the advanced capabilities and libraries it offers that will aid me in making my project easier to complete.

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