Group Conceptual Design

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ME 407

Preliminary Design of Robotic Systems

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1 Introduction

Robotics is an incredibly fast growing field, yet numerous potential innovators for the discipline are never exposed to it. There are many industrial style manipulators available for commercial applications, but their cost is so high that they aren't practical for many educational purposes. Schools in rural areas are extremely financially limited and cannot afford a manipulator, nor an instructor that can handle teaching the course due to complexity.
Therefore we will solve this problem by creating a primarily 3D printed robotic manipulator with a removable end effector. The robot will use a variety of motors and servos to drive the links and will be run by a Raspberry Pi. This will enable the robot to be inexpensive yet still provide educational value.

2 Physical System Overview

Figure 1 shows the overall design for the manipulator. The overall reach of the robot will be approximately 530 mm. This length was chosen to decrease material cost and weight while still satisfying requirement 2.1.2 and 2.1.5, allowing the manipulating to pick and place objects to perform basic tasks.

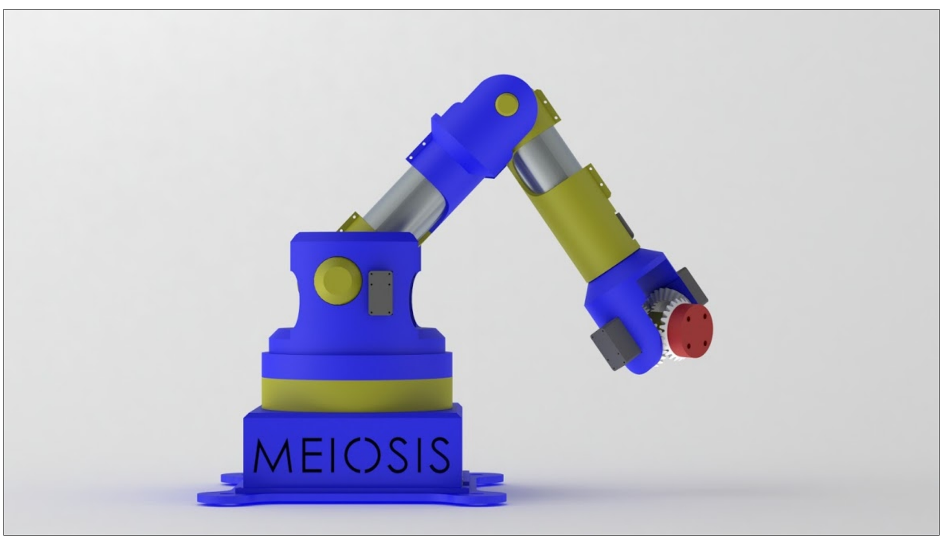

Figure 1: Overall System Conceptual Design

2.1 Base

The base of the manipulator will house several of the electronic components, such as the computational sytem, power supply, and motor controller. A cross section of the base can be seen in *Figure 2*.

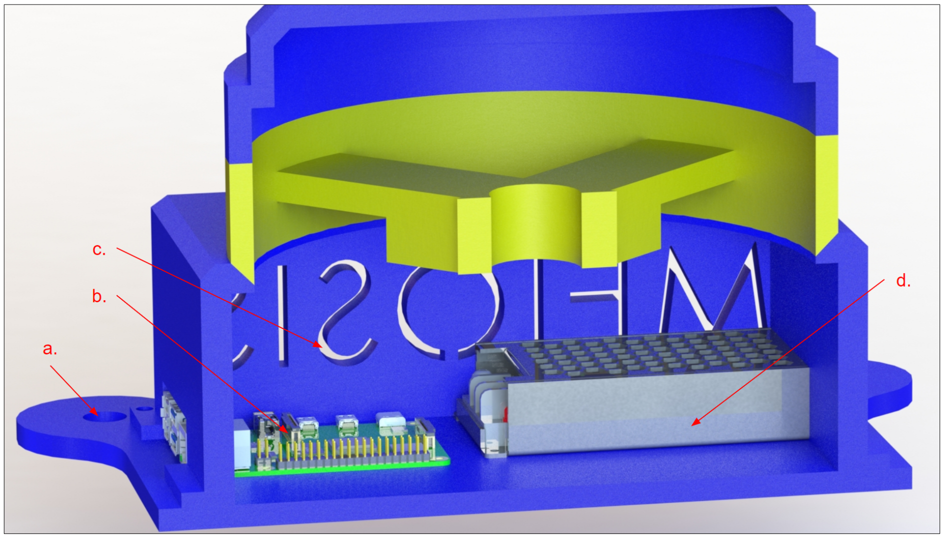

Figure 2: Manipulator Base with Callouts

From *Figure 2*,

a. *Base Supports:* The base supports are located at each corner of the base and will allow the base of the manipulator to be securely attached to a variety of surfaces with either standard bolt/fastener hardware or suction cups.

b. *Computational System:* The computational system will consist of a Raspberry Pi; the primary reason for this system being chosen is to fulfill the budget requirement, 2.1.1. The Raspberry Pi will perform the necessary computations for solving the kinematics of the manipulator and command the motors accordingly.

c. *Airflow Cutouts:* The side of the base will have cutouts to allow for the maximum amount of airflow to pass through; since the power supply is housed inside of the base as well as the computational system, the temperature must be regulated to prevent overheating.

d. *Power Supply:* The power supply will be housed in the base as well; this allows the system to be more accessible and therefore more modifiable, where the end-user can easily expand the system to fulfill their needs.

3 System Functions – Block Diagrams

3.1 Electrical System

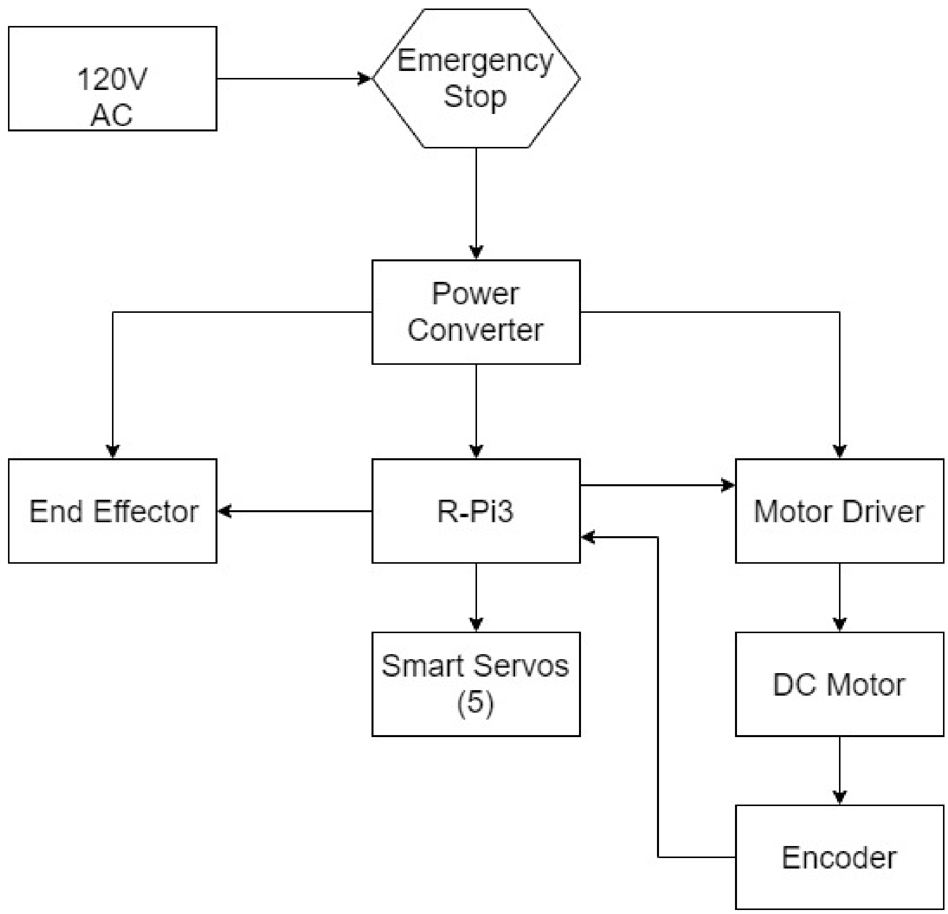

Figure 3: Electrical System Block Diagram

Figure 3.1 shows that the electrical systems of the manipulator will be relatively simple, with power being supplied by the standard 120V AC available from wall outlets. A power converter will be used to adapt the AC voltage to the required voltages for each component. To control the system, a Raspberry Pi will perform the necessary calculations for motor control (described below in software). It will then send these signals to the DC motor driver and the five smart servos. The smart servos have an on-board controller, so no feedback will be necessary. However, the first rotational joint between the base and the first link will be actuated by a DC motor with an encoder to minimize cost.