Specifications

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ME 407

Preliminary Design of Robotic Systems

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EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

Meiosis

Contents

List of Figures

1 Introduction

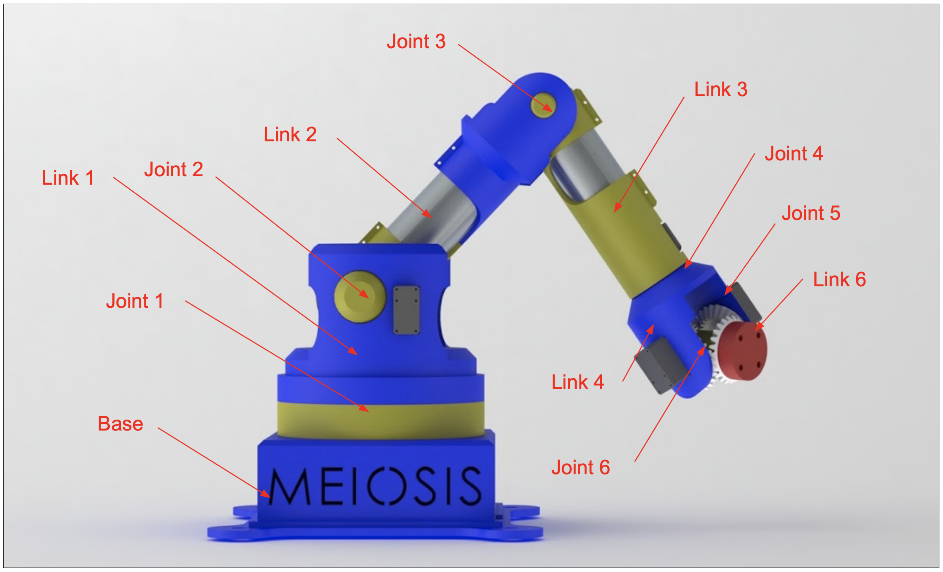

Figure 1: Overview of Physical System

2 Design Requirements

2.1 Hardware

2.1.1 The system shall cost the end-user no more than $1000.

2.1.1.a The cost for the MEIOSIS team to develop the manipulator shall cost no more than $800.

2.1.1.b The system shall cost the end-user no more than $1000.

2.1.2 The system shall be fully dexterous without being kinematically redundant.

2.1.2.a The system shall consist of six rotational joints connected by four links. The last three joints will create a spherical wrist.

2.1.3 The system end effector shall maintain a positional accuracy magnitude of ± 1 mm and an orientation accuracy of $\pm 5^\circ$ eigen angle from the base frame.

To ensure that the robot has educational value, the accuracy must be defined so that any desired positions and movements are achieved.

2.1.3.a The system shall possess the ability to calibrate, or "zero," the end effector position and orientation to within 1 degree of the manipulator's precision.

2.1.4 The system end effector shall maintain a pose repeatability magnitude between 0.1—1.5 mm for the position and $\pm 4^\circ$ eigen angle from the base frame for the orientation.

2.1.4.a Joint one and two of the system shall possess an angle error of no more than .025 degrees.

2.1.4.b Joint three of the system shall possess an angle error of no more than .03 degrees.

2.1.4.c Joints four, five, and six shall possess an angle error of no more than .29 degrees.

2.1.5 The system's reachable workspace shall be a hemisphere with a radius of 300-700 mm.

This workspace will provide enough movement to manipulate objects in order to perform basic tasks.

2.1.5.a The length of link one, two, three, and the wrist shall be 220.8 mm, 250 mm, 200 mm, and 52.5 mm respectively.

2.1.6 The system's dexterous workspace shall be a hemispherical shell within the reachable workspace with a thickness of 280 mm.

This workspace will provide enough movement to manipulate objects in order to perform basic tasks. 280mm is slightly greater than the length of letter paper.

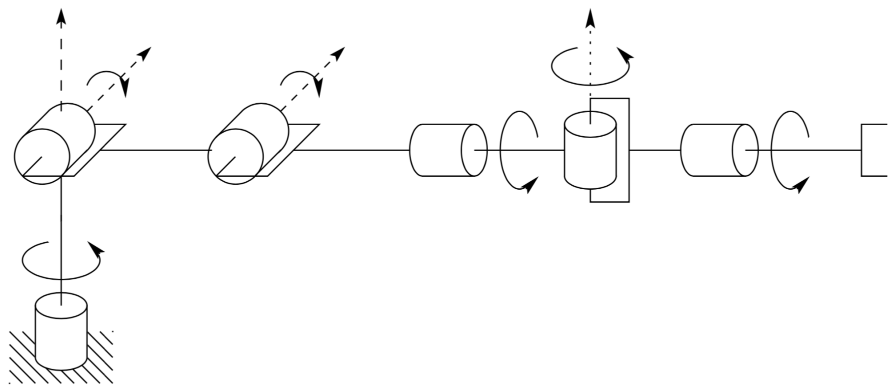

Figure 2: Kinematic Model Representing Zeroed Configuration

> 2.1.6.a *With respect to the kinematic model shown above in Figure 2, the rotational limit of joint one, two, three, four, five, and six shall be* $\pm 180°$, $\pm 9.7°$ *to* $177.5°$, $-150.6°$ *to* $-19.3°$, $\pm 180°$, $-180°$ *to* $-1.6°$, *and* $\pm 180°$.

2.1.7 The system shall have a removable end effector capable of picking and placing a low-odor chisel tip Expo dry erase marker.

This creates a robot capable of performing a variety of basic tasks, which enhances its educational value.

> 2.1.7.a *The system will use an actuatable parallel gripper that can close to 18mm.*
>
> 2.1.7.b *The end effector will attach to the manipulator using screws configured in a pattern that can mount a Dynamixel AX-12A servo.*

2.1.8 The system shall be able to write with a low-odor chisel tip Expo dry erase marker.

> 2.1.8.a *The end effector shall be capable of applying a gripping force of 0.028449 Newtons as to prevent slipping while writing.*

2.2 Software

2.2.1 The system shall be open source.

This will create an easily obtainable, low cost method of distributing the system's source code, which may be modified for personal use.

> *2.2.1.a The software shall be hosted publicly on an online repository and maintain an MIT license for distribution.*

2.2.2 The system shall be capable of operating given only desired end effector cartesian coordinates specified with respect to the base frame.

> *2.2.2.a The system shall have a user interface capable of accepting user input.*
>
> *2.2.2.b The system shall be capable of performing floating point arithmetic for the inverse kinematic calculations.*