ROCO504
Catch-bot

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***Abstract*—The abstract goes here.**

I. Introduction

This demo file is intended to serve as a “starter file” for IEEE conference papers produced under LaTeX using IEEEtran.cls version 1.8b and later. I wish you the best of success.

mds
August 26, 2015

A. Subsection Heading Here

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1) Subsubsection Heading Here: Subsubsection text here.

II. Design Process

A. Problem

1) Inverse Kinematics: Initially it was thought that the commands to each motor could be generated by looking directly at the returned X and Y coordinates of the tracked objects. To move the gripper upwards, the top two motors should rotate clockwise and the bottom two anticlockwise. To move the gripper to the left, the two left motors should rotate clockwise and the right two anticlockwise. This led to the following kinematic solution:

$$\begin{aligned} M1 &= Y - X \\ M2 &= Y + X \\ M3 &= -Y - X \\ M4 &= -Y + X \end{aligned} \tag{1}$$

For high torque motors, elastic cords and a closed loop between the tracked object and the gripper, this approximation would have been functional. However, it would not have been accurate and it would unnesicarrily load the motors. When using stepper motors with low-current drivers, this solution caused the steppers to skip if the gripper was directed more than a few centimeters from the centre of the working area. This led to reevaluation of the kinematic solution.

Inverse Kinematics:

$$\cos(\theta_3) = \frac{{X_{max}}^2 + {l_3}^2 - {l_4}^2}{2 * X_{max} * l_3} \tag{2}$$

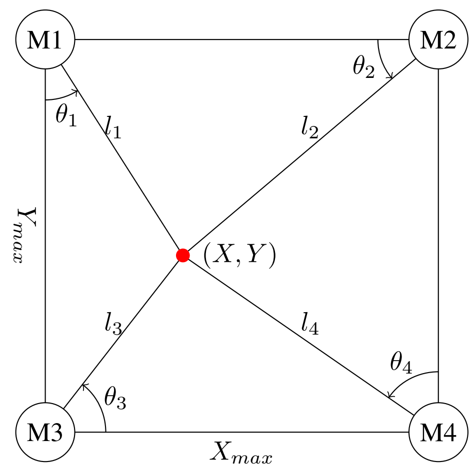

Fig. 1. Kinematic diagram

$$X = l_3 \sin(\theta_3) \tag{3}$$

$$Y = l_3 \cos(\theta_3) \tag{4}$$

Or, without trigonometry:

$$X = \left(\frac{{X_{max}}^2 + {l_3}^2 - {l_4}^2}{2 * X_{max} * l_3} \right) = \frac{X_{max}}{2} + \frac{{l_3}^2 - {l_4}^2}{2 * X_{max}} \tag{5}$$

$$Y = \left(\frac{{Y_{max}}^2 + {l_4}^2 - {l_1}^2}{2 * Y_{max} * l_3} \right) = \frac{Y_{max}}{2} + \frac{{l_4}^2 - {l_1}^2}{2 * Y_{max}} \tag{6}$$

Forward Kinematics:

$$\begin{aligned} l_1 &= \sqrt{(X)^2 + (Y_{max} - Y)^2} \\ l_2 &= \sqrt{(X_{max} - X)^2 + (Y_{max} - Y)^2} \\ l_3 &= \sqrt{(X)^2 + (Y)^2} \\ l_4 &= \sqrt{(X_{max} - X)^2 + (Y)^2} \end{aligned} \tag{7}$$

2) Motor speeds:

3) Motor torque:

B. Research

C. Requirements

D. Solutions

E. Prototype

F. Further problems

1) Kinematics: Initially the kinematic solution considered the gripper as a point. This worked for preliminary testing, but soon proved to be a problem when the limited torque of the stepper motors required equal tension on all cords at all times. This led to the development of the following kinematic model, which considered the gripper as a square.

2) Motors:

3) Arduino:

G. Redesign

H. Final solution

III. Implementation

A. Software

Frames enter the object tracking node at a rate of 60FPS. The object tracker performs a series of filters in different colour spaces on the image before calculating its centre of mass. This coordinate is published to the kinematic controller xxxx milliseconds after the frame enters the object tracker. Upon entering the kinematic controller, the coordinate frame is offset so that the center of the camera image is now at pixel 0,0. The required change in length of each cord is then calculated and set, and from this the required speed of each motor is calculated and set. The kinematic controller node then calculates the current gripper position in order to calculate the changes in length for the next loop. Figure 2 shows the high-level software flow diagram of the robot.

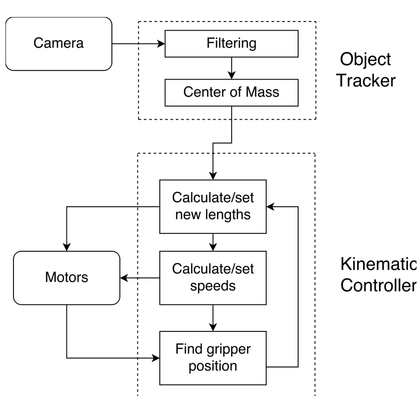

Fig. 2. High-level software flow diagram.

B. Frame

C. Kinematics

D. Grippers

E. Clamps

IV. Experiments

A. Method

B. Results

C. Discussion

V. Overall Discussion

VI. Conclusion

The conclusion goes here.

Acknowledgment

The authors would like to thank...

References

[1] H. Kopka and P. W. Daly, *A Guide to LaTeX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.