Overview

This project builds a robot that can track a moving object. The target object is moving in front of the cameras of the robot, and the robot will manipulate a laser pen to point at the object and track it. Object tracking requires the knowledge of the 3 dimensional location of the target object. Previously, obtaining the 3D location is done by a camera to capture the horizontal and vertical coordinates of the object, aided by an ultrasonic or infrared sensor to measure the depth information. In this project, we intend to achieve the same goal but using only cameras. Two parallel cameras are placed alongside to provide parallax images of the same object, analyzing which yields the 3D coordinates we wanted.

Methodology

1. Locating the object
   - Choice of camera & camera mode
   - Object detection
     i. Frame difference
     ii. Gaussian blur & threshold
     iii. Find contours
     iv. Restriction on contours
   - 3D location construction
     i. Measurement of angle of view & deviation angle
     ii. Rectification of 2D locations
     iii. Common perpendicular line approach
2. Laser beam tracking by motor control
   - Mechanical design of robotic platform
   - Communication between computer and microprocessor
     i. UART on MCU, DMA implemented
     ii. Self-designed communication protocol
   - Position loop control of motors
     i. PID control implemented
     ii. Velocity loop and current loop control nested
   - Trajectory prediction and tracking
     i. Linear fitting
     ii. Dropping of wrong points
     iii. View translation and rotation

Results

<table>
<thead>
<tr>
<th>Limitation</th>
<th>Description</th>
<th>Possible Future Solution</th>
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</thead>
<tbody>
<tr>
<td>Object size and distance</td>
<td>Object size to distance ratio should be from 0.015 to 0.055.</td>
<td>Improve object detection and 3D location construction algorithm.</td>
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<tr>
<td>Object speed</td>
<td>Object speed should be ~15 cm/sec.</td>
<td>Improve object detection algorithm; Use high speed camera.</td>
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<tr>
<td>Environment light condition</td>
<td>May not work in extreme light conditions.</td>
<td>Use higher quality cameras.</td>
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<tr>
<td>3D location construction inaccuracy</td>
<td>Depth information is not accurately determined.</td>
<td>Introduce redundant sensors and devices, such as extra cameras, ultrasound sensors etc.</td>
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