Proposal

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CRAB
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Introduction

I am attempting to solve an application of computer vision as it applies to tracking objects rolling on a plane.

My goals are to successfully track a ball being rolled across a flat surface using just a camera, move to intercept the ball, catch it, and roll it back.

Integrated Systems

The robot will initially use the Mavric-IIB Atmega128 as the main board. It will have a local software solution for Kalman filtering on the gyrochip and the accelerometers. Image processing will be done on a remote PC. As the project progresses, I hope to move the Kalman filter onto a dedicated chip in order to sample at a higher frequency and thus obtain better data. I also hope to move the image processing from a remote PC to a dedicated chip on the robot. This will be the hardest part of the project and will be done only after my robot works.

The robot will use information from sonar sensors to avoid obstacles during sideways motion while tracking a ball. It will also use bump sensors on a manipulator to determine when a ball can be grabbed.

Mobile Platform

The robot chassis will be built on a plastic container (think Tupperware). It will be cylindrical and have holes cut in it for four omniwheels. The omniwheels allow the robot to move in any direction while keeping an arbitrary orientation. This will be useful for movement while keeping an object in view.

Actuation

Because I need my robot to be fast, the wheels will be driven by four small electric motors, requiring four speed controllers. I feel that the level of complexity this adds to the robot is offset by the increase in speed my robot will achieve.

A manipulator claw will be spring loaded and driven with a small, relatively weak, servo.

Sensors

CRAB will have a camera, a gyrochip, a 2D accelerometer, six sonar, and three bump sensors.

The camera will be fixed to the robot's body and will transmit a picture wirelessly to a nearby PC. The amount of data that needs to be processed from the camera is too large to handle on the Mavric-IIB, so it will be processed in MATLAB. I intend to build on the work of Ashutosh Saxena, a PhD student at Stanford, who recently released a depth approximation algorithm that works with a single image. I hope to develop a probabilistic approach to his solution, letting me lower the processing time and resource requirements enough so that I can move the processing to a dedicated chip. This will be the hardest part of this robot and will be attempted last.

Both the gyrochip and the accelerometers will produce very noisy data. I will implement a Kalman filter in software to filter the data and obtain reasonably accurate information. Time permitting, I would like to move the gyro and the accelerometer onto a board with a microprocessor to handle the filtering separate from my main CPU.

I will use six sonar sensor, mounted on the top of my robot in a circular pattern, in order to avoid obstacles. Because CRAB can move in any direction, I need to be able to sense obstacles all around the robot.

The bump sensors at the tips of the manipulator will change the direction the robot travels (if the left sensor is hit, the robot turns left and moves closer, and vise-versa), and a bump sensor at the base of the manipulator will trigger the claw to spring closed around a ball.

Behaviors

CRAB will seek out and catch rolling balls. It will move in any direction while maintaining a fixed gaze on its target. While CRAB is moving to intercept the target, it will avoid obstacles and track its movements with the gyrochip and the accelerometer, enabling it to return to its starting position where it will either hold the ball, or kick it out.