CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S1414

Project Title

Autonomous Navigation and Robust Object Detection through Edge-based Optical Flow

Abstract

Objectives/Goals

The main goal is to create an algorithm that efficiently differentiates stationary objects from the background using the optical approach and limiting the system to one sensor. Our calculation goals include finding the relative position of objects, and finding their time-to-collisions (TTCs). The algorithm was based off of Horn-Schunck Optical Flow and Sobel Edge-Detection.

Methods/Materials

The materials needed were intentionally minimized to a video camera and source code developed with a combination of Matlab and Java. The implemented Optical Flow algorithm was adjusted with a convulsion approach, comparing the luminosities of a group of pixels in consecutive image frames. The output of this algorithm is a gradient map, with each vector representing the motion of a pixel on the image frame. The objects were detected through an enhanced Sobel Image, which creates a binary image of discrete objects. Subsequently, this binary image and gradient map were overlaid to create distinct #blobs# of vectors, which are then grouped with a bounding-box algorithm. Finally, the overlaid gradient map is used to calculate the TTC for each object using a calculation based off of multidimensional calculus and similar triangles.

A further material used in this project includes a robot, designed to test the algorithm, and based off of the LEGO Mindstorms kit. The robot operates under a simple object-avoidance system, turning away from the closest object a specified number of degrees that depends on the TTC.

Results

Each trial has outputs of binary images, gradient maps, and TTCs that are saved in movie format. In addition, videos of the robot running the object-avoidance system from both its perspective and a spectator's perspective have been recorded. These video trials will be viewable during the fair. Since most of the project is conceptual, the TTCs constitute the only form of quantitative data.

Conclusions/Discussion

In each trial, the robot was able to accurately, and in real time, detect the presence of an object and turn away to avoid a collision. This algorithm can be ported into a variety of autonomous vehicle applications, including object retrieval systems and mapping systems. The optical approach developed is advantageous for providing real time implementation, but having the ability to provide more information than radar-based systems despite having only one sensor.

Summary Statement

To differentiate ambiguous stationary objects from a background and find their respective time to collisions through one sensor.

Help Received