CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

S1422

Project Title

Lightweight Path-Inferential Optic Flow Collision Detection for Mobile Robots

Abstract

Objectives/Goals

In this investigation, a lightweight, optic flow-based collision detection algorithm capable of running in real-time was developed with the goal of achieving key benchmarks for both safety and mobility (100% and 80% respectively) while running in real time aboard a mobile robot. Drawing on gyroscopic data, the detector calculates an inferred path triangle, enabling it to respond appropriately to real-world situations in which the camera heading vector is not necessarily in alignment with the vehicle#s heading vector, such as rotation and slip.

Methods/Materials

The detector was implemented aboard a HP Envy TS 14 PC in Python 2.7 using the NumPy and OpenCV libraries. A LEGO Mindstorms NXT 2.0 kit was used to construct a mobile robotic platform with a turntable upon which an iPhone 4s was mounted. The iPhone streamed Grayscale video to the PC for processing. This detector platform was placed in a testing environment, which consisted of a level testing surface perpendicular to a video monitor.

Static and dynamic virtual obstacles were displayed on the screen. By rotating the iPhone mounting turntable so that the perceived origin of normal progressive optic flow vectors was not at the center of the camera#s field of view, conditions of rotation and slip were simulated. A true positive (TP), true negative (TN), false positive (FP), or false negative (FN) was recorded for each trial; the safety and mobility scores of the platform were calculated using the method of Chalupka, et al.

Results

Out of the 64 trials, 100% net safety and 86.5% net mobility were achieved. In other words, the algorithm never failed to detect impending collisions and incorrectly detected an impending collision approximately 15% of the time.

Conclusions/Discussion

These results constitute evidence in support of the safety and mobility hypotheses; the lightweight, path-inferential optic-flow based collision detector developed in this investigation did serve as an effective cue to collision. In the context of other similarly lightweight collision detection algorithms, the detector developed in this investigation is highly successful. My algorithm has a plethora of applications, from assisting the navigation of the blind or visually impaired to refining emergency response robotics to mitigating mission risks for orbital spacecraft.

Summary Statement

A novel lightweight, optic flow-based collision detection algorithm capable of running in real-time was developed with the goal of achieving key benchmarks for both safety and mobility.

Help Received