SJSU SAN JOSÉ STATE UNIVERSITY

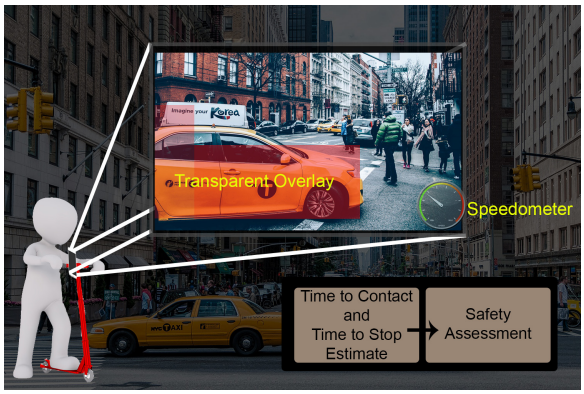
SJSU Undergraduate Research Grants

SaFeR - A Safety Framework for e-Scooter Riders

Smruthi Danda, Mahima Agumbe Suresh
Department of Computer Engineering

Abstract

This project implements an efficient method to assess the safety of e-scooter riders. It takes depth and velocity information to calculate metrics for safety, such as crash time, in order to warn the riders in a timely manner. We aim to create a simple implementation with computer vision and hardware such as a Raspberry Pi and sensors to create an affordable solution. In comparison with the state of the art machine learning and neural networks, our approach is intended to provide results in real-time with a reasonable accuracy.



Research Questions

- How can we find the depth of particular objects relative to a cameras focal point?
- What kinds of image descriptors fit our purpose and how accurate are these descriptors?
- Will we need to focus more on accuracy or efficiency?

Project Activities or Findings

Velocity

- Initial solution: Use optical flow to find distance and speed traveled.
- Issue: Only gives us information relative to the pixels in the image
- Secondary Solution: Use accelerometers and gyroscopes to calculate speed.
- Issue: Not possible to get accurate speed information from an accelerometer or gyroscope alone. Needs more information such as RPM.
- Final Solution: Use a tachometer along with accelerometer

Depth

- Initial Solution: Use a single camera in order to find depth of an object by analyzing type of object.
- Issue: Would need to use neural networks and would not be efficient to use with applicable hardware.
- Final Solution: Use stereo cameras

for all $F_i \in \{F_1 \dots F_N\}$ **do**
  $Depth_i \leftarrow \text{DepthEstimation}(F_i, F_{i-1})$
  $Disp_i \leftarrow \text{DenseOpticalFlow}(F_i, F_{i-1})$
  $v_i \leftarrow \text{SpeedEstimate}(F_i, F_{i-1}, A, G)$
  $TTC_i \leftarrow \frac{2}{d}\left(v_i - \frac{Depth_i + Disp_i}{FR}\right)$
  $TTS_i \leftarrow \frac{v_i}{d} + \delta$
  for all $TTC_{ij} \in TTC_i$ **do**
    $C_{ij} \leftarrow 0$
    if $TTC_{ij} \leq TTS_i$ **then**
      $C_{ij} \leftarrow \frac{TTS_i - TTC_{ij}}{TTS_i}$

Generate a Crash Matrix

Citations

[1] Birchfield, S. and Tomasi, C. A pixel dissimilarity measure that is insensitive to image sampling. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1998.

[2] A. Talukder and L. Matthies. 2004. Real-time detection of movingobjects from moving vehicles using dense stereo and optical flow. In2004 IEEE/RSJ International Conference on Intelligent Robots and Systems(IROS)