Title

1) YOLOv3 real-time object detection for a driver assistance system

2) Basic motion detection applied to an in-car camera system for driver's status monitoring

3) Vehicle camera system designed for a Ford Focus 2018 car for driver assistance, traffic surveying and inner vehicle conditions monitoring

4) Don't lose focus - Integrated camera system for passenger vehicle for comprehensive monitoring

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1 Introduction

Vision-based driver-assistance systems (VBDAs) have emerged as a significant contribution for the improvement of Advanced Driver Assistance systems (ADAS), and have had gradually gained a substantial meaning in people's life: every year approximately 1.35 million lives are truncated as a consequence of road traffic crashes. Moreover, between 20 and 50 million people (depending on year and country) undergo non-fatal injuries, including sometimes disabilities as an outcome. [1]

Nowadays car accidents and related deaths represent a daily occurrence because of other's people carelessness (driver's drunkness, drowsiness, sudden illness), and as several studies show, over 90% of traffic accidents are caused by a human error [1, 2]. Machines, however, are more reliable and consistent and they commit far less mistakes when programmed properly, and therefore they can prevent most of those aforementioned fatalities.

This paper covers designing, developing and manufacturing a smart camera system for a Ford Focus 2018 that is able to monitor both outer and inner conditions. Development includes researching the topic to design and produce a competent solution for a camera system that is a consumer level product, which means that mountings and wiring are implied to car's original wiring as good as possible. An onboard computer for the system is located in the trunk and wiring is done in a way that all the cameras are plugged in with a single universal cable. The monitoring system is capable of detecting 360° surroundings of outside of the car (tracking other traffic, pederestians, etc.), as well as inside of the car by monitoring the drivers state (drowsiness, sudden illness, etc.) and objects not supposed to be in car.

Therefore, this project is motivated by the strong willingness of assuring safety and comfort behind the wheel, that concerns both drivers and passengers, and vulnerable road users: pedestrians, cyclists, and motorcyclists.

1.1 State of the art

Driver assistance systems (DAS) have developed from anti-lock braking systems (ABS) in the 80's and Electronic Stability Control (ESC) in the 90's to modern self-parking and collision avoidance systems in the recent decade. In most recent years, these systems have evolded to fully autonomous driving systems, and nowadays every major vehicle manufacturer are developing them. Most of the manufacturers have atleast prototypes, while several of them have included some level of autonomous driving even in consumer markets. [3].

In recent decades advanced driver assistance systems (ADAS) have been taken into account as vehicle's detectors, benefitting from computer vision technologies especially in terms of costs: an active sensor - that is, laser or radar sensors - is way more expensive than an optical one - for instance CMOS and CCD ones [4]. Especially laser based LiDARs (Light Detection and Ranging) have been popular in autonomous driving solutions, due to their efficiency and high accuracy, but due to their price, some manufacturers see purely optical sensors as a more viable solution [5].

This project aims for applying affordable aftermarket vision to the vehicle, and therefore optical sensonrs (cameras) and computer vision techonologies seen in [4], [6] and [7] are going to be closely related to this project's implemented solutution. Early solutions in 360° camera systems in [8] and [9] represents the general guideline for 4 outside camera placements, where side view cameras are attached to the side mirrors, and one camera is headed to front (bumper/dashboard), and one is located in the back for rear view. Driver's state can be monitored using camera and machine vision as seen in [6], [7] and [10], and especially these detections focuses on monitoring drivers eyes, because it's most easily detected and most consistent sign of human's tiredness.

Everything in vehicle camera systems are based on object detection, which is computer technology related to image processing and computer vision. Detection system that is going to be applied to this project is close to YOLOv3, which represents a state-of-the-art, real-time object detection system that can detect over 9000 object categories applying a convolutional neural network [11]. On a Pascal Titan X it processes images at 30 FPS and has a mAP (mean average precision) of 57.9% on COCO test-dev. In mAP measured at .5 IOU (intersection over union) [11]. YOLOv3, which stands for version n. 3, benefits from few shrednesses as multi-scale predictions and an enhanced backbone classifier with the purpose of performance improvement. The approach used by its developers is the application of a single neural network to the full image. The network splits the image into defined areas, thus predicting probabilities and boundaries for each region [12]. Advantages of this system includes improved rapidity with respect to other systems, because it is 1000x faster than R-CNN and 100x faster than Fast R-CNN [11][12].

2 Methods

What are we going to do to solve the problem, decision making, possible manufacturing methods for custom parts...

3 Results

What are the final positions for cameras, how cameras are mounted to the car, testing the vehicle and inspecting how the system works...

4 Analysis

Going through the project and analyzing it, what did we succeed, did the system work as intended and fullfill the requirements, could something have gone better...

5 Discussion

The conclusions and wrap up of the project, how did we succeed on given task, further development ideas, practical value (could it be easily implemented to other vehicles)...

6 References

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