



Cairo University

VISION-BASED TRAJECTORY CONTROL SYSTEM OF AN AUTONOMOUS VEHICLE

By

Ahmed Desoky Abd El-Aty Sabiha

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Mechanical Design & Production Engineering

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Title of Thesis:

“Vision-Based Trajectory Control System of an Autonomous Vehicle”

Key Words:

Autonomous Vehicle, Raspberry Pi, Modeling and Simulation, Lane Detection, Image Processing.

Summary:

This thesis presents a comprehensive mathematical modeling and simulation for the trajectory of a vision-based autonomous vehicle during moving between lane lines of the structured road. In addition, demonstration building, implementing, and developing a trajectory tracking control system based on computer vision for autonomous cars.

The simulation accomplished by using MATLAB/Simulink software. This simulation mimics the existence of an actual digital camera by using a novel 3D-vision block to simulate the actual images that assumed to be provided by a digital camera connected to an embedded computer. The 3D-vision block uses mathematical equations, execution sequence and logical conditions to create a virtual captured image. So, this virtual image is then used to detect the lane in the front of the vehicle depending on the virtual camera position and its parameters. Inside simulation environment that based on the kinematic model of the vehicle and vision model, the controller is designed in the simulation and is coded in the embedded computer with the optimized control gains.

The implementation presents a system includes a single digital camera, an embedded computer (Raspberry Pi 2), and a microcontroller board to produce an autonomous car to be able to track current road lane, where the digital camera is mounted at the top of the vehicle along its longitudinal axis. The real-time captured images are processed using Python code with OpenCV library over Linux operating system to obtain geometrical data of road lane. From this data, the observable errors can be determined. Finally, a steering controller utilizes these errors in control law that designed in the simulation with tuning in control gains to compute the steering command. The embedded computer then paths this command to Arduino microcontroller board to adjust the steering servomotor.

During this work, a set of autonomous driving experiments is performed. Several evaluations scenarios are shown and discussed about lane detection.

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Ahmed Desoky
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Dedication

To my late parents, who had the arduous task of breeding and raising seven children, who have struggled hard in life to give me the best, who taught me to persevere, and prepared me to face the challenges with faith and humility. Although they are not here to give me the strength and the support, I always feel their presence that used to urge me to strive to achieve my goals in life.

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