Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF V-BOX SENSOR FOR AUTOMOTIVE APPLICATION

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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I declare that this project report entitled "Development of V-Box sensor for automotive application" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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DEDICATION

To my beloved mother, NORIMAH BINTI NOFIAH and father, JOHOR BIN SALEH.

ABSTRACT

Due to technological changes through time, humans are provided with varied conveniences. For tracking vehicle movements from anyplace the tracking device for a car is incredibly convenient. An automobiles efficient tracking system is developed to monitor the movement of fitted vehicles at all times. A V-Box is the instrument used to capture and analyse the performance of vehicles to improve stability, comfort and managing. This project focuses on the design of observers to estimate variables like acceleration and distance using the sensor to collect data and monitor the movement by low cost V-Box systems steering view. The difference between the transmission of the signal and the receiving signal time is calculated. It is mainly aimed at using complementary filter at IMU 6050, GPS to get the location, and raspberry pi as main controller. All of the components including GPS NEO 6M and MPU6050 is used to create for the V-Box sensor. In addition, drivers like to be in a hurry by recklessly pressing the oil pedal and like to press the brakes repeatedly without trying to control the vehicle by slowing down the vehicle or keeping distance while on the road. In fact, brake pads and tires are also easy to wear and need to be replaced frequently because that problem this system can reduce the cost of changing car spare parts because this system can display the speed and angle of the car tires and the driver can ensure good driving conditions. Therefore, a solution the v-box system, this system can record data and can analyze the driver's driving behaviour. This simulation is conducted on the gps and imu sensor. The simulation is conducted by testing the sensor in different destination. From TTU (Taman Tasek Utama))to FTKEE, FTKEE to Pertonas and Pertonas to Mydin. Also, the data are collected by comparing the measurement from the GPS and IMU 6050 This vbox also be able to offline analysis the control system for the cars based on the recorded data. In analysis, V-Box get data is the location such longitude, latitude, google map, stering behavior and speed with diffrence destination.

ABSTRAK

Disebabkan oleh perubahan teknologi melalui masa, manusia dibekalkan dengan pelbagai kemudahan. Untuk menjejaki pergerakan kenderaan dari mana-mana tempat, peranti pengesan untuk kereta adalah sangat mudah. Sistem pengesanan cekap kereta dibangunkan untuk memantau pergerakan kenderaan yang dipasang pada setiap masa. V-Box ialah instrumen yang digunakan untuk menangkap dan menganalisis prestasi kenderaan untuk meningkatkan kestabilan, keselesaan dan pengurusan. Projek ini memberi tumpuan kepada reka bentuk pemerhati untuk menganggar pembolehubah seperti pecutan dan jarak menggunakan sensor untuk mengumpul data dan memantau pergerakan dengan pandangan stereng sistem V-Box kos rendah. Perbezaan antara penghantaran isyarat dan masa isyarat penerimaan dikira. Ia terutamanya bertujuan untuk menggunakan penapis pelengkap di IMU 6050, GPS untuk mendapatkan lokasi, dan raspberry pi sebagai pengawal utama. Semua komponen termasuk GPS NEO 6M dan MPU6050 digunakan untuk mencipta bagi penderia V-Box. Selain itu, pemandu suka tergesa-gesa dengan menekan pedal minyak secara melulu dan suka menekan brek berulang kali tanpa cuba mengawal kenderaan dengan memperlahankan kenderaan atau menjaga jarak ketika berada di jalan raya. Malah, pad brek dan tayar juga mudah dipakai dan perlu kerap ditukar kerana masalah itu sistem ini dapat mengurangkan kos menukar alat ganti kereta kerana sistem ini dapat memaparkan kelajuan dan sudut tayar kereta serta pemandu dapat memastikan keadaan pemanduan yang baik. Oleh itu, penyelesaian sistem v-box, sistem ini boleh merekod data dan boleh menganalisis tingkah laku pemanduan pemandu. Simulasi ini dijalankan pada sensor gps dan imu. Simulasi dijalankan dengan menguji sensor di destinasi yang berbeza. Dari TTU (Taman Tasek Utama))ke FTKEE, FTKEE ke Pertonas dan Pertonas ke Mydin. Selain itu, data dikumpul dengan membandingkan ukuran dari GPS dan IMU 6050 vbox ini juga boleh menganalisis secara luar talian sistem kawalan untuk kereta berdasarkan data yang direkodkan. Dalam analisis, V-Box menunjukkan data ialah lokasi seperti longitud, latitud, peta google, tingkah laku stering dan kelajuan dengan destinasi yang berbeza.

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LIST OF SYMBOLS

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LIST OF ABBREVIATIONS

V	-	Voltage
	-	
	-	
	-	
	-	
	-	
	-	
	-	

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CHAPTER 1

INTRODUCTION

1.1 Background

A V-Box is the instrument used to capture and analyse the performance of vehicles to improve stability, comfort and managing. The dynamics of the automobile, for example, longitudinal and lateral accelerations and a yaw speed, should always be known to these systems when different manoeuvres are carried out in order to function in the vehicles (brakes, steering and suspension) and to produce a satisfactory performance. In the IMU sensors measure the angular rates of yawing and accelerations directly through rate gyroscopes and accelerometers. This project focuses on the design of observers to estimate variables like (acceleration, distance, angle of laziness) using the sensor data of current cars and monitor the movement by means of low cost V-Box systems on steering and front tyre (left and right).

The Raspberry is a small-scale microprocessor that offers a very popular alternative to Arduino, BASIC Stamps and other sorts of microcontrollers. It can be used to develop a virtual lab that can collect and store all data from IMU sensors, including the accelerometer, gyroscope and magnetometer, as well as GPS coordinates from the sensor and data fusion. In addition, the Global Positioning System (GPS) works with accurate location information. This allows tracking the traffic of a vehicle or person. For instance, a GPS system tracking the way in which a V-box system is progressing can be used.

1.2 Problem Statement

Nowadays, many research studies focus on the design of observers, so the data supplied by the sensors put on existing cars or low cost devices to tackle this problem may be utilised to estimate these variables. Now many new cars no have good car control systems. In addition, drivers like to be in a hurry by recklessly pressing the oil pedal and like to press the brakes repeatedly without trying to control the vehicle by slowing down the vehicle or keeping distance while on the road. In fact, brake pads and tires are also easy to wear and need to be replaced frequently because that problem this system can reduce the cost of changing car spare parts because this system can display the speed and angle of the car tires and the driver can ensure good driving conditions. Therefore, a solution the v-box system, this system can record data and can analyze the driver's driving behaviour.

1.3 Project Objective

The objectives of this project are as follows:

a) To design a V-Box system using Raspberry Pi

b) To monitor and record data from the IMU sensor and the GPS via the V-Box

c) To analyze car motion from V-Box's data

1.4 Scope of Project

By reducing the demands for this project, a number of guidelines are given to ensure that this project meets its targets. The scope of this project is:

a) The V-Box comprise of IMU sensor, GPS, and one camera to monitor automotive vehicle movement

b) Raspberry Pi is the main controller to process data from all sensor and camera.

c) In one vehicle locations a web camera type is fitted at seatbelt to monitor stering behavior.

d) A complementary filter is applied for IMU Sensor Fusion to determine vehicle speed and acceleration.

e) GPS is used to determine vehicle distance, speed and acceleration compare to IMU.

f) All the data will be analayze and camera be recorded and view offline for analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter discusses about the articles related to this project. It consists of the products that have been developed by institutions before this project. This chapter contains the theory and implementation of the component and equipment used in the previous project.

2.2 Vehicle Coordinate System

The reality is that the true misalignment cannot be measured simply. It is based on a very accurate INS/GNSS system, which is used as a basis for the movement variables. As indicated in Figure 2.1, two calibration approaches are given and confirmed experimentally to estimate the rotation of 3D between the ground and both the IMU and vehicle co-ordinate systems. The combination of these two revolutions offers a reference 3D to the vehicle coordination systems between the IMU and the GPS (Marco *et al.*, 2021).

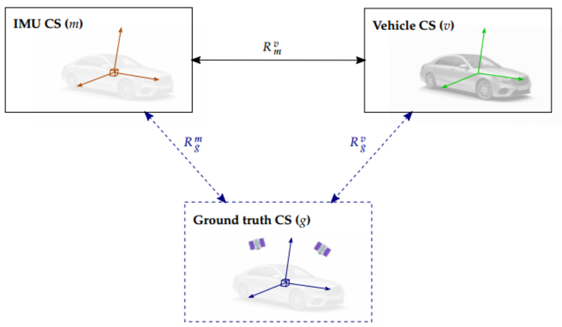

Figure 2.1 Car coordinate system

Besides that, in the use of the wheel speed information dead reckoning method, the vehicle trajectory is assumed to be circular according to the mileage and vehicle yaw angle change to estimate the position change. At the same time, according to the GPS speed information dynamic estimation of wheel radius, to reduce the different driving conditions, wheel radius change of position calculation (Zhu *et al.*, 2017).

Improved localisation and mapping in autonomous vehicle systems, as indicated in Figure 2.2, are the continuous study topics. To avoid crashes and safely drive a car that is often divided into 4 basic aspects like perception, location and mapping, path planning and control it is essential for obtaining sub-decimeter precision level. The car uses an online sensor gaggle to detect, comprehend and interpret an environment that encompasses static and dynamic barriers, such as moving vehicles, pedestrian vehicles, road signs, signals and road curbs. (Fayyad *et al.*, 2020)

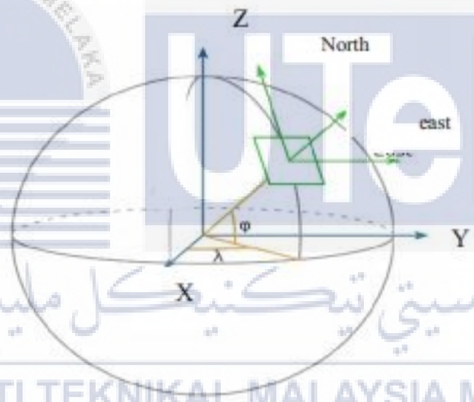

Figure 2.2 The horizontal system of local and geocentric coordinates

2.3 Camera in Autonomous Vehicle

The development of the AV called the monocardial view, stereo and camera mainly employs three camera types (built-in camera). For specific ADAS applications, including as forward-collition alarms, foot detection, traffic signal recognition, lane start alarm, progress monitoring and blind spot monitoring as well as intelligent headlight control, such as the images displayed in Figure 2.3, these cameras are all needed. The optimum way for blind spot sensing to enable for longer views is for the cameras to be mounted close to the side view mirror. In addition, at least 360 views from a stand-alone car on each side and on the front and back are taken from cameras (Herman and Ismail, 2017).

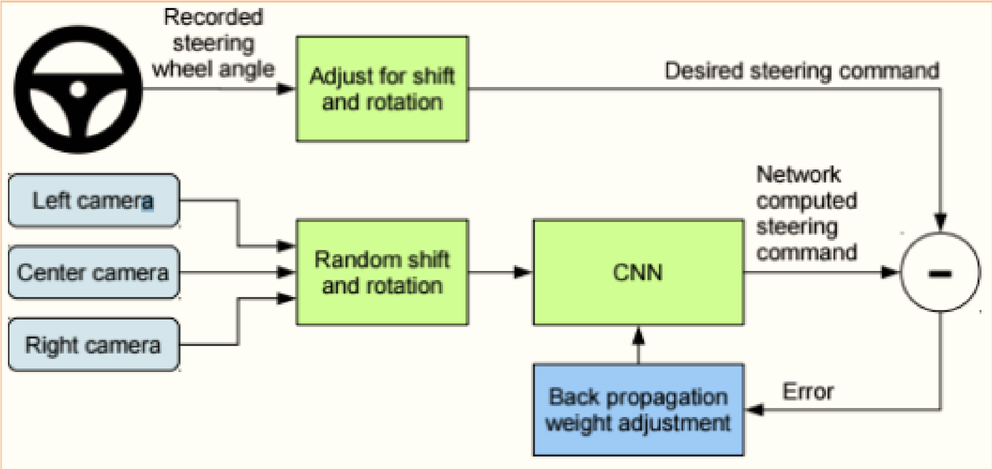

Figure 2.3 Camera training system

The strategy is based on combining data from many types of sensors at a basic level. The suggested technique, in particular, makes use of real-time LiDAR and camera data. The initial stage in the process is to calibrate the LiDAR and camera sensors, which entails estimating the extrinsic characteristics as well as the intrinsic characteristics of the camera. The intrinsic parameters of the camera were determined using the standard checkerboard calibration approach, and the extrinsic parameters of the LiDAR and camera were determined using a planar 3D marker board. Following that, using the calibration settings indicated in Figure 2.4, the LiDAR points are mapped onto the camera image. Finally, several performance evaluation methodologies were employed to verify the output of the LiDAR and camera in the form of fused data. The suggested data fusion approach's key benefit is that it provides an efficient depth estimation procedure for autonomous systems in driverless vehicles (Chu *et al.*, 2012).