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Investigation of transition from Human Driving to Autonomous Driving Vehicle: Physiological Signal Analyse from the Driver

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ABSTRACT

There are various surveys attempting to gauge the public's perception of the autonomous vehicles. Surveys shows that the security issues related to self-driving vehicles and self-driving vehicle performance are the main concerns for the humans. Current autonomous vehicles more focus on the technologies rather than consideration on the passenger perception and emotion while inside the autonomous vehicles. The ongoing research on human perceptions on autonomous vehicles mostly focused on surveys, interviews and social observations rather than other scientific investigation methodologies such as using deep learning technology for emotion, facial expression or safety concern investigation through simulation. This project aims to expand human–Autonomous Electric Vehicle (AEV) interaction research through the investigation of human responses, and facial expression while driving on an AEV. 100 subjects were selected for the experiments. The EEG signal, face analysis and sensors data will be recorded during the experiments. The autonomous vehicle will be tested at UniMAP circuit at Universiti Malaysia Perlis. The subject's acceptance and perception to the autonomous vehicle will be studied.

Keywords:
Acceptance level, emotion, autonomous, EEG, face analysis

1. Introduction

Many questions remain unanswered by existing literature about human responses to the autonomous vehicles. The research to human response and acceptance to autonomous vehicle are undeveloped compared to acceptance people to the robots. The past research on human perceptions on autonomous vehicles more focuses on surveys, interviews and social observations. Study by Cisco [1] found slightly higher levels of interest in riding in autonomous vehicles than the other surveys, the results varied considerably by country, and most respondent didn't agree when asked about allowing their children to ride in autonomous vehicles.

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Krok [2] found that the regional differences play a big part in the acceptance of autonomous vehicles. Nearly nine-tenths (9/10) of respondents in New York and California think self-driving cars will improve quality of life. Half of Pennsylvania respondents believed that autonomous car would reduce accidents. 72% of respondents believe that manual driving should be preserved [2].

University of Michigan Transportation Research Institute (UMTRI) survey in 2016 shows that 37% were concerned about the prospect of riding in a fully autonomous car, about the same 36% as in 2014. 45.8% preferred to no self-driving, and 38.7% preferred partial autonomous. Only 15.5% preferred fully autonomous vehicles like the Google car, which do not have brakes or a steering wheel for the driver to take over. The respondent to an UMTRI's survey are from 618 licensed U.S. drivers [3]. An Alix Partners survey in 2016 with total of 1,517 respondent in the U.S. were asked the questions differently. 73% of the respondent said they would like a self-driving car in the future [4].

This project aims to expand human–Autonomous Electric Vehicle (AEV) interaction research through the investigation of human responses, facial emotion and AEV Technology while driving on AEV. The field studies of this project include the autonomous driving at UniMAP Circuit. The facial expression and EEG signal will be recorded for the perception analysis. One hundred subjects will be selected with the age ranging from 18 to 65 years old. The age range is selected to cover all driver's driving experiences. Humans sometimes did not express their emotions through facial expression. Whereas, the brain signal (EEG signal) can specificially distinguish the human emotion [5,6]. The recorded EEG signal will be compared with the registered emotional database in order to identify the human emotional state while on the autonomous vehicle. In addition, the facial expressions will be captured and analysed by using Affectiva software. The Affectiva software uses computer vision, machine learning and deep learning methodologies to identify the human emotions.

This research helps to identify factors that differentially effect on the individuals' attitudes to AEV including gender, age, facial expression, AEV perception and exposure to the autonomous system. This research also will lead us to understand if there is a wariness of autonomous driving technology and concern for personal safety on the road. Because of the autonomous vehicles are developed to improve the Quality of Life (QOL) of humans. Safety, happiness, and well-being of the human can be improved with the AEV driving system.

2. Methodology

Figure 1 show the overall process for the study of the human/subjects to the autonomous vehicle. The autonomous vehicle are install with sensors such as IMU, sonar, and GPS module for the path tracking and obstacle avoidance. The MyRIO controller used for the sensors integration and actuator controls. The subjects' EEG signal will be extracted using wireless Emotive Epoc+. Facial expression are analyse based on image analysis of the subjects while on the autonomous vehicle. Finally, subjects' emotion will be classifed classified based on data from EEG signal and facial expression analysis.

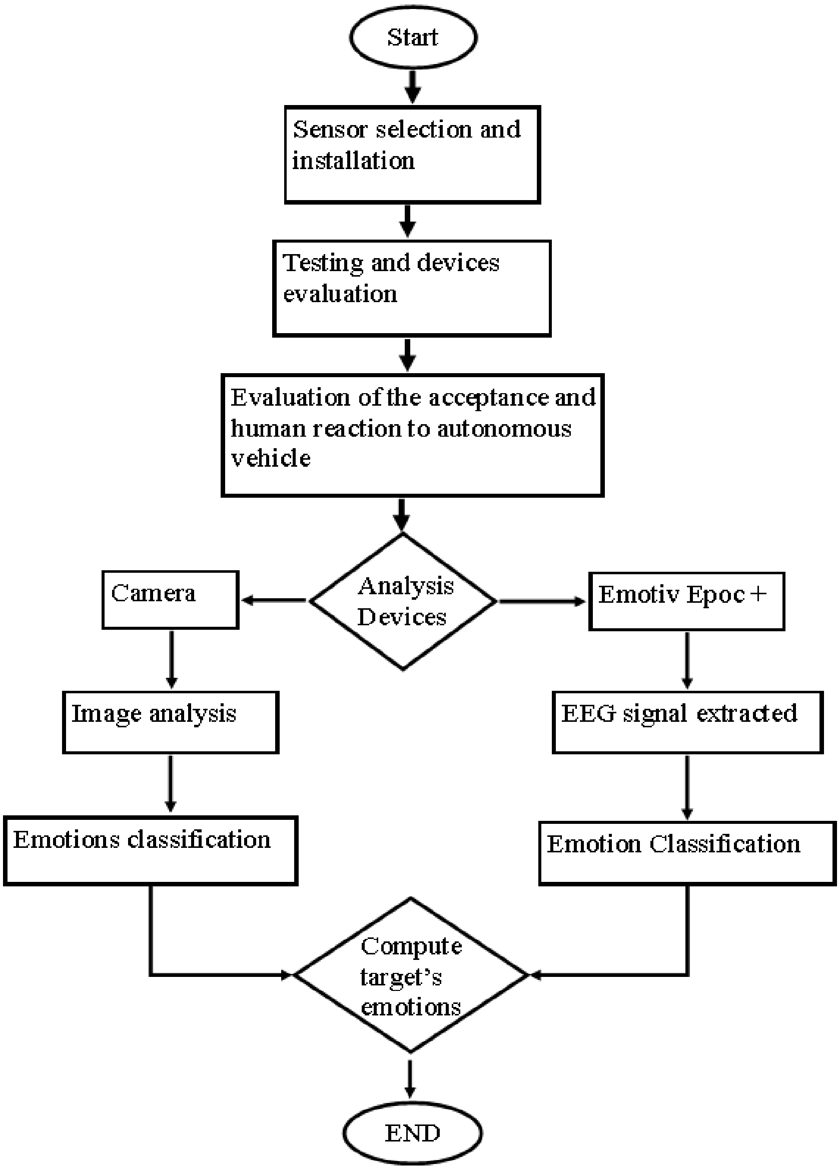

Fig. 1. Flow diagram for the study of the human acceptance and perception to the autonomous vehicle

2.1 Selection Device and Installation

The electric buggy car equips with sensors, which are MyRIO controller from National Instrument (NI), sonar, GPS module, Inertia Measurement Unit (IMU), including stepper motor, encoder and alarm sensors. The NI controller is used for controlling sensors including stepper motors. Six sonar sensors are used to detect nearby objects or obstacles. Two sonar sensors are installed at the front and rear of the electric buggy car. The remaining 2 sonar sensors are installed at left and right sides of the electric buggy car. The GPS module is used in navigating the vehicle to follow the desire path. The information like the vehicle coordination, speed, bearing and travelled distance are extracted from GPS data. The IMU is used to determine the orientation of the electric buggy car. The stepper motor is used to control the brake pedal [7]. The acceleration is controlled control directly from NI controller to the input voltage by using a voltage divider technique. The encoder is attached at steering shaft in order to read the steering wheel angle. The alarm sensor is used as an indicator if there are any obstacles on the path. The parts installation including sensors will take place at Institut Kemahiran Mara (IKM) Beseri as one of the collaborator for this project.

2.2 Testing and Evaluation Devices

Sonar, GPS module, encoder and stepper motor are tested to evaluate the performance of each item after the installation. In the experiments, the buggy car is driven in manual mode in the selected path for the sensor data validation purposes [8]. The readings from the sensors will be analysed to determine its usability. The integration of all sensors will be tested to investigate the overall performance of the AEV systems [9,10].

The complete AEV systems will be tested at UniMAP Circuit, which is located at the main campus Ulu Pauh. The circuit's distance is 1200 m with 11 corners. The AEV equips with three modes, which are autonomous mode, semi-autonomous mode and manual mode. The autonomous mode will navigate the AEV through the circuit by following the predetermined waypoint or target coordinate. The semi-autonomous mode is when the operator navigates the AEV from the station. While for the manual mode, the passenger can control the AEV through LCD control panel on the dashboard.

2.3 investigate People Reactions while Driving in the Autonomous Electric Vehicle

The emotions of the selected subjects are investigated by monitoring their EEG brain signal through Emotiv Epoc+. Emotiv Epoc+ is a wireless Electroencephalography (EEG) device that can read and record the EEG signal of the subjects [11]. The face expression of the subjects are recorded and analysed. The subject's facial expression were analyse by using Affective software as shown in Figure 2. 100 subject will be chosen for this experiment, which are 50 male and 50 female. Age of subject are between 18 to 65 years old.

The experiments are conducted at UniMAP circuit. The UniMAP circuit situated at UniMAP Pauh Putra Campus. The AEV is set to drive around the circuit with the distance of 1200 m. The AEV can be controlled either manually from the station or autonomously. The passenger or subject can manually override the controller using LCD control panel if necessary.

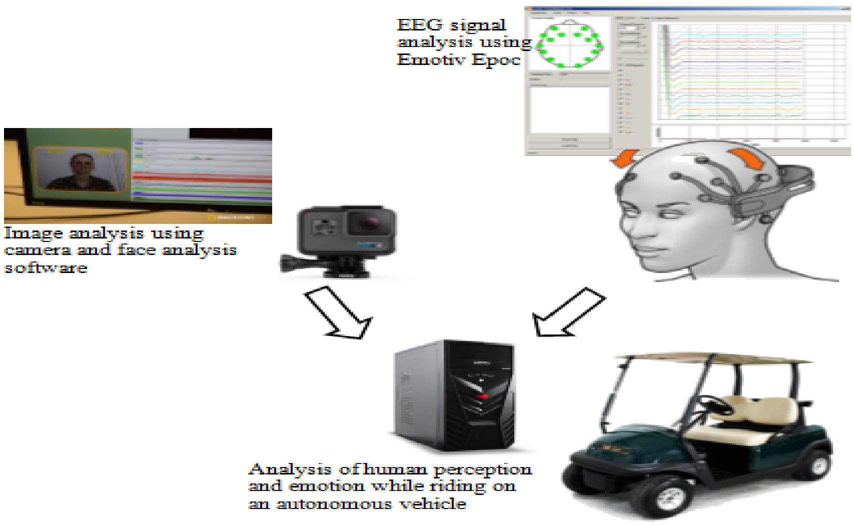

Fig. 2. Experiments setup for the human acceptance/perception to the autonomous vehicle

3. Conclusion

Currently, the mass production autonomous vehicle only reach level 3 of the SAE Automation Level. The transition of the autonomous vehicle to the next automation level are ongoing. The level 4 automation is the high automation, which is the vehicle can be perform the autonomous drive without driver intervention. This situation can be a drastic change for the users who are comfortable with current automotive technology. The users concern about their safety while riding on an autonomous vehicle. This research conduct in order to understand the current factors that contribute to the acceptance of the users to the autonomous vehicle.

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