Analysis of Human Behaviour while Controlling the Steering Wheel of a Buggy Electric Vehicle (EV)

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Abstract. Human ability to make a decision and recognize pattern are based on their intelligence level and experience. This ability makes the driver alert and knows what they need to do at certain situations. This paper aims to study human behavior while driving the vehicle at the desired path. Certain criteria subjects are selected with the purpose to study their driving pattern. The subjects must own a driving license and driving experience less than 10 years. The subject then drives the vehicle at the designed paths, which is straight and right turn. The drive pattern for the subjects shows a similar pattern but different characteristics. The experiments used to create a fuzzy controller that imitate human behavior while controlling the steering wheel. The steering wheel angle, position, heading and speed of the vehicle are recorded during the experiments. This paper only focus on the analysis of human behaviour based on steering wheel angle recorded.

1. Introduction

Steering wheel control need for an autonomous vehicle navigation system. The steering wheel usually controls by using a motor [1]–[3] or other suitable actuator. The controller use to control the actuators for navigation. However, the navigation by controller alone make the autonomous vehicle lack of comfort and human-like factor. The future passengers of the autonomous vehicle needs to feel safe and comfort while using the autonomous vehicles. Other researches related to steering wheel control which are focus on the comfort and safety of the passenger still in the development phase [4], [5]. Fuzzy controller [6] and Neural Network [7] developed to imitate human ability of the decision making. Development of autonomous car by Google, Toyota, BMW, and others multinational company still lacks the fundamental experiments to support the autonomous vehicle success. Steering rate control [8], steering by wire [3], yaw stability [5], and zero-radius steering [9] are the methods developed in order to improve the steering control of an autonomous vehicle.

The data collection and analysis used for future reference in developing the controller for the steering wheel. The experiment uses 5 subjects to gather data on steering wheel control [10]. The data use to set the baseline or benchmark in order to create a controller that imitate human driving pattern. The controller needs to retain the passengers’ comfort for an autonomous drive in the future. The driving experience helps the driver to determine the appropriate action based on the path taken [11].
This paper consists of an abstract, introduction, methodology, result and discussion, and a conclusion. Abstract explain the brief description of this paper. The introduction consists of research background and inspiration for research. The methodology explains the method of experiments. Result and discussion present experiments result and explanation from the result. Finally, the conclusion concludes the finding from the experiments.

2. Methodology

2.1. Flow Chart

Figure 1. Flow chart for Human navigation test

Figure 1 shows the process flow for the human navigation experiments. The selected subjects must have a valid driving license with driving experience less than 10 years. There are 2 path selected for data collection, which are straight and right turn. The experiments repeats 5 times for each path. Then, the steering wheel are extracted and filtered. The selected result represent in Figure 3 and Figure 4.

2.2. Test setup

The experiments consist of right turn and straight path maneuver with 5 subjects selected in order to study the characteristics of human while driving. The path for experiments shown in Figure 2. The experiments done at Institut Kemahiran Mara (IKM), Beseri, Perlis Malaysia. Distance of the path is 40m include the corner. The subject start at point (1) and stop at point (2). The subjects instruct to maintain a constant speed during the test. The subject must own a class D driving license with driving experience less than 10 years [12]. Data of steering wheel angle taken while the subjects drive on the paths. The result selected after 5 trials. The vehicle used for this experiment is a Yamaha electric vehicle. The specification of the vehicle show in table 1.
3. Result and Discussion

The result presented in Figure 3 and Figure 4. The positive value of steering wheel angle indicate the rotation on clockwise direction while negative value is rotation to counter clockwise direction. In Figure 3, the transition from straight line into the curve path can be seen at time 11.7 second by subject #1. The steering angle change smoothly while take the corner. At 16.3 second, the sudden change in steering angle when the subject try to drive straight again. Inefficiency of rack and pinion steering system can be seen as the driver turn the steering. Subject #2 drive more smoothly. The straight drive and drive at curve can be distinguish by the different of steering wheel angle. At 10.5 second, the subject #1 enter the curve with maximum steering angle of 157°. The orientation of the vehicle straight again at 20.9 second. The drive pattern for both subject different in term of smoothness. The transition from straight path to curve are more smother for subject #1. However subject #4 use less effort in order to take the same curve. This is because the maximum steering angle by subject #4 less than subject #1 even they taking the same curve.

Figure 4 show the steering wheel angle for the straight path for subjects #3, #4, and #5. The steering wheel angle recorded for the straight path are varied from -16° to 15°. The uneven road and road gradation are the main cause for the angle variation for the straight path navigation. The variation of the steering wheel angle are consider small if compared to the maximum steering wheel angle recorded, which is 408°. Subject #5 recorded the highest steering wheel angle (absolute value of 16.5°) at 18.3 sec.
Figure 3. Steering wheel angle for the selected subjects on right turn path

Figure 4. Steering Wheel Angle for the straight path for selected subjects.

4. Conclusion

Drive pattern for different subject show different characteristic. The bell shape graph for steering wheel angle show same pattern but different characteristic for each subject. The behaviour when subject take the curve based on their experience and attitude. The speed taken for the experiments almost constant throughout the experiments. From the experiments, the extracted data use to develop a Fuzzy controller. The average and standard deviation use to develop the membership function for the input and output of the Fuzzy controller.

5. References

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