28M-08

専門家の選択的注視機能を利用した高効率機械学習による自動運転車の実現

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＜要旨＞

In this research, we proposed a new idea for the design of an efficient diver-less car. Most of the attempts to design self-driving cars, collect all possible data from the surrounding environment. This not only makes the system costly, it needs lot of processing for decision. This is similar to a novice driver, who knows driving rules but yet to learn where to attend. An expert driver's selective attention, through experience, helps to collect only important information from the environment, thus reducing the processing load. In this project, we explore the visual selective attention of expert driver, and extract those features. In addition, we also collect the features of driving behavior of an individual, from which personal driving experiences could be transferred to the system of self-driving vehicle.

1　研究の概要

Driverless car or self-driving car projects are undertaken not only by many car companies, but also tech companies like Google, uber, Softbank. The general approach is to collect video and audio data from all directions, in addition to sensor like LIDAR, GPS, odometry data. In addition to the cost of these sensors, processing of the data needs enormous amount of computations, warranting high end computational power on board, and　as well as many car companies. Humans perform the same task, with two eyes and ears. Through experience, human drivers learn to attend to important aspects. Learning this selective attention is the key to reducing the amount of data to analyze for taking driving decisions efficiently.

2　研究の内容

In this research, we did our experiments in two steps, (1) investigate whether the visual attention pattern between expert driver and novice one are different or not, (2) to identify the visual cues where an expert driver focuses. In Fig. 1, while driving on a road as shown on the left, where there is no other traffic or pedestrians, visual attention is straight or on side mirrors. There is little difference between an expert driver and a novice one. When the driving is tricky, like narrow mountain road or on a crowded road inside city, the difference in visual attention pattern are very different. In addition, we collected bio-signals like electroencepahlogram, electrocardiogram, pulse, and muscle contraction data from the driver's body. This data is used to find out the time lag between an alarming event on the road and breaking or steering the car, with minute details to compare between an expert driver and a novice one.

3　これまで得られた研究の成果

We collected data from 10 subjects, 4 of whom are regular drivers and rest 6 do not drive. The time-series data of eye-fixations (point of attention) are collected. The distance between two time series is calculated using dynamic time warping (DTW), and signals are clustered. When the data is collected in a scenario like in Fig. 1, no clear cluster was observed. When the data is taken while driving narrow mountain roads, two clear clusters were formed, reflecting that the visual attention for two groups are different. In addition, as shown in Fig. 2, as shown in the upper part, a novice driver watches many objects (red circles), whereas an expert driver's attention is attracted by the car in the front and a pedestrian about to cross the road.

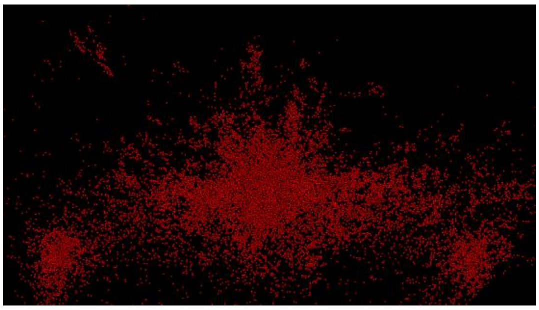

Fig. 1: Outline of the proposed system

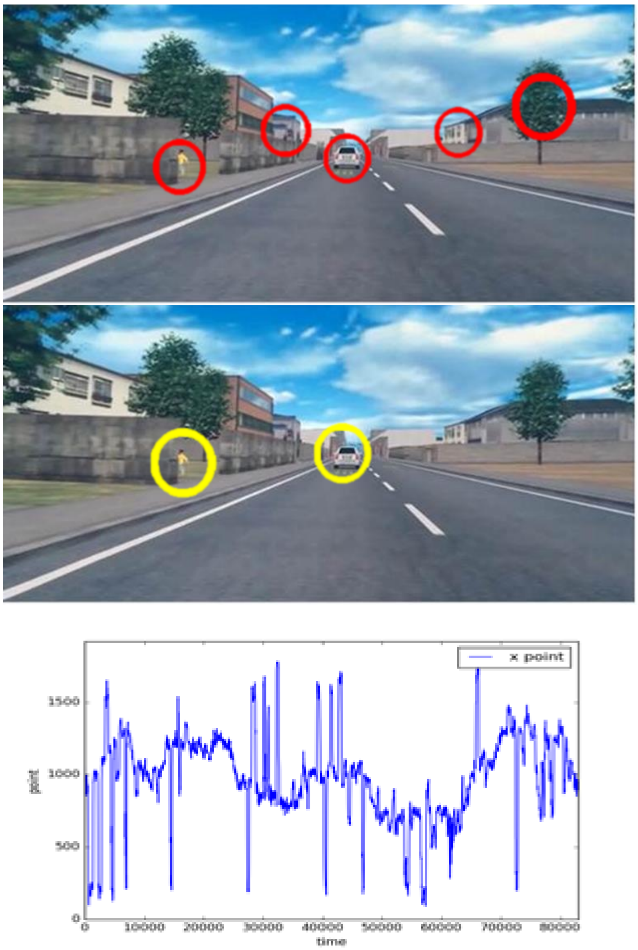

Fig.2 Eye-tracking data from novice and experienced driver is shown in the above two images. Expert driver concentrated only on important objects. The bottom plot is the y-axis of eye-movement.

4　今後の具体的な展開

From the above results, we conclude that novice drivers' attention is attracted at different objects of little importance to safe driving. On the other hand, expert drivers' visual attention is towards object which are important, like a pedestrian who may try to cross the road, or the car in front which may suddenly break. The list of such objects were divided into two categories, (1) all moving objects, (2) a few stationary objects like signal. For driverless car, it is important to detect such objects only, and take necessary decision and corresponding action. In addition, as shown in Fig. 3, we collected bio-signals from both young drivers and old drivers. The recognition time are different, with old drivers responding slowly. When an old man switch to diverless mode, the car should behave according to the original user. This needs training from previous driving data.

In addition, the total delay, from stimulation of a visual image of an alarming situation to action like braking, we divided into two parts – delay between visual stimulation to perception in the brain, and perception to actual action of braking. If the time delay is too long for safe driving, it will suggest the driver to forgo her/his driving license. In addition, the separate delay values will give an indication of what exactly is wrong with the driver, and what remedies to be taken.

5　論文・学会発表等の実績

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8) **IEEE Education Lecture**, “A Top Down Approach to Time-series analysis with bio-signals,” March 2017.

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14) **Key-Note Speech**, “Anomaly Detection in Time-series Data,” International Conference on Frontiers of Information Technology, Application and Tools (FITAT), April, 2017, China.

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17) **Goutam Chakraborty**, Zong Han Wu,"Analysis of time-series eye-tracking data to classify and quantify reading ability," International work-conference on Time Series, June, 2016, Granada, Spain.

18) **Goutam Chakraborty** and Shigeki Horie, "Towards an Efficient and Convenient Brain Computer Interface," American Association of Artificial Intelligence Spring Symposium, Palo Alto, California, USA, 21-23 March, 2016.

６　受賞・特許

該当なし

７　参考文献

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