

Research on Implementing of Human Ethics in Automated Driving Using Driver's Choice Behavior

Kaito kusakari¹⁾ Toshio Ito¹⁾²⁾

1) Shibaura institute of technology, Department of Machinery and Control Systems
307, Fukasaku, Minuma, Saitama-City, Saitama, 337-8570, Japan

2) Hyper Digital Twins Co., Ltd., Niu Building 2F, 2-1-17, Nihonbashi, Chuo-ku, 103-0027, Japan

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In recent years, there are five issues in the practical application of fully automated driving: practical application of sensors, takeover, mixing of manually and automatically driven vehicles, liability issues in accidents, and ethical issues that arise in the event of an accident. In this research, we will consider the implementation of ethics in automated driving. The trolley problem is the ultimate theme in ethics.

A thought experiment that applies this trolley problem to self-driving cars is the moral machine shown in Fig.1, made by a research team at the Media Lab of the Massachusetts Institute of Technology. This is a site where self-driving cars investigate which way to go if the brakes break down and they have to go to either side.

The results of the survey showed a common tendency to give priority to helping people rather than animals, large groups of people rather than small groups, and young people rather than the elderly people. In other words, we think that the choice of the trolley problem is reflected in human ethics. We think that making an ethical model for each individual and installing it in an automated vehicle will lead to the solution to ethical issues. In this study, we applied the trolley problem to an automated car, had the driver experience the situation, and examined the changes in brain waves and cerebral blood flow during the experience. If the vehicle moves in an undesired direction, the driver becomes impatient and changes in brain waves and cerebral blood flow are expected to increase compared to the desired direction.

First, the participants were asked to ride in a driving simulator, and after installing an electroencephalograph and a cerebral blood flow meter, they were asked to view five situations with the Moral Machine diagram on a tablet as a preliminary survey, and then the experiment was conducted after surveying which they would choose. The experimental screen of the driving simulator is shown in Fig.2.

Results of EEG analysis and cerebral blood flow measurements are shown in Fig.3 and Fig.4. EEG analysis showed that in situations where the participants' ethical viewpoints were relatively consistent, the ratio of β/α , which is the β wave emitted when the brain is active, to the α wave emitted when the brain is relaxed, became larger when the participants moved in an unwanted direction after the warning sound. The F3 EEG measurement point was found to be the most likely location to exhibit this tendency.

The cerebral blood flow measurement also showed a greater concentration when the ethics went toward the unwanted direction concerning the matched situation. The difference was especially large when more than 7 seconds elapsed after the warning sound. This suggests that EEG and cerebral blood flow are likely to differ following ethical tendencies in the trolley problem.

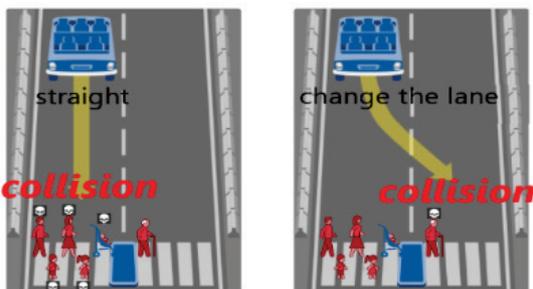


Fig.1 The moral machine

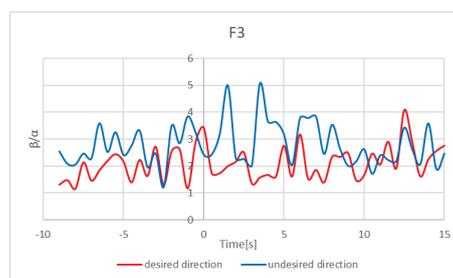


Fig.3 Result of F3's EEG analysis in first situation



Fig.2 Example of the situation

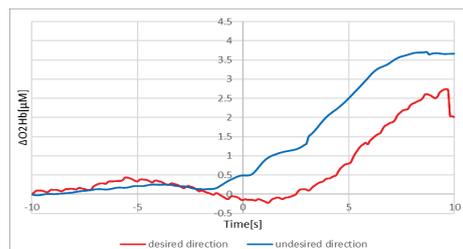


Fig.4 Result of cerebral blood flow in first situation