NO.1

Year 2023	**Summary of Thesis**

Student No.	Last name, First name
M２２２００２０	Ikegami Ryo

(Title)

Driving Assistance Based on Machine Learning using Optical Flow for Power-Assisted Wheelchair

1. Background and Purpose

In recent years, various human supports by robotic devices have been developed due to aging society. In our laboratory, vision-based power assist control of wheelchair (Fig.1) has been proposed by using Optical Flow Vector (OFV). However, this OFV-based approach needs to be developed in order to be applicable for more general indoor situations including dynamic obstacles [1]. In this study, a power assist control method based on velocity estimation and environmental classification using OFV and Convolutional Neural Network (CNN) is proposed for obstacle avoidance and driving assistance force, and its evaluations are conducted by several experiments.

2. Outline of Proposed Approach

The environmental mode is defined at first. Driving environment divided 3 areas (left, center, and right), and their combination with existing the obstacle in each area bring 2^3 = 8 environmental modes (Fig. 2). The CNN with outputs of velocity and environmental mode is trained by collected data including the OFV visual features, actual translational velocity v, angular velocity ω and corresponding environmental mode. After trained, the CNN is expected to be able to estimate mode and appropriate wheelchair velocity, and then the impedance value and assistance force are switched/calculated according to mode and velocity in the proposed method.

3. OFV training and Correcting the datasets

In our approach, the HSV-formatted image, which is generated from OFV data, is transformed into RGB format for CNN input data as followings. This flow shown in Fig. 3. While moving the wheelchair straight in each target environment with 8 environmental modes by hand-powered and additionally passing along narrow path (Fig. 4) by hand-powered, all data were collected and stored for learning datasets.

Graduate School of Science and Technology, Chitose Institute of Science and Technology

NO.2

4. Experiments

The virtual assistance force for modifying the wheelchair motion into the narrow path (Fig. 4) direction is verified by experiments. When the CNN estimates narrow area (Mode 5), the wheelchair generates assistance force according to estimated angular velocity ω_{est}. Fig. 5 shows the results of this experiment when approaching angle to narrow path was 30 degree from right side. While the wheelchair turned right (3.2 s-5.3 s), the assistance force is generated, and it made the velocity ω modifying close to ω_{est}. As a result, the wheelchair was successfully passed narrow area.

5. Conclusion and Future Works

The CNN-based driving assistance was proposed and verified by experiments. In future works, other various situations need to be considered for further developments.

Fig. 1 Wheelchair Robot

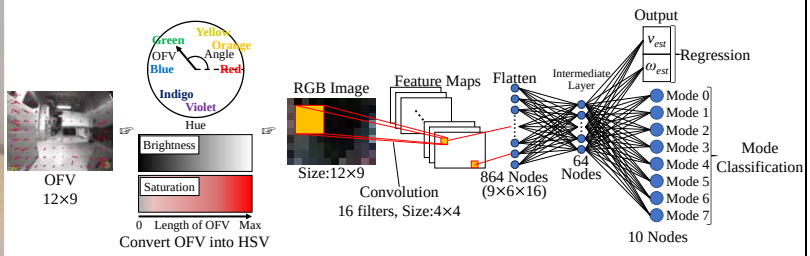


Fig. 3 Flow from OFV Calculation to the CNN Process

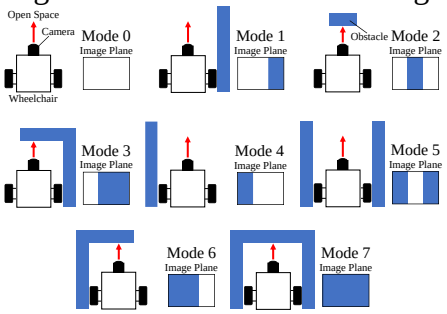
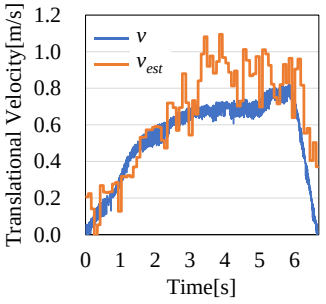
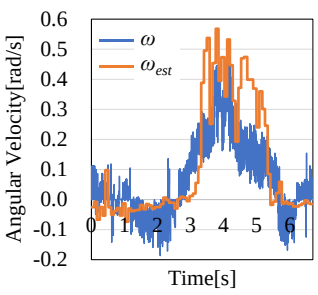


Fig. 2 Environmental Mode

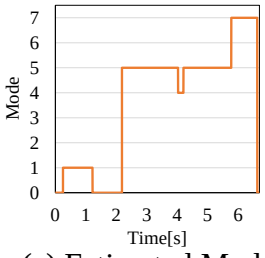


(a) Translational Velocity

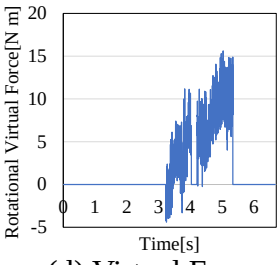


(b) Angular Velocity

Fig. 4 Passing to Narrow Path



(c) Estimated Mode



(d) Virtual Force

Fig. 5 Experiment Data

References

[1] Kuwajima Takashi, “Driving Assistance Control for Power Assisted Wheelchair Based on Environmental Mode”, Graduate School of Science and Technology, Chitose Institute of Science and Technology Master Thesis, 2020

Graduate School of Science and Technology, Chitose Institute of Science and Technology