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Human-like Artificial Intelligent Wheelchair Robot Navigated by Multi-Sensor Models in Indoor Environments and Error Analysis

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Abstract

Intelligent mobile robot navigation in indoor environments is still a challenge. In this paper, we propose a method in which the wheelchair robot imitates human like navigation by interacting with the surrounding environments. Two types of sensor data are used to train neural networks, which are later used to control the robot to reach the goal location in different indoor environments. The robot navigates from the start to the goal location in the environments with obstacles. In first model, we used the Laser Range Finder (LRF) sensor data as input of the neural network. In the second model in addition to the LRF data, the processed camera sensor data are also utilized. We compare the performance of two neural networks models by analyzing the error between the human and neural network based real robot navigations. The experimental results show that our proposed models are efficient for mobile robot navigations. In addition, errors are analyzed in this paper.

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Keywords: Wheelchair robot, navigation, human-like, neural network, fusion sensor model, independent LRF model.

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1. Introduction

Research on wheelchair robot navigation is becoming a very important topic due to the aging problem of the world population. The number of elderly people is growing in nearly all the countries[1], including the developed countries.

Most of the elderly people, with immobility problems, use the wheelchair in order to move to a specific destination in indoor or outdoor environments. However, controlling the wheelchair using the joystick is easy especially by the elderly people. Therefore, development of autonomous wheelchair robots has attracted many researchers working in the field of mobile robotics. The works on wheelchair robots are focused in indoor and outdoor environments. In indoor environments, the wheelchair robots are implemented in museums. For example, Nourbakhsh developed the Insect Telepresence robot to help museum visitors at the Carnegie Museum of Natural History[2]. Shibusawa et al. focused on the behavior through art appreciation at the museum and proposed a method for the wheelchair robot to support painting appreciation[3].

Navigation in outdoor environments is much more complex because the robot has to move in completely different environments. Therefore, the robot has to switch to different navigation algorithms as the environment changes. For this purpose, artificial intelligence, such as neural network and Genetic Algorithm are utilized for robot navigation[4,5,6].

In this paper, we propose a learning by demonstration method for the wheelchair robot navigation, where a human serves as a teacher for the robotic system. At first, the user controls the robot using Joystick. During the robot motions, we collect the data from sensors and actuators. Then, we train two types of neural network to control the wheelchair robot. We use two types of models for robot controller. In the first model, we use the sensor data from Laser Range Finder (LRF) as input for the neural controller. In the second model, we add the processed data from camera image to the sensor data. According to the models, the wheelchair robot plans a path to navigate the destination position by avoiding all type of obstacles. The user does not have to pay attentions to the control during the navigation period. We compare the performance of robot navigation during the human controlled motions and the neural-controlled motions. In addition, we analyze the errors for two types of controlled motions.

The paper is organized as follows. The wheelchair robot and experimental environments describe in Section 2. Robot controlled by neural network mentions in Section 3. The experimental results present in Section 4. Finally, we give the conclusion and future works in Section 5.

2. Wheelchair Robot and Experimental Environments

2.1. Wheelchair Robot Overview

In the experiments presented in this work, we utilize a programmable wheelchair robot, which is driven by two independent Yamaha AC motors in the two sides of the wheels (shown in Fig. 1). The LRF is placed in front of the robot and a USB camera is on the top part of the wheelchair robot. All the sensors data are processed by the control PC placed in the backside of the robot.

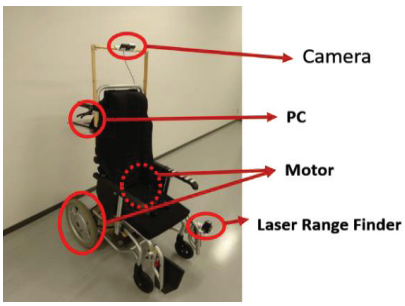

Fig.1 Wheelchair robot

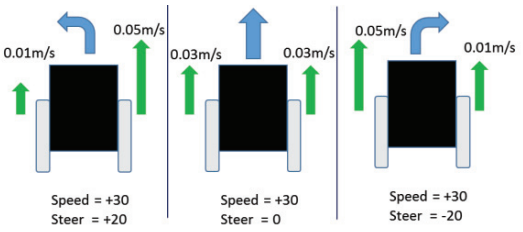

Fig. 2 Wheelchair robot control