Human Following Robot with Posture Control

A Proposal Prepared for the
Final Project of the Graduate Course
CS401: Intelligent Robots

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Abstract

This is a project of the intelligent robot class. Our goal is to implement a human-following robot with posture control in a ROS environment. Some mature packages will be used. For example, we will use turtlebot_follower to implement the following functions. We also plan to use Kinect's built-in features to capture human joint information and then implement posture control.

1 Background and Motivation

Sine the first flashlight following robot was invented in 1929 by Dr. William Grey Walte, signal following robots is used in numerous fields such as carrying loads in industrial zones, airport by following the colored line on the ground. In recent years, robot technology has advanced significantly. Some new technology such as face recognition and dynamical path planning, the possibility of robots that are human-friendly that are able to coexist with humans and support humans effectively comes into being. Human following robots are used in numerous fields such as taking care of human in hospitals, helping people during shopping. The most important things for building a human following robot is to verify the leaders identity and estimate the relative position between the human and the robot. Our group choose "human following robot with posture control" because it is a relevant topic in the world today especially in China elderly population increase greater, human following robot has huge demand in Pension industry.

2 Related Work and Novelty of This Work

Robotic perception is related to many applications in robotics where sensory data and artificial intelligence/machine learning (AI/ML) techniques are involved. Examples of such applications are object detection, environment representation, scene understanding, human/pedestrian detection, activity recognition, semantic place classification, object modeling etc.

Perception is an essential building block for autonomous intelligent robotics system and another blocks is control. To do perception, usually, in traditional mobile robot manipulation use-cases, the navigation and manipulation capabilities of a robot can be exploited to let the robot gather data about objects autonomously. In the aspect of the technique, most of the robotic perception systems use machine learning (ML) techniques, ranging from classical to deep-learning approaches nowadays.

Segway Robotics team brought the Loomo robot at the world Robot Conference in 2017. As a mobile service robot, Loomo can be awakened and controlled by voice. Our work is to design a human following robot with posture control, so it will similar to Loomo but not exactly the same.

3 System Setup and Problem Statement

The main system we use in this project is ROS. As we know, the Kinect is a motion sensing input device produced by Microsoft. We intend to make use of Kinect to enable the robot to recognize human's skeleton and postures.

Our goal is to realize a robot that can follow the people and can react to some certain postures of people, that is, people can pose to command the robot.

The problem of our project can be mainly divided into two part. Firstly, is how to let the robot follow the people while he/she is walking. We want to use the turtlebot_follower package to recognize the target to follow, and then let the robot follow that direction (if the robot is too close to the human, it should stop of course). Secondly, the robot should be able to recognize the skeleton of human in order to recognize people's posture command. It can be realized by using the Kinect devices which can track up to six skeletons at one time. The recognition of posture is realize by collecting and analyzing the joint information provided by the Kinect.

4 Proposed Design and Methods

According to our requirement, there are two parts of algorithms include gesture recognition and human following functions.

The gesture recognition function requires us to complete the matching of the gesture through the processing of the human joint information. We can use Kinect to obtain three-dimensional information about the human joint (see next section), and then extract the feature values for further operation. Among them, we can get static eigenvalues like the relative position of the joint, the angle of the joint and other characteristics.[3] And we can select dynamic characteristics like the speed, acceleration and other information of a specific joint. Then we select the most representative feature value, train the model of the gesture recognition through the logistic regression method. And then control the start and pause of the robot following mechanism according to the command corresponding to the recognized posture.[4]

And in terms of the following function, we found that there are already mature software packages (turtlebot_follower) available for us to use. What we need to do is to continuously monitor the user's posture while the follow-up mechanism is running, and stop following if there is a gesture that represents a stop command. Also, deal with the boundary condition: let the robot slowly stop after the stop command is issued.

5 Hardware and Software Platform

In terms of hardware, we use the turtlebot2 robot, which mainly uses its depth of field camera and Kinect.

Turtlebot2 introduction: TurtleBot is a low-cost, personal robot kit with open source software. TurtleBot was created at Willow Garage by Melonee Wise and Tully Foote

in November 2010.[5]

Kinect introduction: Kinect (codenamed Project Natal during development) is a line of motion sensing input devices produced by Microsoft. Initially, the Kinect was developed as a gaming accessory for Xbox 360 and Xbox One video game consoles and Microsoft Windows PCs.[6]

In terms of software, our project will be implemented in ROS and simulated in MATLAB.

In the posture recognition part, we use Kinect to collect the user's posture information. Kinect's real-time skeletal tracking technology captures the three-dimensional position of up to 20 joint points of the body. Through the algorithm we designed, using the joint information provided by Kinect as a parameter, we can realize the recognition of the human body posture, and then implement the design through the subsequent control algorithm.[3]

The following function would be implemented based on turtlebot_follower, which can get a point cloud map by the depth camera. Then we can calculate the point cloud center coordinates in a certain area as the target following point. After finding the target, we can control the robot movement to implement the following function according to this coordinate and the set safety distance.[7]

6 Goals, Metrics and Timeline

Based on the project working direction we mentioned before. The goal of our project can be literally separated to these few tasks order by our planning process for whole project: Robot vision and human skeleton recognition, Robot’s human detection and tracking, Robot posture recognition.

For the first task, we need to prove that robot can get the information of human body and our computer can get the signal from the robot. This is the basic task for we can make the connection between isle robot and target human body.

For the second task, we need to prove that our robot can have the right reaction to the moving human body that is tracking. This is the main content we focus on during the first half semester. For the next half semester , we will focus more on the posture recognition so that we can do some extra controls when the robot is tracking us such as stop order or target changing.

7 Staff Planning

Based on the background and project experience, we will have different sub groups to finish our whole project. Pan Tianci and Wang Kai are more familiar with the computer vision field so they are mainly responsible for the first task and the third task. Chen Min and Wang Shuxin have the experience of robot mapping and pathing , so they focus more on the second part. Ouyang Yicheng is more skilled on coding so they will finish the coding part for them , debugging and testing.

8 Reference

[1] http://davidbuckley.net/DB/HistoryMakers.html

[2] https://ieeexplore.ieee.org/document/6106314

[3] 刘开余,夏斌.基于 Kinect 的实时人体姿势识别[J].电子设计工程, 2014,22(19):31-34.

[4]"ROS 学习笔记（四） 先锋机器人跟随-javaee 论坛", *Bbs.javaee.cc*, 2019. [Online]. Available: http://bbs.javaee.cc/post/270550_1_1.html. [Accessed: 19- Mar- 2019].

[5]"TurtleBot", *En.wikipedia.org*, 2019. [Online]. Available: https://en.wikipedia.org/wiki/Turtlebot. [Accessed: 25- Mar- 2019].

[6]"Kinect", *En.wikipedia.org*, 2019. [Online]. Available: https://en.wikipedia.org/wiki/Kinect. [Accessed: 25- Mar- 2019].

[7]"turtlebot/turtlebot_apps", *GitHub*,2019. [Online]. Available: https://github.com/turtlebot/turtlebot_apps/tree/indigo/turtlebot_follower. [Accessed: 19- Mar- 2019].