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SIMULTANEOUS LOCALIZATION AND MAPPING BASED VOICE ENABLED WHEELCHAIR

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Abstract: *The main aim of this work is recommended to control a wheel chair by voice of the person or patient who uses the wheel chair for their daily needs. The system is designed to facilitate the movement of elder, handicapped and also blind peoples those who are not able to move well by them. Problems in existing system are it can only use by non-blind people. No array mic is included, so noise cancellation is not possible for input commands. By using SLAM algorithm we can map each room. So the person sitting in the wheel chair does not need to tell the direction which he needed to go, instead he can tell the wheel chair in which room he want to go. Array mic is used here. So noise cancellation and better acceptance of voice is possible. An obstacle sensor is included in the system to detect the presence of obstacles in the way of movement.*

Key Words: **IMU sensor, Pocketsphinx, Odometry, Encoder**

1. INTRODUCTION

Wheel chair is one of the most used mechanical devices in the world, used by aged or physically challenged people. But for using this, user needs a self-assistance by hand to move. Statistics reveals that 17% of world population which is about 0.655 billion people are suffering from different kind of physical disabilities. A basic manual wheelchair includes a customized seat, foot resting portion and four wheels: two, caster wheels at the front and two large wheels at the back. Other varieties of wheelchair are often variations on this basic design, but can be highly customized for the user's needs. An electric-powered wheelchair is a wheelchair that is moved by means of an electric motor and navigational controls, usually a small joystick mounted on the arm portion, instead than manual power.. Joystick controlled wheelchair are widely used throughout the world. But the difficulty is that handicapped people having issues with finger movement are unable to control the joystick since it needs hand control. Voice enabled wheelchairs are available now a days. But the voice activation which can only be used by un blinded person. As the voice is the most common mode of communication, the proposed system aims to design a voice controlled wheel chair by using Simultaneous localization And Mapping algorithm. The design also provides some additional features like obstacle detection for the safe movement. By using this algorithm we can map each room. So the person sitting in the wheel chair does not need to tell the direction which he needed to go, instead he can tell the wheel chair in which room he want to go. Use of array mic reduces the noise in the input commands. The goal of the system is to help the disabled ones to move independently and it can eliminate enslavement.

2. LITERATURE SURVEY

In 2019, Tshibamb Yav Beston et.al [1] proposed a survey of autonomous wheelchair has been proposed for physically handicapped people, which serves their crucial role for maneuvering by simply moving their neck. To accomplish this objective, they include Arduino board programmed for processing and controlling the wheelchair. Micro switches are used here to sense the neck movements of the physically disabled person and which further send this to Arduino for initiating actions to move the wheelchair correctly. GPS module is connected with the Arduino to track the movements of physically disabled person in case of urgencies. In addition to this, GSM module is also included here for sending important information regarding the physically challenged persons health issues if any, like heart beat rate or body temperature, send this to his/her registered care-taker.

In 2019 Varsha Pathak et.al [2] proposed a paper related to the Smart Android phone handling the wheel chair system using application. The wheelchair System is recommended to control a wheel chair by using the mobile phone through an android application. The objective of this work is to serves the movement of disable people or handicapped and also for the aged people who are not able to move themselves well. The result of this design will allow those isolated people to live a life with not depending on others. Android technology is a key which may provide a new approach of human interaction with machines or tools. Therefore, by using android application their problem can be solved and we can control the movement of a wheelchair.

In 2018 D.Vijendra Babu et.al [3] proposed a mobile robot work accordingly with oral commands. The system is classified in to two sections as speech recognition engine;

hidden Markov Models is used as the method for recognizing oral commands. The robotic control unit was developed based on the ARIA environment, which is given by the robot manufacturer. This paper explains about the voice controlled wheel chair system which using speech recognition through a Bluetooth module. The system is designed to control a wheelchair using the voice of person who uses wheelchair. The objective of this paper is to help the movement of people who are disabled, aged or handicapped who are not able to move themselves.

In 2018, Vikash Raj et.al [4] proposed an Eye Monitored Wheel Chair System which allows movement of wheelchair depending on the eye movements of the person who uses it or sit on it. The person who suffers from disease quadriplegia, all the four limbs of the patient are affected and the person can only move their eyes and they can only partially tilt their head. Here the author created a prototype in which a patient sitting on the wheel chair is can control the direction by seeing in that direction properly. The camera would take a snapshot of his iris, which will then processed by using MATLAB, It will then send that signal to the motors via the Microcontroller through the Serial Port to locate in a correct direction. This Eye monitored wheel chair is user friendly and economical and available in cheap rate to everyone.

In 2017, Mohammad Ilyas Malik et.al [5] proposed a system to control a wheel chair using the voice of person who sits on it. The objective of this project is to facilitate the movement of people who are disabled or handicapped and elderly people who are not able to move well. The aim of this system will helps physically challenged people to live a life with less dependence on others for their daily needs. Speech recognition technology is a recent technology which will provide a new way of human interaction with machine. So the problems that they face can be resolved by using speech recognition technology for the movement of their wheel chair. This can be optimized by using the smart phone device as an interface device. In this work interfacing has been developed therefore to design a program for recognizing speech and also for controlling the movement of wheelchair and an application which can manages the graphical user commands. This work includes an arduino kit Microcontroller unit and two DC motor to initiate the movement of wheel chair and Ultrasonic Sensors are used to detect the obstacles in between wheelchair and the way of direction.

In 2016, Dularisahu [6] proposed a paper includes the electronic wheelchair that implemented for the disabled person. The purpose of this eye controlled wheelchair is to get rid of the assistance required for the physically challenged person. In this system controlling of wheelchair is depends on eye movements and a central switch which can trigger by the user. Camera is placed on wheelchair in front of the user, for capturing the images fall on eye and it tracks the position of eyes pupil by using some versions of image processing techniques. According to eye pupil position of user, motor will be correctly moved in required direction such as left, right and forward and backward. Ultrasonic sensor can be mounted in front of wheelchair for safety to encounter the obstacles and then stop the wheelchair movement automatically. A central switch that is mounted on wheelchair for encounters emergency and stop the movements in require direction if anyone want to stop the movement. This is economical and cost effective wheelchair system.

3. METHODOLOGY

The system is designed to facilitate the movement of elder, handicapped and also blind peoples those who are not able to move well. Problems in existing system are that it can only use by un blinded people. No array mic is included, so noise cancellation is not possible for input commands. By using SLAM algorithm we can map each room. So the person sitting in the wheel chair does not need to tell the direction which he needed to go, instead he can tell the wheel chair in which room he want to go. Array mic is used here. So noise cancellation and better acceptance of voice is possible. Raspberry pi 3 b+ is the microcontroller used here.

Teensy 3.2, Gy 85 imu sensor, Kinect sensor, Ps3 eye camera, encoder motor are the components used here. Robot Operating System is used as the meta operating system. Rviz, Pocketsphinx are the softwares used here.

3.1 ROBOT OPERATING SYSTEM (ROS)

Robot Operating System (ROS) is robotics intermediate. It includes ROS master and ROS slave. Although ROS is not an operating system. It provides services designed for different computer clusters. It is possible, however, to integrate or incorporate ROS with real-time code**.** The function of ROS is to connect the different nodes. From each nodes messages are arrive as output. Publish and Subscribe method is done here. The output from each node is published on different topics. Another node which wants to communicate with them subscribe on topic.

The advantage is that we can write programmes on different nodes in different language. We can reduce complexities by differentiating a system into nodes. Ubuntu is the operating system inside the microcontroller. Use Ubuntu as a host, ROS is installed and act as a parasite. The data given by teensy is in the form of coordinates. Z axis denotes rotation, X axis denotes linear motion and the Y axis denotes the height. ROS possess many nodes in it. Teensy publish odometry data on a topic of ROS and the same time cmd vel (Command Velocity) subscribe on it. Laser data is also published on the topic on ROS. Keyboard requested ROS master for publishing to cmd vel. But ROS knows that topic is activated and there are no subscribers. When the subscriber is active ROS act as intermediate between the nodes

(publisher and subscriber).ROS master is inside the raspberry pi. Nodes can be connected using IP addresses.

3.2 ODOMETRY

An important aspect of SLAM is the odometry data. The goal of the odometry data is to provide an approximate position of the robot as measured by the movement of the wheels of the robot, to serve as the initial guess of where the robot might be in the map. It includes two sensors. Inertial Measurement Unit (IMU) sensor and encoder motor. Encoder is used to count the rotations in motor driver L298.

IMU sensor includes accelerometer, gyroscope and compass. Accelerometer is used to find acceleration and velocity. Gyroscope provides information about the orientation of the system like in which direction the system lying and whether the system is lying above any obstacle. Compass gives the direction of the system. Compass itself is not sufficient to give the direction. Because the data from compass is raw data. Raw data is not accurate. But it can be made correct by sensor fusion. Data from IMU sensor changes when time goes on. So data correction is needed here.

For this purpose we use encoder data which takes each and every rotation of the wheel. Fusion of IMU sensor data with wheel encoder data is called Odometry data. Odometry data is given to Teensy. Teensy is a high level programing board which has processing power faster than aurdino. Teensy is used to covert odometry data to a suitable form which can understand by ROS. Teensy process the odometry data and given to Robot Operating System (ROS).

3.3 LASER DATA

Kinect depth sensor is used here. It includes an infrared (IR) beam transmitter and infrared beam receiver. IR beam receiver is a CMOS sensor camera. The transmitted IR beam travel to a distance and hit back. The receiver captures the beam that bounce back. IR transmitter can send IR beam to all objects in its resolution frame. Therefore the obstacles in the way of movement can be tracked easily. The time between transmitting and receiving the IR beam after being reflected is called Time of Flight (TOF). An image includes array of pixels.

TOF from each and every pixel in resolution area were taken. ROS doesn't deals with sensor data. Transformation of sensor data gives laser data which includes header, minimum distance, maximum distance, range, minimum angle, maximum angle, minimum time, maximum time etc.

3.4 TRANSFORMATION

Transform is a coordinate frame tracking system and a standardized protocol for publishing transform data to a distributed system. Two types of tf nodes are there. Publishers nodes publish transforms between coordinate frames on tf. Listeners node listens to tf and cache all the data heard up to cache limit. There is no central source f tf information or history before a node was started. In transform tree each link is cached. 10 second is the default cache time. It will work with multiple disconnected trees. Values of transform are there is no data loss when transforming multiple times, no computational cost of intermediate data transformations between coordinate frames, the user does not need to worry about which frame their data started, transformation about past location is also stored and accessible but not before recording locally was started. Core methods of transformation are look up transform and can transform. From look up transform it get the transform between two coordinate frames. Can transform tests if a transform is possible between two coordinate frames. Wait for transform and message filter are the synchronization methods used in transformation. In wait for transform block until timeout or transform is available. In message filter subscribe to a topic and provide the call backs only when there is enough tf messages to transform the data.

3.5 MAPPING

Laser data has coordinate frame and ROS forms local map. Local map is a combination of grids. ROS compares local map with global map.

3.6 SLAM/NAVIGATION

The SLAM process consists of a number of steps. The goal of the process is to use the environment to update the position of the robot and its environment. Since the odometry of the robot is often erroneous we cannot rely directly or only on the odometry data. We can use laser scans from the environment to correct and update the position of the robot. This is attained by extracting features from the environment and re-observes the robot when it moves around. An EKF (Extended Kalman Filter) is the brain of the SLAM process. It is responsible for updating where the robot confirms that it is based on these extracted features. The EKF keeps track of an estimating the uncertainty in the robot position.

If we want to go from one place to another, we give the input command. By looking odometry data, can calculate how many rotations are there made to reach current location, in which direction the system lying, what is its velocity, number of orientations can be obtained. By creating local map and comparison with global map we can go anywhere within the boundary (Global Map). Cost map is also created and stored in the time of training or creating

global map. For example, when the system encounter an obstacle in the way of movement then the cost map defines when to stop it find an obstacle. In this project the cost map for the system is 20 cm. that means when the distance between system and obstacle is 20 cm the system must stop to avoid collision with obstacle.

3.7 VOICE RECOGNITION

For voice recognition software Pocketsphinx is installed in raspberry pi. Ps3 eye camera is used here and we use its array mic for giving input commands.

Software acts as node and input commands are published there as coordinate after transformation.

3.8 VOICE RECOGNITION WITH NAVIGATION STACK

Navigation stack subscribe on software which acts as node and take the coordinate value. According to program ROS can analyze which place is indicated by that coordinate value.

CONCLUSION

Due to rapid technological development, more advanced user friendly electronic devices are available in more compact form than that of the previously produced ones. These developed devices are being used to improve the lifestyle of the physically disabled persons and able them to keep pace with others in the society. The proposed system has a voice recognition module which can be designed using SLAM algorithm. . By using SLAM algorithm we can map each room. So the person sitting in the wheel chair does not need to tell the direction which he needed to go, instead he can tell the wheel chair in which room he want to go. Array mic is used here. So noise cancellation and better acceptance of voice is possible And finally we can conclude that those people who are socially isolated or lag behind due to their physical disability will have the opportunity to move freely without any assistance like other people of the society by using their voice commands.

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