FUZZY BASED AUTONOMOUS ROBOT FOR AVOIDING OBSTACLES

Dr.S.V.Manisekaran[1], M.Ramaraj[2], J.Mohamed Yousuff[3]

[1] Assistant Professor, [2,3] PG Scholar Department of Information Technology

Anna University Regional Centre, Coimbatore (India)

ABSTRACT

This project is to develop an autonomous robot with four wheel drive. It is capable of negotiating the obstacles with a leg motion mechanism. When the obstacles are encountered, wheels are lifted and moved ahead in a stepping like motion and lowered back down. It can also avoid any obstacles by changing the path by using fuzzy logic and path planning. When the vehicle encounters terrai n intractable by leg motion, with its current posture, the vehicle change its posture until it can traverse the terrain. Many robots are developed for industrial use, and home use Autonomous robots are characterized by their ability to execute tasks deprived of any human intervention. Decision making requires full or partial knowledge of the surrounding environment, or workspace, in which the agent is operating. Recent advances in sensor technology have enabled the use of reliable multisensory perception systems. Uncertainty in the perception stage leads to accumulated localization. Processing of collected data and accounting for errors is essential for accurate mapping and localization. When some interrupt occurs, it should take the correct decision using path planning algorithm and SLAM (Simultaneous Localization And Mapping). This autonomous robot which is not controlled by joystick, instead it is controlled by brain computer interfaces for intended movements from electrical activity. This robot will tolerate some rough environments. Some examples of access barriers are steps at the entrances of buildings, curbs without ramps and gutters and holes in the road.

Index Terms: Gait Algorithm, Mobility Performance, Obstacle, Personal Mobility Vehicle, Autonomic Robotic Wheel Chair, Rough Terrain, Terrain Topology.

I. INTRODUCTION

A Robot is mechanical or virtual intelligent agent that can perform tasks automatically guidance, typically by remote control. The robot is usually an electromechanical machine that is guided by computer and electronic programming. Robotics is the branch of technology that deals with the design, construction, operation, manufacture and application of robots and computer systems for their control and information processing. Robotic technology is used to deal with hazardous situation such as dealing with suspicious packages and collection of intelligence. Sensors are used to sense the environment and give useful feedback to the device. Robotics can be described as the current pinnacle of technical development. Robotics is a science using the continuing advancements of mechanical engineering, material science, sensor fabrication, manufacturing techniques, and advanced algorithms.

Proximity sensor easily detects the presence of any object. Our robot will follow the technique of bat to detect obstacle in its path. If the receiver receives this reflected wave then we can be sure that there is an obstacle in front of the robot. The time difference between the transmission of the light wave and the reception of the reflected wave is

calculated. Since the speed of the sound wave .we can calculate the distance of the obstacle. This is done in two parts. The first part consists of taking visual information of the object. Camera is used to take images and we would use various image processing techniques to extract the object from the image. The second part consists of taking the range information of the object. . A photo electric sensor is a device used to detect the distance, absence, or presence of an object by presence of an object by using a light transmitter, often infrared, and a photoelectric receiver. The principle behind infrared automatic door (or) find the obstacles sensors is the transmission and receiving of infrared light. An element known as a light emitting diode (LED) transmits active infrared light, which is reflected on the floor and received by an optical receiver known as a photo diode (PD).

1.1 Deviate the Vehicle

The most common barriers to widespread autonomous robot use are uneven footpaths, uneven ground, and curbs. Based on this, it is clear that an ability to negotiate uneven terrain and obstacles approached at an oblique angle would greatly expand the usability of autonomous robots. Therefore, we have developed a autonomous robot named RT-Mover P Type 3, which can traverse steps approached not only from the front, but also at an oblique angle. The main feature of our development is its leg motion mechanism. The ability to lift each wheel up and down in accordance with the terrain is paramount to the ability to traverse steps approached at an oblique angle. This is a autonomous robot has the lowest number of actuated axes among currently available four-wheel-based mechanisms capable of lifting each wheel up and down independently while keeping the seat part horizontal. This means that the leg motion mechanism of our autonomous robot is among the simplest. The general strength of our autonomous lies in its energy efficiency due to the wheel-based mechanism, as well as the simplicity of the mechanism.

1.2 Sensing the Obstacles Using Proximity Sensor

These are possible motions for enhancing static stability, and find that only the steering axis on the leg motion side can be used to enhance static stability for the following reasons: The support-side steering axis should already be turned all the way in one direction or another in order to maximize stability, and the pitch axis is controlled to maintain the seat horizontal. Thus, to increase the static stability margin, the steering axis on the leg motion side is rotated around the leg motion wheel.

1.3 Controlling Tilt in Some Terrains

Localization and Mapping have all been applied in robot for path planning. It is proposed of that artificial forces repelled the robot away from the obstacles and attracted it towards the goal position. Sensor based reactive planning methods have been proposed. Control based methods require formulating accurate models for the robot and the environment which can be a rather daunting or terrain task

1.4 Automating the System

An autonomous vehicle, also known as a driverless car, driver-free car, self-driving car, or robot is an autonomous vehicle capable of fulfilling the human transportation capabilities of a traditional vehicle. As an autonomous vehicle, An autonomous robot is a robot that performs behaviors or tasks with a high degree of autonomy, which is particularly desirable in fields such as space exploration, cleaning floors, mowing lawns, and waste water treatment. It can find the position of the vehicle and navigate their own routes to destinations on the fly by:

- Computing safe and unsafe areas on the surface within the field of vision.

- Computing optimal paths across the safe area towards the desired destination.

- Driving along calculated route.

- Repeating this cycle until either the destination is reached, or there is no known path to the destination.

1.5 Path Planning

Planning is not only one of the fundamental problems in robotics, it is perhaps the most studied. Early efforts to develop deterministic planning techniques showed that it is computationally demanding even for simple systems. Exact roadmap methods such as visibility graphs diagrams adaptive roadmaps attempt to capture the connectivity of the robot search space. The use of graph search methods involves discretization of the workspace and their performance.

Degrades in a high dimensions. Efficient discretization can be achieved on the expense of completeness and high-resolution discretization is computationally expensive. The emergence of novel computational methods inspired their use in path planning. Methods such as Fuzzy Logic Control , Neural Networks, Genetic Algorithms, and Simultaneous

II.RELATED WORK

A number of researchers have developed schemes for controlling leg motion of a leg-type machine along with consideration of footstep width and vehicle stability Cohen et al (1989). Our research is similar in that our algorithm adjusts vehicle posture such that leg motion can be carried out by considering footstep width and vehicle stability. However, our PMV (Personal Mobility Vehicle), which has fewer leg motion drive axes than do conventional leg-type machines, is different in that it requires the support points bearing the vehicle weight to be shifted in order to secure stability for leg motion. In contrast, a leg-type machine can utilize its large number of degrees of freedom to easily adjust its center of gravity without shifting the support points in order to increase its stability Chapelle et al (2008). Because of this difference, the gait algorithms adopted for conventional leg-type machines cannot be utilized here. Also, while reference does discuss research on a mobile platform that is structurally similar to our PMV (Personal Mobility Vehicle), the discussion extends only onto a verification of its mobility under a fixed gait. Therefore, the proposed algorithm in this paper is completely new, and we provide the first evaluation of a gait algorithm through both experimental and numerical analysis, which is expected to be extremely useful for research on PMVs of this type Chapelle et al (2008). we configured the vehicle to provide adequate mobility stably with a simple mechanical structure, taking a four wheel model as the base. Our PMV (Personal Mobility Vehicle) can move in two modes: a conventional wheel mode and a leg motion mode. Shows that our PMV can maintain the horizontal orientation of the seat.when one side wheel is on an obstacle in wheel mode, and perform the pivot turn and the sideways motion by aligning its wheels with 90 steering angles. During wheel mode, the seat of the vehicle is kept in the horizontal position through feedback controls of the pitch axis and front and rear roll axes. The vehicle has a total of 13 drive axes are four driven wheels of four axes at front and rear steering axes. Then two axes at front and rear roll axes. Next two axes at a pitch axis a seat slide mechanism axis and another is footrest mechanism .The footrest mechanism merely serves to move the footrest out of the way when moving the front wheel leg and is irrelevant to the gait algorithm discussed

the gait algorithm Nakajima (2011). Upon excluding the above axes from consideration, we can say that this mechanism is rather simple because it consists of only four drive axes, four driving wheel axes, and front and back steering axes Nakajima (2011).

Planning is not only one of the fundamental problems in robotics LaValle (2006), and Choset (2005). It is perhaps the most studied Latombe (1999). Early efforts to develop deterministic planning techniques showed that it is computationally demanding even for simple systems Reif (1979). Exact roadmap methods such as visibility graphs adaptive roadmaps, attempt to capture the connectivity of the robot search space. Cell decomposition methods, in which the workspace is subdivided into small cells, have been applied in robotics Search algorithms such as Dijkstra (1959). Find an optimal solution in a connectivity graph, whereas are tailored to dynamic graphs. Hart et al (1968). The use of graph search methods involves discretization of the workspace and their performance degrades in high dimensions. The work in generates state lattices using motion primitives and combines them with graph search algorithms but, it still suffers from undesirable discretization. Efficient discretization can be achieved on the expense of completeness and high-resolution discretization is computationally expensive Pivtoraiko (2011) and Beom et al (1995).

The emergence of novel computational methods inspired their use in path planning. Methods such as Fuzzy Logic Control Beom(1995), Martinez Alfaro(1998) and Gomez Garcia et al(2002). Neural Networks Janglova (2004), Genetic Algorithms, Gerke(1999), Yanrong et al (2004). Ant Colony Optimization Garcia et al(2009) and Simulated Annealing have all been applied in robot path planning. Khatib (2010) and Maekawa et al (2010). Those are proposed of the potential field method such that artificial forces repelled the robot away from the obstacles and attracted it towards the goal position. Potential fields were also applied for mobile robots in, however they suffered from falling into local minima and performed poorly in narrow regions. Koren and Borenstein (1991). Sensor based reactive planning methods have been proposed. Control based methods require formulating accurate models for the robot and the environment which can be a rather daunting task Howard (2007) and Kelly et al (2012).

It is pointed out in that technologies required for a general autonomous UGV(Unmanned Ground Vehicle) can be divided up into five areas: mobility, localization, navigation, planning, and communication Durrant Whyte (2001). The relationship between them is depicted. It is deals with the vehicle mechanism design, the motion control technique, and the interaction between the vehicle and terrain. It is concerned with the kinematics and dynamics of the vehicle platform and the control algorithms for the vehicle as well as all actuators outfitted on the vehicle to obtain the desired motion on a certain terrain. It is allows the vehicle to be connected with human operators and other vehicles or systems. Whether the vehicle is fully autonomous or not, it requires a communication link to co-operate with other vehicles or the base station in many missions. It is related to estimation of the vehicle position and attitude in a fixed frame: for example, an earth-fixed coordinates system. It is concerned with robust algorithms for more accurate estimation to deal with sensor uncertainties. Taking information from internal and external sensors as inputs, its outputs affect both navigation and mobility processes Durrant Whyte (2001).

It handles information obtained from environment sensors to build up a map of the environment. The representation of the environment is then used to control the vehicle in small area around the current vehicle position in order to follow a trajectory defined in a planning process. It also manages obstacle detection and avoidance. It is makes use of all known information from prior maps, mission goals, sensory and control structures to generate trajectories, or way points and other actions for the vehicle to execute. However, due to

the incomplete knowledge of the world in outdoor missions, the vehicle must use the environment information gathered along the local path to update or rebuild the trajectory Durrant Whyte.

III.SYSTEM ARCHITECTURE

Architecture diagram is the representation of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks. It is typically used for higher level, less detailed description aimed more at understanding the overall concepts and less at understanding the details of implementation.
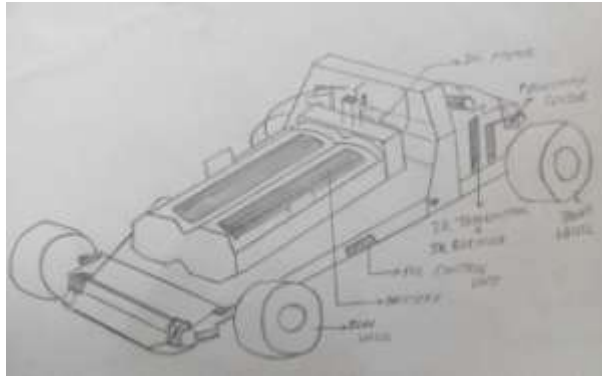
Figure 3.1 System Architecture

The figure 3.1 represents the architecture of proposed system. Autonomous robot is designed to be operated remotely. The major components used are IR sensors in the front and back wheels to sense the environment. This sensed data is given to the processing unit having 16F877A Micro controller. The function of this processing unit is find the presence of objects or any obstacles present in that environment using those sensed information. The type of obstacle is identified whether it is small or large. If it is small obstacle then the autonomous robot tilted so that the DC motor starts rotate. It should stop its rotation when the wheels got stabilized. Otherwise it should deviate its path.

IV AUTOMATIC MOVES

This module is used to describe the movement of the autonomous robot. Here the movement of the autonomous robots is made automatically which avoids the human effort used for controlling the robot.

4.1 PATH SENSE AND AVOIDING OBSTACLES

While moving there should be more obstacles in the path of the autonomous robot. The obstacles may be small or large. Hence it is necessary for the autonomous robot to find those obstacles while moving in its path. Thus this module sense the path of the autonomous robot using SLAM (Simultaneous Localization And Mapping) algorithm and identifies the obstacles if present.

4.2 SMALL OBSTACLE MOVING

The obstacle found in the path of autonomous robot is small, then the autonomous robot should tilts automatically for passing that obstacle. So that the movement of the autonomous robot continous smoothly. Thus this operation is performed by this small obstacle avoidance module using SLAM algorithm.

4.3 LARGE OBSTACLES DEVIATION

This is the final module which is used to deviate the path of the autonomous robot if the large obstacle is found in its path. The deviation of the path is identified using the SLAM algorithm which is based on finding the X, Y and Z axes coordinates.

IV. RESULTS

This shows the rotation of wheels when the switch is ON. The stability of wheels is identified by the rotation of the DC motor.
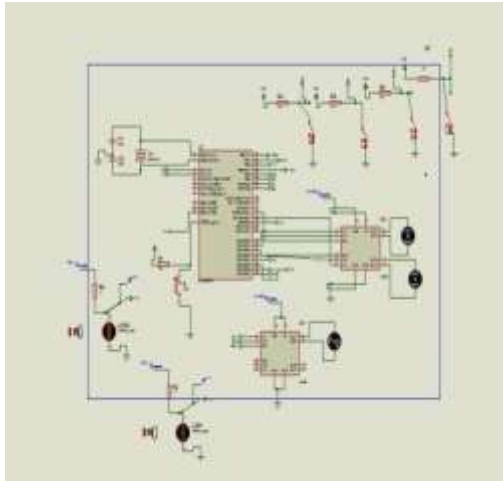
Figure 4.1 Design of the simulation output.

Figure 4.1 is the simulation output design. Vehicle will move forward when first switch is ON , likewise the vehicle will move backward if second switch is ON, vehicle will move right side and left side when third switch is ON. Light Dependent Resistor will be due to the light source. If light source is low the resistance will be high. If two light source is not in equal voltage , the balance motor will be rolling to make the two light source to be balanced.

V CONCLUSION

Autonomous robots are used in many applications. It has established its success in solving the intricate problem of robot leg motion. Here we developed an autonomous robot which moves automatically. The proposed system continue moving independent of the terrain. While moving it finds its obstacles and avoid those obstacles using the SLAM(Simultaneous Localization And Mapping) algorithm. This method have been proposed to improve the efficiency of planning and the quality of plans. Simulation is done in the Proteus 8 environment by using fuzzy and wheel. Measure the wheel motion angle and controlled by wheel motion mechanism

Design robot with four wheels. Photo electric sensor placed at front wheel. For forward and backward leg motion dc-motor is used. Detection of obstacles is done using various sensors, and determined whether to traverse or deviate from it. In this phase, The path sensing module is simulated using Proteus software and the rotation of the DC motor is observed which shows that the wheels are stable. In the next phase I will implement in the hardware

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