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A Study of Design and Development Approaches of Robot Navigation System for Obstacle Avoidance

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Abstract- The advent arrival of autonomous robot has rendered many engineering as well as other fields of applications such as surveillance, emergency response, industry, media, transportation, defenses. The usage of autonomous robot is becoming easier and economical. However, obstacle detection and avoidance are having a huge importance of autonomous mobility of the robot. This autonomous nature has also been needed for automatic path planning of robot and has given a surge towards developing the best obstacle avoidance techniques. Because of complex environment which may be static or dynamic, the robot must get information about the surroundings via sensors. Most of the existing robots use infrared and ultrasonic sensors to detect proximity with the obstacle. To avoid collision with unexpected obstacles, the robot uses ultrasonic range finders for detection and mapping. Despite several years of research, navigation planning and obstacle avoidance are still fundamental issues in the development of a mobile robot. These problems are being addressed by many researchers in past two decades. Sensor based as well as rule based controllers are quite evident, especially, when comes to complex and dynamic environment. Consequently, UAV, is gaining interest where obstacle collision avoidance remains a challenge. As the collision avoidance strategy mostly depends on the performance of various sensors, the effect of their limitations on the obstacle avoidance algorithm have been observed and discussed in this paper. This paper provides critical analysis of the obstacle avoidance techniques, which are having the ability for navigating a robot autonomously in unknown environments without any collision.
Keywords – Autonomous Robot, Sensor, Navigation, Obstacle Avoidance, Path Planning, Collision.

I. INTRODUCTION

This paper introduces the design and development approaches as well as their consequences in research meant to build up another calculation for avoiding obstacle depending on sensors (ultrasonic), and including the sensible level of computations have been discussed. Most of the approaches are therefore have been effortlessly utilized as a part of ongoing control applications with microcontroller [5]. With the overall propensity of maturing populace and the expansion of incapacitated people because of illnesses and mischance's, expanding interest in robot navigation [7]. With the improvement of wideband code division numerous entrance (WCDMA) innovation, which is one of the popular technology in deciding navigation path has been widely used as WCDMA media transmission systems and have been broadly embraced in numerous nations. Because of shortage of radio assets and high cost of system framework, media transmission arrange administrators must make a decent system intending to control the plan, while keeping up adequate performance of portable correspondence services[7]. In the current paper, authors have discussed the existing algorithms for obstacle avoidance. In the subsequent section II of this paper, various algorithm for path navigation and control in presence of obstacles have been discussed.The comparative study of the existing robotics systems have been provided in section III. And in section IV , concluding remarks have been offered.

II. PREVIOUS WORK

2.1 Existing Algorithms for obstacle avoidance-

Formulation of a method for path planning and collision avoidance is a trivial to achieve. In this paper,we present various scheme to demonstrate which scheme to performs well across wide variety of path approximation techniques.

2.1.1 Bug Algorithms–

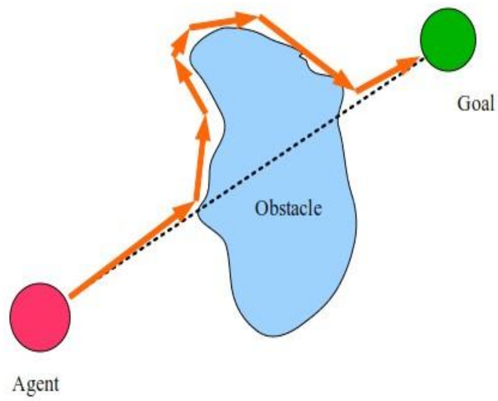

Figure 1. Bug algorithm

The Bug algorithm is one such type of algorithm which is commonly used as a sensor based agent for path finding [1]. In this algorithm, when it found the obstacle near, the robot discover the points and then it will measure distance X (a, b) between points 'a' and 'b' with the most brief separation from obstacle, and then leaves the obstacle starting here.

2.1.2 The Potential Field Algorithm –

In potential field algorithm, robotic system is determined by virtual powers that is used to move it, to achieve the goal, or for changing the direction of robot from the obstacle. The directions/way is fully controlled by the resulting of this power. Notwithstanding its style, this algorithm still does not tackle every one of the downsides of the above algorithms, inefficient for use in limited area, and is diificult for frequently used applications[1].

2.1.3 VFH Algorithm-

VFH stands for vector field histogram and this algorithm overcomes the sensor issues for using sensor readings taking from polar histogram .The polar histogram is utilized to recognize every one of the sections sufficiently extensive to enable the robot to go throughout. The determination of the specific way to be trailed by the robot depends on the assessment of a cost work, characterized for every entry. This relies upon the arrangement of the way followed by robot, and upon the distinction among the new and existing introduction of wheels. This algorithm proves better for overcoming sensor clamor issues, yet includes an extensive calculation stack, which makes it hard to execute on installed frameworks[1].

2.1.4 The Bubble Band Technique-

This technique characterizes an "BUBBLE" which contain accessible free space on all side of the robot. Path planning and obstacle avoidance both are merging in this technique. For a given position, this technique represents the maximum distance between the robot and the obstacle in all direction. A path which is computed previously follows by agent without allowing high reduction between bubbles of continuous positions, and thus obtain to draw flat path.

At the point when an obstacle is experienced, it goes about as a compressive power to the air pocket, diminishing its size and expanding its strain (as though it was a flexible band). The goal of the controller is to discover the situation for whenever step which will decrease this bubble/air pressure. This strategy can think about the operator's real shape.

2.2. Formation of control system –

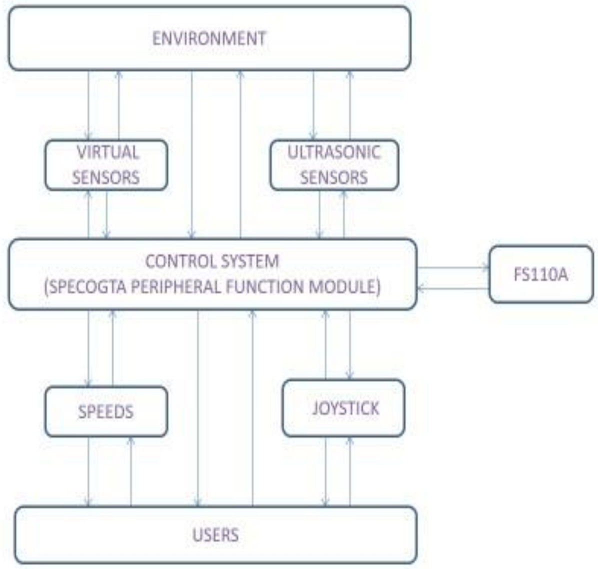

Figure 2: Architecture for MiiChair[7]

2.3. Trajectory Parameter Spaces (TP-Spaces)-

The researchers have discussed the issue of evaluating the distance to obstacles for any-shape robot, and have proposed a TP-Space to distinguish the obstacle and moving robot. In subsequent subsections various parameters used have been discussed:

2.3.1. Distance-to-Obstacles-

"Distance to obstacles"(separations) is a basic concept of any route algorithm, 'since it gives the agent information for picking following development. For our best knowledge, all existing work on receptive route make an understood presumption that has never been addressed: separate to-obstacles are registered by methods for a solitary settled way demonstrate: either straight, contingent upon the kinematic agent/robot compels or not. Then Separations are brought those two dimension ways, however ways followed by robot are really characterized as ceaseless arrangements of areas and introductions, that is, as three-dimensional bends in "C-Space" See Figure 3. In next subsection, the complete description of TP-space have been provided [8].

2.3.2. Definition of TP-Space-

The researchers(Dr. Gitanjali[1],Nikita[2],Anuj[3]) have shown another approach for the responsive path of a kinematic and versatile agent, in perspective of an unmistakable and essential section of the issues of robot shape and kinematic limitations, and impact evading. For this, we have built reflection robotic system which stipends us utilizing a gathering of way models (PTGs) to get a transcendent testing of the entire C-Space from which constantly and better collision free courses towards the objective region can be found. The researchers have shown how the theory of way models connects with the presentation of impeccable way models into our open course structure extraordinary for a non-arranged way to deal with oversee robot navigation [9]

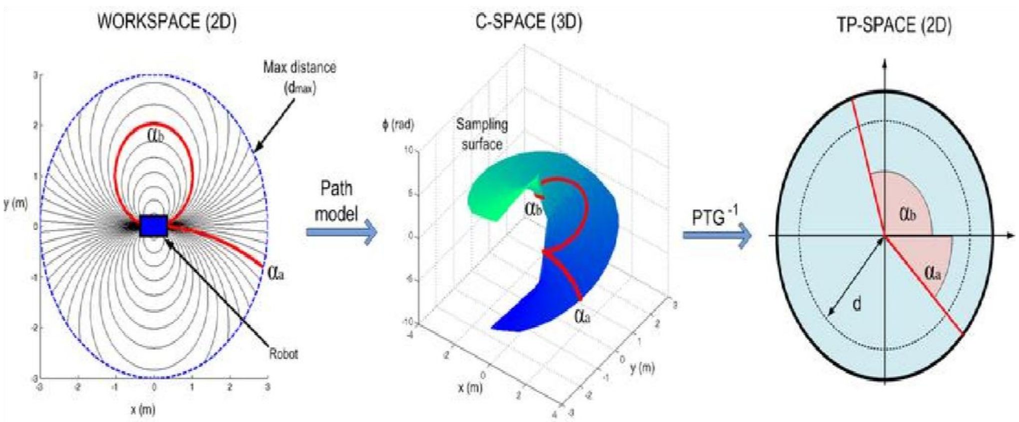

Figure 3: TP-Space model

2.4. Real-Time Obstacle Avoidance-

Most of the earlier real-time obstacle avoidance approaches were based on artificial potential fields [8]. The robot is kept at a safe distance from obstacles by a repulsive force, while being drawn towards the goal by an attractive force .In the vector field histogram approach a direction of motion is chosen based on sensory information such that obstacles are avoided while the robot continues to move towards the goal. As with the potential field approach the robot can get trapped in local minima. Extending this approach, parameterized path families, or more specifically steer angle fields, take the non holonomic kinematic constraints of the robot into account when choosing a motion. This reduces the search space and makes the approach more efficient [7]

2.4.1. Motion Planning-

There is an extensive amount of robot movement arranging algorithms displayed in the writing. In low down dimensional arrangement spaces, similar to those for versatile robots, the utilization of a route work is by all accounts an engaging way to deal with movement arranging. A route work speaks to an essentially nearby "minimafree1 counterfeit" potential capacity that can be utilized locally to manage the robot to the worldwide objective. Developing a network based route work brings about extremely basic and computationally proficient movement arranging algorithms [7].

2.5. Dynamic Window Approach-

Another method for obstacle avoidance is Dynamic window in which kinematic and run time requirements of autonomous robot are taken into account. Kinematic requirements are considered by straightforwardly searching the speed space of a robot. The space of searching is the arrangement of tuples (a, b) of translational speeds 'a' and rotational speeds 'b' that are usable by the robot. Admissible velocities are those velocities which are selected from all velocity tuples that enable the robot to stop at some distance before hitting an obstacle, given the present position, speed and the increasing speed capacities of the robot [7]. This approach for obstacle avoidance was best suited for all types of robots. Portability of robots are increased taken into account as an advantage in which obstacle detection and avoidance can be performed in dynamic environment at high [7].

2.6. Autonomous Robotics System Experiments for obstacle-

This experiment is about designing the mobile based autonomous robot by using 'fusion technology' in which multi sensor information system is embedded to establish the 'environmental model'. Along with Fusion technology, a polar coordinate vector method is combined to design the above said model. For obstacle avoidance and self-navigation, robot obstacle avoidance applied. For checking whether the proposed theory is valid or not, this experiment used Matlab and robot platform for advance designing and its simulation (analysis of proposed theory). For simulation a model is designed on matlab platform which is given in the figure below. In the given figure, red shows robot(mobile robot) and in front side of the red, it set up a 180 degree viewing window, the passageway is the two sides of the dark part, the dark center part is the obstruction demonstrate/model given in the following diagram below:

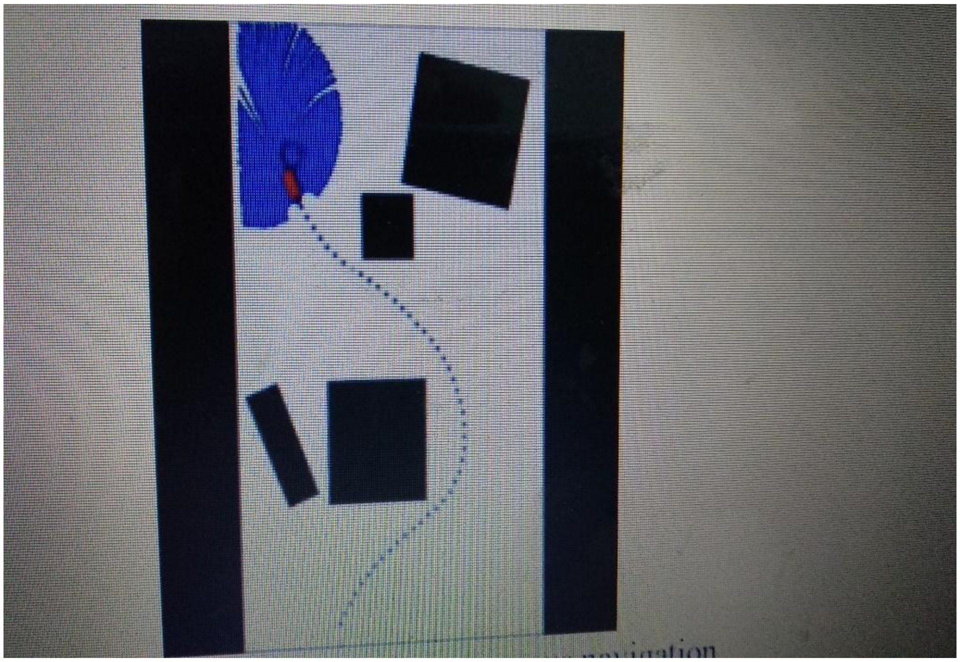

Figure 4: Experimental setup I

2.7. Vehicle Navigation and Obstacle Detections-

In this paper, basic module of robotic system has been designed for car navigation and obstacle detection which is purely based on RFID and Ultrasonic sensors. RFID is basically a radio frequency basedd technique which is used to identify the object by radio frequency and getting data without human presence.

The designed prototype is mainly prepared for industries transportation work in which goods are transferred from one place to another place. And this prototype are totally autonomous because of ultrasonic sensor. There are three main devices are used in this prototype which is 'RFID TAG','RFID reader' and 'ultrasonic sensors'.RFID tag have one unique number which is called as EPIC CODE (have identity code) for all tag . When the tag comes near about the RFID Reader by using ER waves, then data from tag will transfer to that reader which is further given to the main controller for next processing .Due to previous said activity, result of which the prototype moves left/right/ back/forward using RFID TAG .This result depicts that robotic system move until it will lead the Tag.

Addition to this, prototype has RFID reader and tag which is placed in 'lamp post'. System will moves forward according to the data in RFID Tag .In microcontroller EPIC code will defined there. In EPIC code, predefined set are there depicts that whether the prototype/vehicle moves in which direction that is in forward/backward or left/right. Figure given below shows designed prototype having three main said devices RFID tag, RFID Reader and ultrasonic sensors.

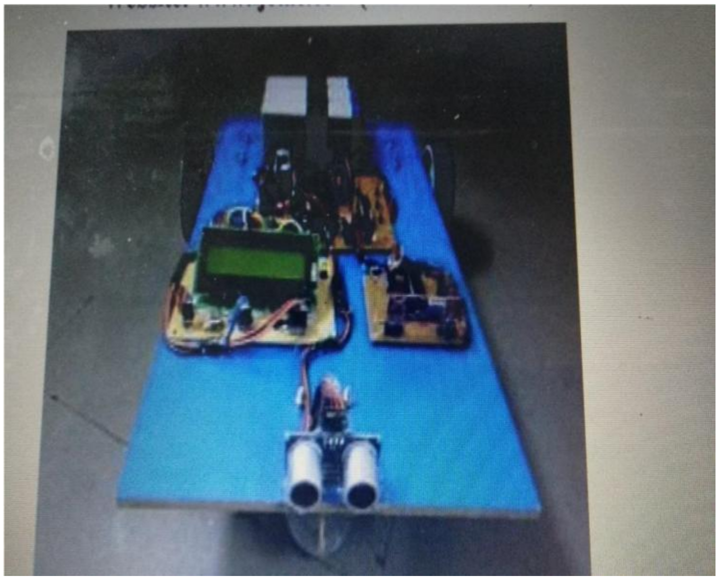

Figure 5: Experimental setup II

III. COMPARATIVE STUDY

Table 1 Comparative study of the existing systems-

References	Achievement	Limitation
1	The ultrasonic ranging sensor system and infrared distance sensor "laser radar" system were established in the robot.	Robot environment is mainly divided into 2 parts- 1. front 180 degree 2.back 180 degree. Therefore, 6 ultrasonic sensors are used to find the front and 6 back area which in turn requires more power supply and make robot less efficient
2	In this proposed strategy, data created by crosstalk gives significant information to exact and solid obstacle position. Accordingly the measure of helpful information increments fundamentally ,giving more dependable and precise detecting framework	CROSSTALK is one such issue with the utilization different sonars working in which one sonar gets the reverberate from a flag leaves by neighboring sonars.
3	"The robot automatically moves along hallways using the scanned range data until a tag is found and then refers to the topological map for the next movement."	1-Accuracy of robot navigation is very less in existing system. Automatically movement of robot requires more sensors. 2-It cannot move the robot accurately by using this existing system
4	"The objective can be achieved by portable robot without using a way following algorithm. That grants to the robot to spare the time squandered in the way following activity."	A versatile robot takes after the data on the off chance that it exists from its situation towards the objective. Otherwise, it produces a free impact movement to move around the recognized obstacles
5	"VFH* is equipped for managing risky circumstances that would require the robot to considerably back off or even stop."	The VFH* strategy isn't extremely touchy to its parameter esteems, and just brief period is normally required for parameter tuning. For whatever length of time that conditions 1 to 3 are fulfilled and the parameter esteems are chosen sensibly, the VFH* technique

		performs well.
6	In this paper, we built up a practical installed multi-mode control framework for canny wheelchairs	No limitation.
7	First analysis: Simulated robot Second analysis: Robotic wheelchair Third analysis: Comparison to the "curve approach" Fourth analysis: Dynamic situations	one depicted in this work, has restricted predicting capacities and it must be focused on that any responsive framework, incorporating the will most likely be unable to locate a substantial way in every one of the circumstances

IV.CONCLUSION

The paper provides a control model as well as a window based approach. The paper discusses the motion/path planning algorithm with RFID and microcontroller. Various obstacle avoidance techniques such as bug detection algorithm, vector field histogram, bubble band techniques have been discussed It has been found that in a dynamic environment, the autonomous robot has to be monitored by reactive obstacle avoidance behavior and analysis of signal which are received from the sensors.

From the analysis of the existing approaches, some important conclusions can be drawn for obstacle avoidance. First , the Ultrasonic/IR sensor has been found to be most suitable for obstacle detection detection as it is of low cost and has high ranging capability. Second, because the study aims towards the obstacle detection and collision avoidance for dynamic environment, the most of the approaches are utilizing a prototype with constrained acitivities and execution. On the off chance that one need to actualize in reality, and it can be done by utilizing the propelled innovation , for example , GPS, GSM and propelled sensors for better path/motion outlining . And final third is that the signal received by sensors should be compared for proximity analysis and more salient direction is considered to be the most consciously recognized path/motion.

V. REFERENCES

[1] L. Ren, ―Obstacle Perception and Obstacle-avoiding Strategy research of Mobile Robot Based On Laser Range Finder,‖ Harbin: Harbin Institute of Technology, 2007

[2] Barshan B., Kuc R., 1990, "Differentiating Sonar Reflections from Corners Planes by 13mploying an Intelligent Sensors." IEEE Trans. on Pattem Analysis and Machine Intelligence, Vol 12, No. 6, pp. 560-569.

[3] Kousalya, R., P. Musthafa and G. Murugesan, An Intelligent Mobile Robot Navigation Technique Using RFID Technology-(Ijaest) International Journal of Advanced Engineering Sciences and Technologies, 8(1): 065-074

[4] Djekoune Oualid, Achour Karim & Toumi Redouane (2005). Ultrasonic sensing based navigation for mobile robot with obstacles avoidance

[5] Ulrich, I., Borenstein, J.: VFH: Local Obstacle Avoidance with Look-Ahead Verification. In: Proceedings of the IEEE International Conference on Robotics and Automation, vol. 3, pp. 2505–2511. IEEE Computer Society Press, San Francisco (2000)

[6] F. Niu, ―Research on the Multi-mode Control System of Intelligent Wheelchair,‖ Nanchang: Nanchang University, 2009

[7] J. L. Blanco and J. Gonzale, and J. A. Fernandez Madriga, ―Extending obstacle avoidance methods through multiple parameter space transformations,‖ Autonomous Robots, vol. 24, no. 01, pp. 29-48, 2008.

[8] Brock O., Khatib O., "High-Speed Navigation Using the Global Dynamic Window Approach," IEEE Int. Conference on Robotics and Automation, Detroit, USA, 1999