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A Novel Approach to Navigation of a Robot using a Memorizing Algorithm

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ABSTRACT
Navigation is a very important aspect of any mobile robot. A robot that can autonomously navigate its own path is always desired for. New and employable technologies pertaining to navigation is the need of the hour. This paper sheds light on a rather simplistic and basic approach to navigation making use of a simple Algorithm. This Algorithm helps the robot to memorize the path taken and then use this memory to navigate the same path autonomously. Such an algorithm is very applicable in situations where a low cost robot is to be built with high accuracy for performing repetitive actions,for instance a floor cleaning robot or a surveillance robot.

Index terms
Navigation, Robotics.

1. INTRODUCTION
A robot is built basically to lessen the human effort involved in performing a particular task as far as possible and to do the same more efficiently. A lot of effort is made to make the robot more human like by giving it a good user interface which includes response, recognition, autonomous navigation etc. In navigation, human beings generally avoid obstacles while navigating by making a simple judgment of an obstacle or not. This type of mechanism is also used in robots where the robot navigates by avoiding obstacles in its path.
Many existing technologies are available for navigation such as line follower, collision avoidance navigation, navigation using image processing are some to mention. The method of using Image Processing in the navigation of the robot is by using a web-cam based robot. The robot captures images of its environment in real time,thereby it comes to know of any hindrances in its path and then using Image Processing techniques it determines the most efficient, collision-free pathway to its destination [15].The various Image processing techniques include line detection, edge detection, cell decomposition method and many others.Since this technique does not involve many sensors it makes it very useful, but at the same time image processing tools and its algorithms are very complicated to apply.
The line follower mechanism is also used very commonly for fixed path navigation. In the line follower mechanism, the robot as the name suggests follows a 'line' or a path predetermined by the user. This pathis usually a physical white or black line on the floor or a complex path comprising of many turns and intersections[6].The sensor used in a basic line follower is the Infrared sensor. The infrared sensor determines whether a line is present or not.The accuracy of the line follower depends on the number of sensors used. The disadvantage in this scheme is that lines have to be drawn for the robot to travel which is a tedious process, the lines remains fixed thus reducing flexibility of direction changing in presence of obstacles, also in some cases lines cannot be drawn physically on the area to be traversed.
The method of collision avoidance is a method of navigation in which the robot travels on a random path and when it encounters an obstacle, it changes it direction. The shortcoming of this method is that the path traveled by the robot is random in nature thus reducing efficiency; also the same path may be sometimes travelled more than once thus leading to wastage of power.With these disadvantages a simpler method comes as a welcome surprise to facilitate better navigation. Many new technologies have been invented and implemented that can give good results and accuracy in navigation and some of them are given in the references.
An important aspect of a human being is that oflearning. A human being has the ability to memorize the path he or she has traveled. This aspect can be used in a robot to keep a record of its path and travel the same without any future help. With this, the robot has to be only taught how to travel a particular path first and then it will do the same on its own. This paper presents an algorithm which will help to store a path travelled by the robot. The algorithm uses data values of small storage space hence can be applied to store many paths. Since in today's world memory storage is not an issue the robot can be taught to navigate many such paths and all of these can be stored in its memory. This stored path can be edited by the user and hence it can be taught to avoid obstacles whenever and wherever placed. The robot is initially taught how to traverse through a particular region with maximum efficiency through the how to reach its destination by avoiding obstacles and taking the shortest path possible. If the user is not present, thenany other method of navigation can also be applied and the path taken can be stored in the memory. The method of navigation can be any of the above mentioned or any other method. The robot has to be only taught to traverse the path, the algorithm obtains and stores certain data relevant and then the robot automatically traverses through the same path. These data values can be also altered anytime of the navigation path thus it can help to avoid obstacles if present. The algorithm is compatible with any existing technology and can be used to achieve better navigation.

2. PROPOSED SYSTEM
This paper proposes an algorithm which will eliminate the use of complex circuitry and different sensors. Different sensors can be used in this system for the robot to learn its path but in this paper we will make use of a simple remote to navigate the robot.
As shown in the figure 1, we have a basic block diagram of a micro-controller based robot. The inputs or commands are given to a micro-controller from a remote and the micro-controller gives the input to the motor drivers which drive the motors. The micro-controller is the brain of the robot which

helps in executing certain commands in accordance with the algorithm.

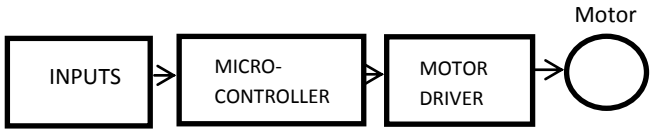

Figure 1.Basic Model of Robot

The Memorizing Algorithm consists of two modes:
1. Learning mode.
2. Playback mode.

2.1. Learning Mode:

In this mode, a variable 'a' is assigned to count the forward motion of the robot every 50ms or any specified period of time. The shorter the duration, higher will be the accuracy. Two arrays are defined for the right and left motion of the robot. The port 0 of the micro-controller is programmed as the input port and the inputs from the remote are given at this port. Four pins are required of the micro-controller to assign for the forward, right and left motion and the playback mode. When an input is detected at the pin of the port, the micro-controller will take a specific action. In this algorithm forward button is connected to 'pin 1', the right button is connected to 'pin 2', left button to 'pin 3' and replay button to 'pin 4' of port 0 of the micro-controller and the output was given to port 2. Each time the forward button is pressed the variable 'a' will be incremented by one and the micro-controller will accordingly give the command to the motor driver to move in the forward direction. When the right button is pressed the micro-controller will accordingly send a command to motor driver to take a right, the value of the variable 'a' at this instant is stored in the 0^{th}position of the right array. And the pointer to the array positionis then incremented by one. Similarly when the left button is pressed the microcontroller sends a command to the motor driver to take a left turn and the value of the variable 'a' is stored in the 0^{th} position of the left array, also the array pointer is incremented by one.

Therefore for every forward motion the variable 'a' is incremented and for right and left motion, that value of the variable 'a' at theinstance robot took a right or left turn is stored in the respective array. At the end of the execution of the program, the variable 'a' will have a value and the left and right array will have different values of 'a' according to when a left or right was taken. The figure 2 gives an example of how the robot moves about a path. The triangle shaped object is the robot.As shown the value of 'a' at the initial position is zero. As shown the value of 'a' is incrementing after an interval of 50ms. As shown, when a right turn was taken the value of 'a' was 8; this value is stored in the 0^{th} position of the right array. Similarly, when a left turn is taken the value of 'a' is stored in the left array.

2.2.Playback Mode:

In the playback mode, a loop is defined starting from 'j'= 0 to the variable 'j'='a'. Each time the value of 'j' is incremented the robot moves in the forward direction and then compares its value with the value in the left and right array. When a match is found it takes the corresponding left or right and also the array pointers points to the next value of the array. The table below will show how the value of the variable is stored in the array.

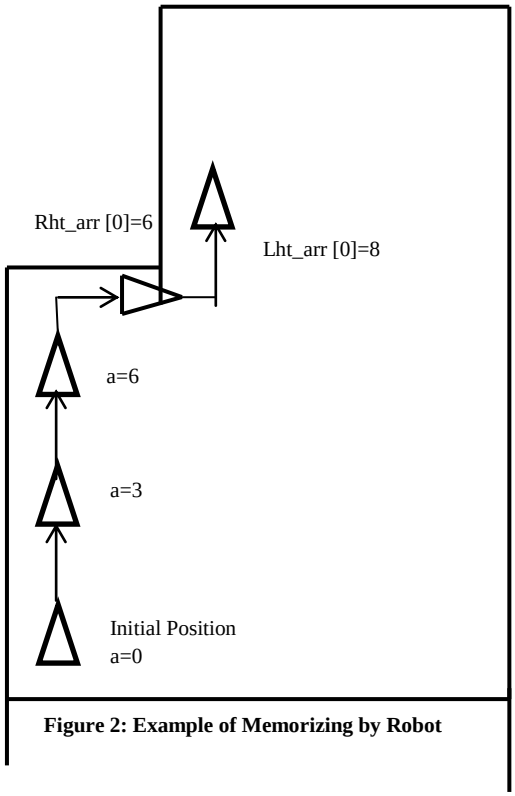

Figure 2: Example of Memorizing by Robot

Table 1: Values of 'a' stored in the left and right array.

Value of the pointer[x,y]	Values in the Rht_arr[x]	Values in the Lft_arr[y]
0	6	8
1	15	20
2	17	21
3	25	22
4	30	43
5	32	45
6	35	47

As shown, the arrays are given by Rht_arr[X] and Lft_arr[Y], and their respective pointers are given by X and Y. The values in the array are the values of variable 'a' for which the micro-controller had taken a left or right turn. During playback, these values are compared with the incrementing variable 'j', accordingly a left or a right turn is taken and the path is repeated.

There is although one shortcoming in the algorithm, that is, if the right or left button is kept pressed for more than once during the learning mode then, the same value of variable 'a' will be stored in the corresponding array at the consecutive positions. Now during the playback mode, the value of 'j' is incrementing and comparing with values in the left and right array to see if there is a match. When there is a match the array pointer will be incremented and also the value of 'j'. Now, if there is the same value in consecutive position of the

array the next value will never be recognized since 'j' will never have the same value again. Thus, during such a situation the algorithm will fail.

To overcome this problem, an enable variable is used during a right and left turn. When a right or a left turn is taken, the enable variable is made 1. Now if the right button is pressed again it will check to see if enable is 1 or 0. If enable is'0' then it will take a right, if not then it will not execute any command. During the forward motion the enable variable is made '0'. Hence, the robot can take right and left turns only after one forward motion.

The variables that were used in the playback mode that is the left and right array and the variable 'a' can be stored and used whenever the robot travels the same path again. These values can also be edited hence we get a compatible and accurate navigation through the use of this algorithm. As these values do not take much of the memory space many such paths can be stored and then played back whenever necessary.

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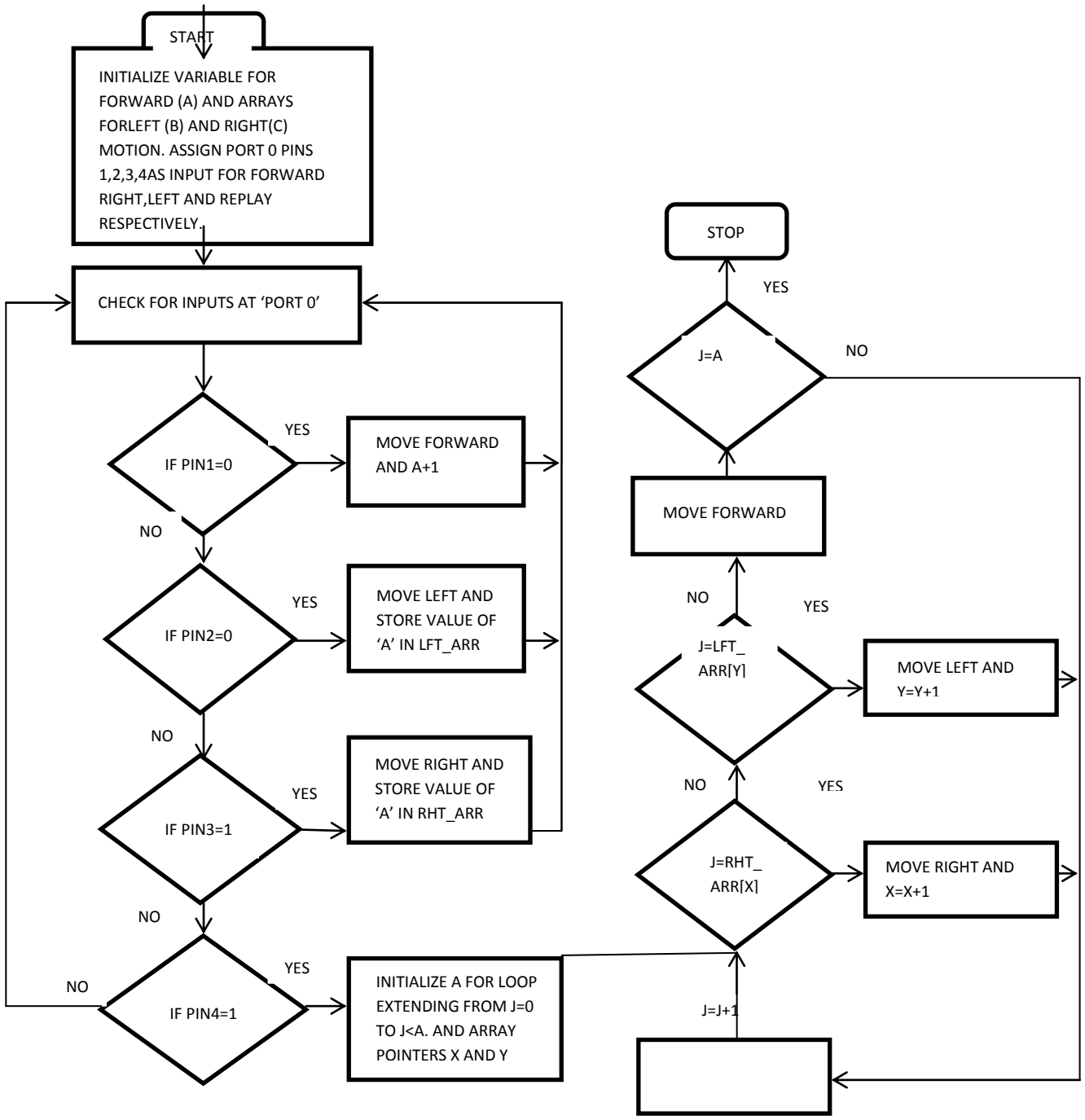

Figure3: Flowchartof the Memorizing Algorithm

3. CONCLUSION

The algorithm was found to be a suitable replacement for other existing navigation systems in which repetitive motion was persistent. Also, since no additional circuitry is involved in this algorithm,it can be easily used in the existing systems.The parameters needed to travel a path in the algorithm are a forward variable 'a' and the left and right array. These parameters do not take much of memory space hence the robot can be able to learn to travel many paths. The paper presented the controlling of the robot by the use of a remote. Any navigation technique can be used to obtain the parameters for the algorithm. And these parameters can be changed whenever required hence making this algorithm even more remarkable. Since a more accurate and less expensive technology is the need of the hour, this algorithm will prove to be greatly applicable.

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