Implementing 360^0 rotation of Robot on its axis

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ABSTRACT
In today's world of technology robots are widely used either for some specific tasks that are too dangerous to be performed by humans such as exploring outer space or at the bottom of the sea or for some repetitive type of task which is quite boring for a man. Now-a-days artificial intelligence is widely being implemented in robotic models to make them intelligent enough to behave like a human. The robotic model described in this paper is specifically designed for not only sensing the obstacles in the path but also to eliminate them from the path by picking them up and placing them at another location. Besides this, the robotic model is capable of taking 360^0 turn on its own axis, which can be implemented in four-wheelers to make them more convenient to small parking places & efficient turns which is the need of today's transportation industry. This paper focuses and implements an autonomous robot which is not only capable of performing obstacle sensing but it can also take 360^0 rotation on its standing place.

General Terms
Robotics, Robot, Artificial Intelligence.

Keywords
Robot, Obstacle sensing, 360^0 rotation, Sensors, Microcontroller, Autonomous.

1. INTRODUCTION
In general, a robot is a mechanical or virtual intelligent agent or any operated machine that can perform tasks automatically or with guidance and replaces human effort, typically. In practice a robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Robots can be autonomous, semi-autonomous or remotely controlled. The word *robot* first appeared in a play by the Czech writer Karel Capek in 1920 [1]. Robots may or may not resemble and perform functions like human beings. But they are often designed to perform tasks repeatedly and in an efficient manner.

Robot is generally made up of three components- Mechanical structure comprising the body of the robot through which it interacts with the environment, Sensors to sense the physical actions in the environment and provide useful feedback to the processing device, and Control Systems (processing devices such as microcontroller) that take actions according to the feedback provided by the sensors [2].

There is no one definition of robot which satisfies everyone and many people have their own. But every robot has the same three construction phases i.e. Input phase- Sensors are used as input devices. They sense the physical activities occurring in the environment and provide relevant feedback to the processing devices, processing phase- Microcontroller is used as a mini processor which takes actions based on the input received from the sensors. These mini processors are used where space, power and cost are critical and output phase- where actions are performed by the robot. In this phase generally the motors rotate as a result of action taken.

A robot can perform various functions such as it can sense objects placed in its path, it can pick an object and place it at other location, it can serve, it can play and much more. To be very specific, here, we have made an autonomous robot which can perform obstacle sensing and pick and place of an object and is able to take a 360^0 rotation on its own axis. Obstacle sensing is not a new concept but enabling a robot to take 180^0 rotation is a new concept which saves the space taken in turning any vehicle/robot. Thus if we want a moving robot to suddenly stop and start moving in the backward direction then it can just rotate on its own axis, making a 180^0 rotation and start moving in the backward direction.

This paper is organized as follows:

Section 2 discusses the components of the robot. The features like obstacle sensing, pick & place and the 360^0 rotation of our robotic model are listed in Section 3 and the implementation part and motor rotation circuit diagram are discussed in section 4 and 5 respectively.

2. COMPONENTS OF THE ROBOT
i) Mechanical Structure-such as arms, wheels etc. It comprises the physical parts of the robot.

ii) Sensors- device used to sense the physical condition in the environment.

iii) Control Systems- these are processors used to take some kind of decision.

2.1 Mechanical Structure
The mechanical structure consists basically of the robot body that includes arms, dc motors and wheels. Some force such as electricity is required to make the arms and wheels turn under command.
One of the most interesting aspects of robot in general is its behavior, which requires a form of intelligence**.** The sensors fitted in body of the robots, gets input signal from the environment and sends the data to the control unit in the form of signals. The control unit works on the data received based on programming embedded in that and gives the output signal to the output ports, which in turn activates the connected components of robot according to the mechanical structure. Our robot consists of two wheels, an arm and gripper to hold the object in addition to the motors used in the robot.

2.2 Sensors

Robots operate according to a basic measurement, requiring different kinds of sensors. A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. A *sensor* is any device, such as a thermometer, that detects a physical condition in the world [3]. Sensors interact with external environment and transforms the energy associated with what is being measured (sound, light, pressure, temperature, etc.) into another form of energy. Some common sensors used in robotics include light sensors, touch sensors, sound sensors, and acceleration sensor. Two IR sensors have been used in the robot, out of which one is used to sense the path and other is used to detect the obstacles in the path.

2.3 Control Systems

Microcontrollers are generally used as control systems in the robot. They are intelligent electronic devices that deliver functions similar to those performed by a microprocessor (CPU) inside a personal computer. Generally the microcontrollers are being programmed according to the specific purpose for which the robotic model is being constructed [4]. One of the major differences between CPUs and microcontrollers is the number of external components needed to operate them. Microcontroller Atmel Atmega's 8 has been used as the controlling device in our robot.

2.4 Motors

The dc motors are used in the robotic model for their capability of moving in clockwise direction and anticlockwise direction depending upon the direction of the flow of current in the system. If the motors are moving in forward direction and we wish to stop it suddenly and want to move it to backward direction. It is too easy to do it with dc motors just by changing the direction of the flow or current [5]. In the arms the stepper motors are used which are more powerful and more convenient to use in case when we want to move in limited degree angles[6].

3. FEATURES OF OUR ROBOTIC MODEL

The robotic models are designed and manufactured for some specific task or for some repetitive tasks. Our robotic model is specifically designed for not only sensing the obstacles in the path but also to eliminate them from path. Besides it the robotic model is capable of taking 360^0 turn on its own axis.

3.1 Obstacle Sensing

For obstacle sensing, two sensors have been used. As discussed earlier, sensors are used as input device. They sense the objects placed in the path of robot and gives relevant feedback to the microcontroller. One of the two sensors is used to sense the path which is a black strip and the other one is used to sense the objects lying in its path. IR sensors have been used for this purpose. One IR sensor that has been used for sensing the path is not affected by light.

3.2 Pick and Place

The Pick and place feature of the robotic model is unique which eliminates any obstacle being sensed by the sensors. When front sensors gets any obstacle in the path, they sends signal to the microcontroller. The controller activates the arm of the robot which captures the obstacle in the path and places it outside the path. Or according to specifications it can turn back on its path and place the captured obstacle back to its originating place, i.e. from where the robot started to move on the track.

3.3 Rotation of robot on its axis

There arise two situations where the robot needs to perform a 180^0 rotation. The first one is it can find the object in front of it and have no path to follow neither on left nor on its right. Then the robot will take a 180^0 rotation on its standing place. Thus the robot will follow the path in the backward direction. The second condition being that the robot can find the objects in all the three directions- front, left and right. In this case, the robot will take 180^0 rotation on its axis and will start moving in the direction it came from. However the robot is able to take 360^0 rotation but these situations can make robot to take the decision to rotate itself by 180^0 whenever and wherever required. Two methods can be used for taking a 180^0 move; first one is that the motor on the left keeps on rotating in the backward and that on the right keeps on rotating in the forward or vice versa leading to turn in anticlockwise or clockwise direction respectively. In accordance with the comfortability one method can be chosen, however we have implemented anticlockwise 180^0 turning capability in the robotic model.

4. IMPLEMENTATION

4.1 Implementation part for Obstacle Sensing

When the sensors senses any obstacle in the path they sends signal to the control unit which in turn stops the movement of the wheels and takes the action either to change the path or removing the obstacle from the path depending upon which type of obstacle is in the path.

We have made the path of black and white strips; the robot follows the black path only. Initially, the robot follows the straight line, checking the objects and the path after every millisecond. The two DC motors have been attached to the two wheels on left and right. A motor can make a wheel to rotate in both forward and backward direction. These two motors rotate in forward direction making the robot to move straight. Wherever the robot senses the object in its path of motion, it makes a check on its left side. If no object is lying on the left side, it takes left turn. The motor on the left will now rotate backwardly and the motor on the right will rotate forwardly causing the robot to take sharp left turn. Otherwise it checks on its right. Again if no object is lying on the right side, it takes right turn and start following the path on its right. For taking right turn, the motor on the right rotates back and motor on the left rotates forward. This whole process is repeated until the robot finds objects in all the three directions i.e. in front, in left and in right.

We have used four pins- 1, 2, 3 and 4. Pin 1, 2 and 3 are used for sensing the path while pin 4 is used for obstacle sensing. If the pin 2 remains off, this indicates the presence of path straightway. But if pin 2 and 3 are off then it indicates that the robot has to take right turn, while in case of pin 1 and 3 being off the robot takes left turn until we gets only pin 2 off. This way the robot detects the path and makes its moves. Now for sensing the objects the robot uses the second sensor at pin 4. A single pin of that sensor is sufficient to detect an object. Whenever that pin is on that means an obstacle is lying on the path.

4.2 Different ways to take 360^0 rotation

The movement of the robotic model is defined in its five different movement activities. As all the four wheels of robotic model are independent of each other to move in any direction i.e. forward as well as backward, the movement can be defined in following categories:

i) All four wheels in the same direction either forward or backward.

ii) Front and rear left wheels are in no move but front and rear of the right moves in forward direction.

iii) Front and rear wheels of left side moves in backward direction while that of right side moves in forward direction leading to sharp turning conditions on its own axis.

iv) For turn in right direction the right sided wheels are in no move condition while left sided wheels moves in forward direction.

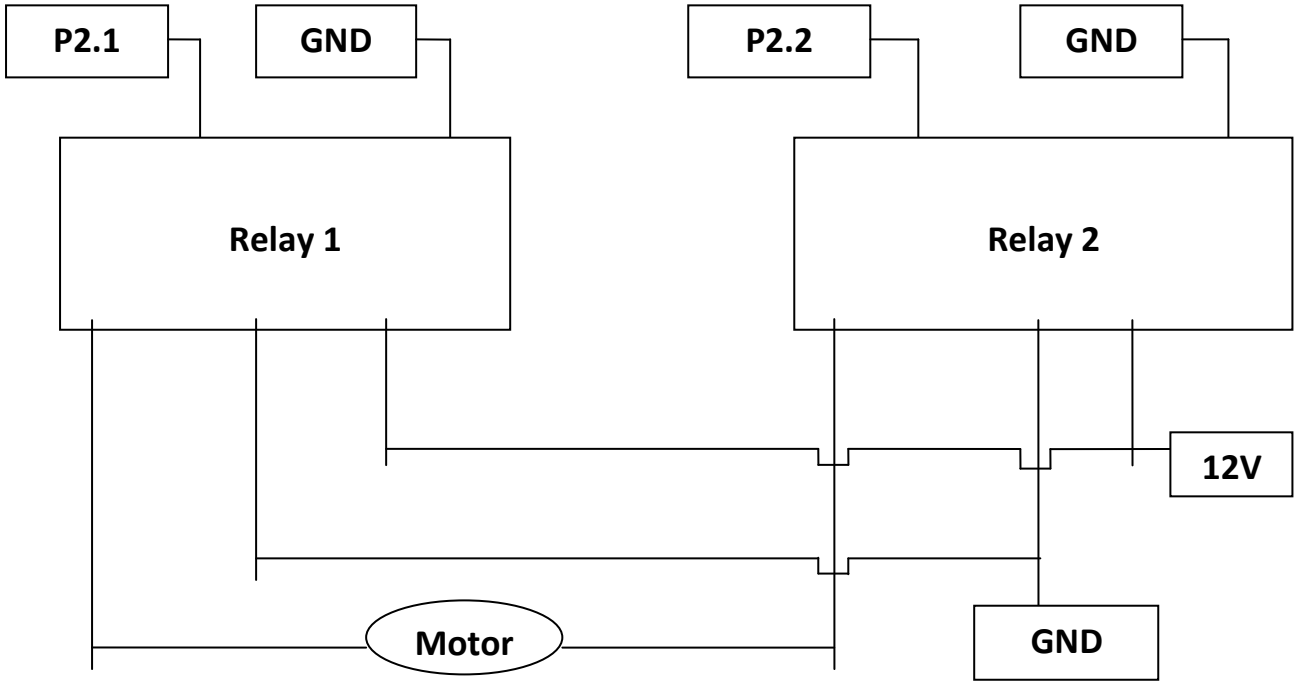
v) For sharp right turn, both right sided wheels moves backward while left sided wheels moves forward again leading to sharp turn on its axis.

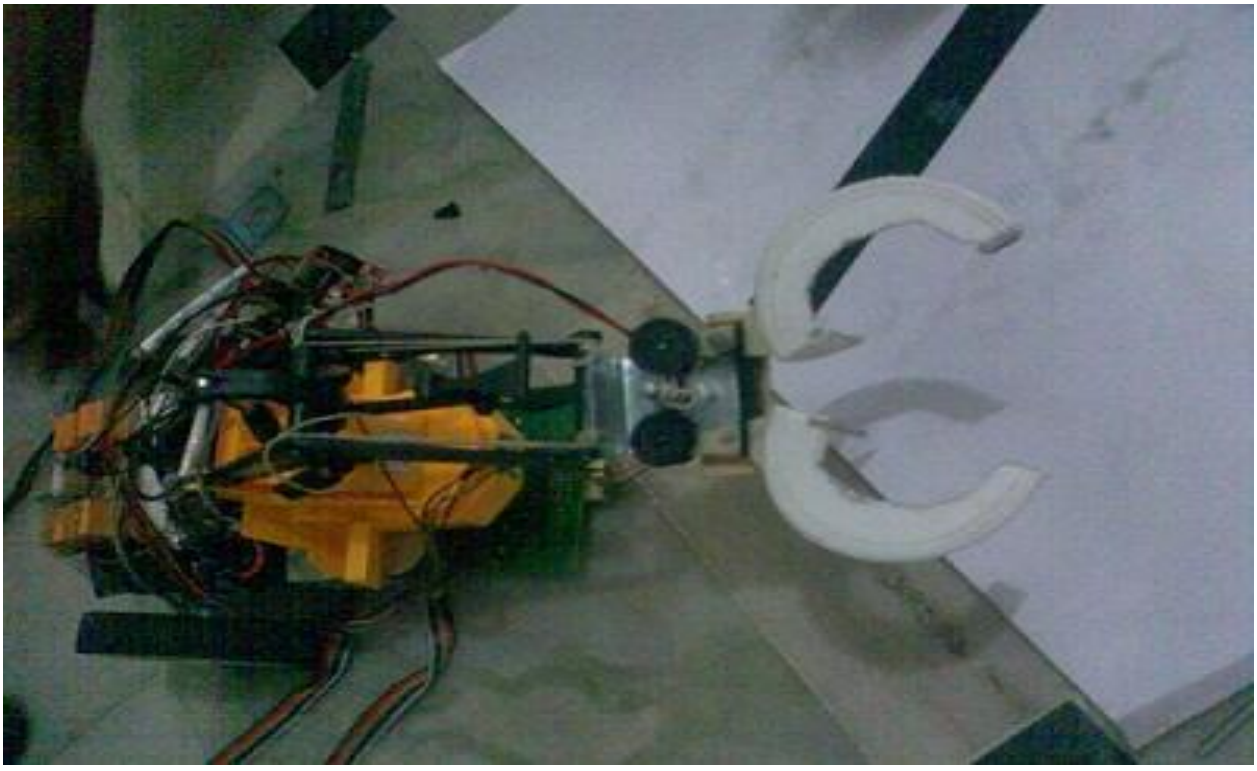
5. MOTOR ROTATION CIRCUIT DIAGRAM

The circuit diagram which has been used to rotate the motors is discussed here. Two relays have been used in each motor for rotating the wheels of the robot. A relay is an electrically operated switch. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal [7]. Such relay circuits along with programmed input signals are used to control and monitor the motion of the motors attached with the robotic wheels [8].

When only the pin 2.1 is ON, then the current flows such that the motor will rotate in forward direction. When only the pin 2.2 is ON then motor will rotate in backward direction. However when both the pins are on simultaneously the current flows both in forward and backward direction making the motor not to rotate neither in forward direction nor in backward direction. Note that here we have used pin 2, but it is not necessary to use exactly this pin. Any pin can be used for this purpose. The motor rotation circuit diagram is as follows:

Fig 1: Motor rotation circuit diagram





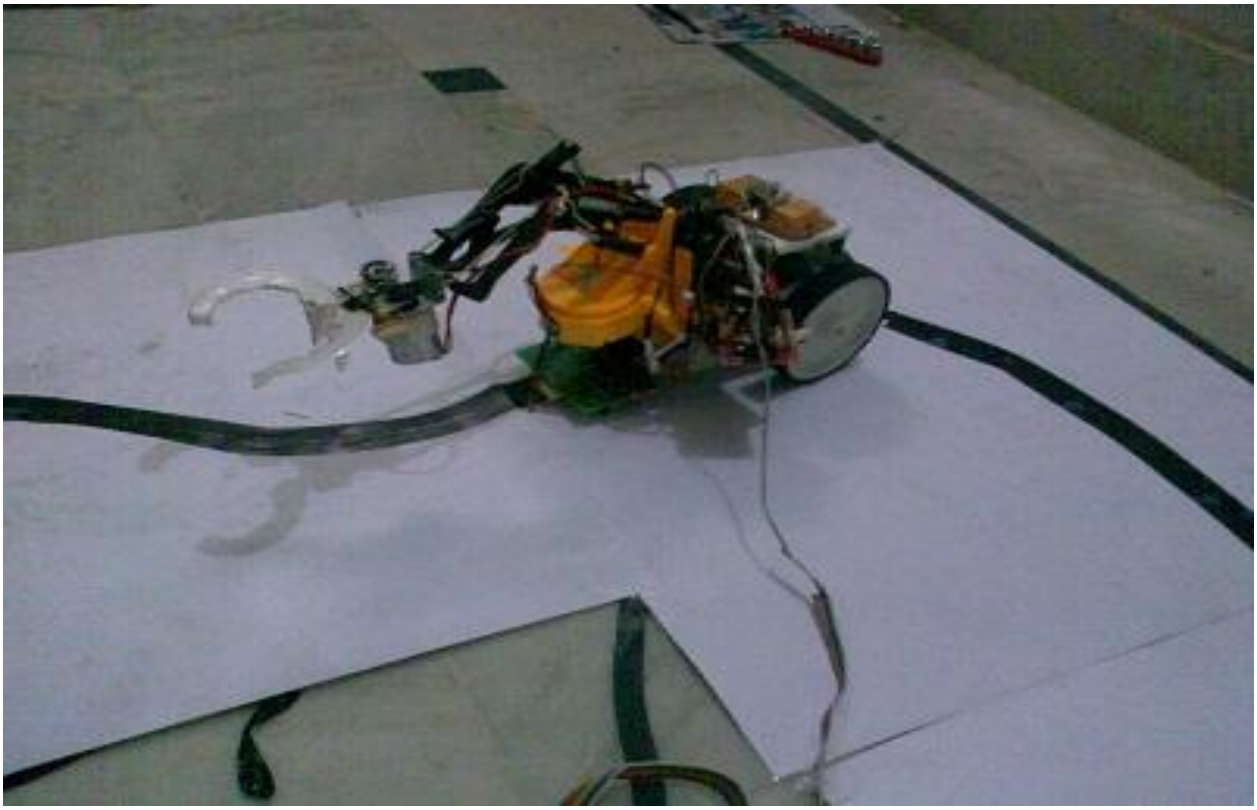


Fig 2: Snapshots of working robot

6. CONCLUSIONS

All the four wheels connected to the dc motors individually are independent of each other to move forward or backward. So the robotic model is free to move in any direction as described. The implementation of this model in the four-wheelers will lead to efficient turning capabilities of the vehicles on the road and will also provide the easiest parking conditions discovered up-till now by enabling the vehicle to turn on its own axis. This robot can be used to sense the obstacles placed in the path, if found they can be removed from the path and most importantly the robot is able to take 360^0 rotation on its own axis, however only 180^0 rotation is required during following any path. This can be related to a scenario where a car is stucked in a traffic jam and it needs to turn and go back then this 180^0 rotation can be taken by the car which can be proved helpful because it saves the space and thus time taken by the car to turn itself 180 degrees. This type of robot looks to be very useful in finding possible path as well as obstacles in the dense areas or mines where using human efforts seems to be dangerous [9]. As the robot is able to take 360^0 rotation as discussed, with some improvements it can be used in future for inspecting all possible directions specially during war times by using its complete rotation on its own axis, and as it is autonomous it can also be used as a spy without any fear of human loss.

7. REFERENCES

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