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RF Based Wireless Bomb Defusing Manipulator Robotic Arm

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ABSTRACT:A RF based wireless manipulator robotic arm for bomb defusing in risky environment, where human being cannot enter is discussed in this paper. A three degrees of freedom (dof) robotic arm is used for the purpose of wire cutting. The robot can be controlled using joysticks which are provided in the wireless remote control. RF based communication is used for controlling the robot within a range of 100m. A wireless camera is used for a visual feedback which helps the operator to do the required operation.

KEYWORDS: Degrees of freedom, joystick, motor driver

I.INTRODUCTION

The world need robots for a countless number of reasons, including hazardous jobs and automated manufacturing. Robots are employed in roles ranging from cleaning up dangerous waste and chemical spills to disarming bombs and protecting soldiers in the field. Due to the advanced technologies developed so far, human efforts are now being replaced by robots which leads to greater productivity and has created a drastic change in the automation of industries.

The bombs and explosive devices are responsible for loss of many lives, properties and infrastructures. Security personnel are trained effectively to combat and manage such risky situations, but had failed to completely handle it at all times. Introducing robots as a solution is an acceptable and practically possible case. Robots have capability to overcome the human limitations. This has prompted the need for the development of a robotic arm which can be used to defuse dangerous objects such as the bombs or explosives before they explode, thereby protecting lives and properties. Robotic arms are used in cluttered workspaces in homes and factories. Moreover they are used to operate autonomously in hazardous environments, and also they can interact safely with humans in close proximity.
In this paper, a manipulator robotic arm capable of defusing bomb, controlled by an operator from a safer distance is implemented. The inbuilt features are defusing unit and wireless control.

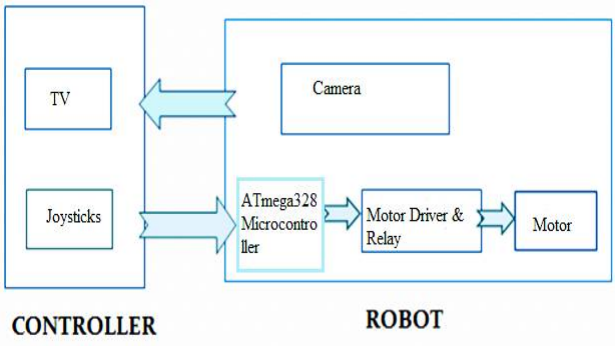

Fig.1 Block diagram

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II. RELATED WORK

A model to control robotic arm through human gestures using accelerometer is presented in paper [1]. In this a three axis accelerometer is mounted on human hand in order to perform the action of robotic arm according to the action of human hand. Accelerometer is connected to the Atmega 16 Microcontroller which is programmed to take analog readings from accelerometer and transmit them using RF transmitter to the receiving unit at robotic arm. Movements of the robotic arm are achieved through Servo-Motor.
The objective of the paper [2] refers to development of a hazardous object detection system that can be applied to the robotic arm gripper that will pick and place the object. Jennic's JN5148 microcontroller was used.

III.APPROACH TO DESIGN

We implemented the robotic arm by combining the three designs discussed below. During the design development, the drawback of each design was analysed and appropriate modifications was done.

DESIGN 1

The design of the robotic arm mainly consists of a base body which will enable the robot to move in all direction. The robotic arm is mounted on top of the base body. The robotic arm consists of four dc gear motor. A defusing unit is used to deactivate the bomb by cutting the wire where a wire stripper is attached to the gripper. The gripper can move up and down as well as rotate. A spur gear and worm gear combination is used to open and close the gripper. The elbow of the robotic arm also uses a similar mechanism which consists of two spur gears, a worm gear and a 10 rpm dc gear motor. The user can control the robotic arm using joysticks in the remote control. The remote control is connected to the robot using wires. The side view and the perspective view of the robot is shown in the fig.2

Perspective View Side View

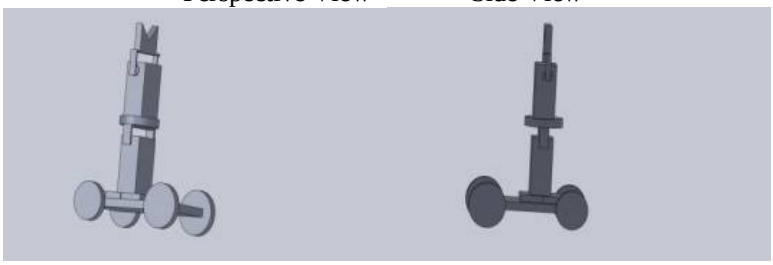

Fig.2 Design

In this method the wire stripper could not cut thick wires. This is due the fact that maximum torque of the motor could not be delivered to the wire stripper. Considering this drawback another design was introduced.

DESIGN 2

The main difference of first design compared to the second design is the change in the mechanism in which the defusing unit was controlled by the dc gear motor. In this design approach, one end of the wirestripper is fixed to the joint of the robotic arm and the other end is free to move. The free end is connected to the dc gear motor using a belt drive mechanism. The main advantage of using this mechanism is that the maximum torque of the dc gear motor can be delivered to the wire stripper thus enabling it to cut thick wires. The fig.3 shows a typical defusing unit.

Fig.3Defusing unit

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DESIGN 3

In third design the wired approach to control the robot was replaced by a wireless technology. RF transmitter and receiver are used to communicate between the remote control and the robot. The robotic arm with three degrees of freedom is shown in the fig.4.

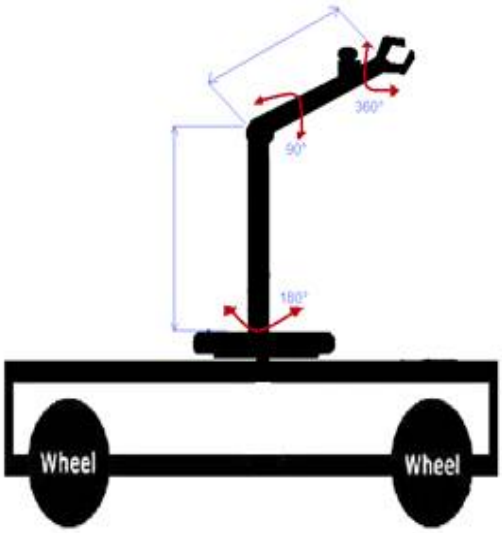

Fig.4 Degrees of freedom

IV.SYSTEM OVERVIEW

A. JOYSTICK

The whole robotic system is controlled using three joysticks. The x, y control signals from joysticks are given to the 12V DC relay for the base body movement and to the motor diver IC L298n for the arm movement which controls the movement of the robot in required directions.

B. MICROCONTROLLER

The control signals given by the joystick is given to the ATmega328 microcontroller. The required movements of motors will be programmed in the microcontroller.

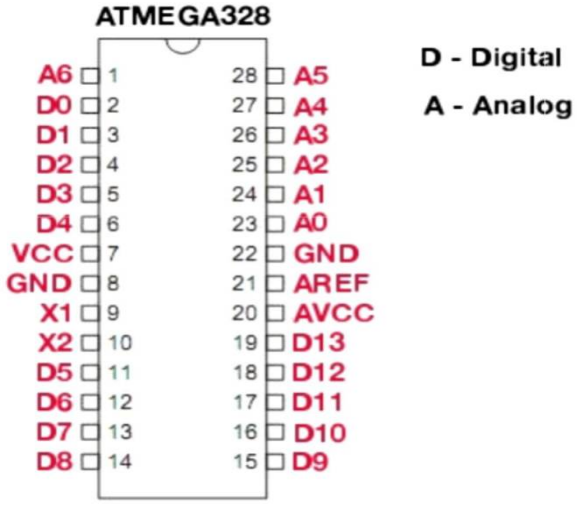

Fig.5 Pin diagram of ATMEGA 328

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C. MOTOR DRIVER IC

Motor driver IC is used for providing required power to the motors. The driver IC used is L298n for driving dc geared motors. The L298 is an integrated monolithic circuit in a 15-lead Multiwattand PowerSO20 packages.

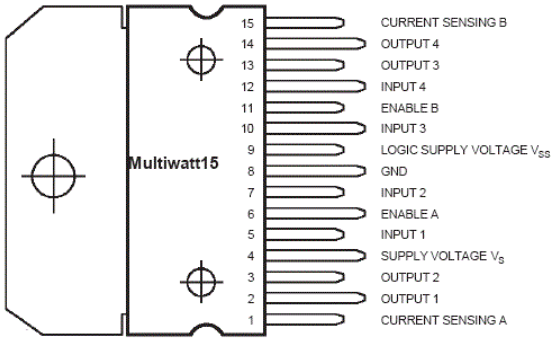

Fig. 6 Pin diagram of L298n

D. CAMERA

A wireless camera is used for providing visual feedback to the operator with the help of a TV.

E. RELAY

A 12V dc relay is used for driving the Johnson motor. It is an electrically operated switch which uses an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Usually relays are used to control a circuit by a low-power signal.

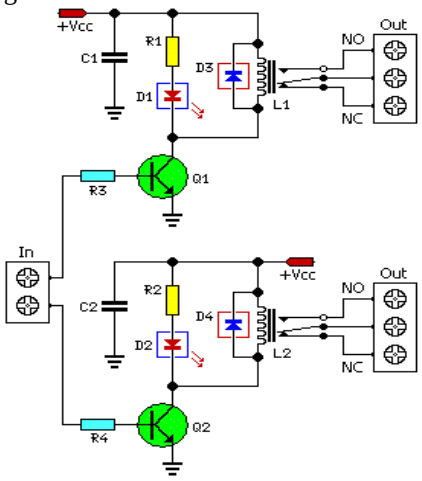

Fig. 7 Relay circuit

F. MOTOR

DC geared motors and Johnson motors are used for the movement of arm and base respectively. 45RPM, 10 RPM 12V DC motors with gearbox.

V.WORKING

The joystick is a device which is made by coupling together two potentiometers. When the knob of the joystick is rotated with respect to its mean position, the two potentiometers produce variation in the resistances. The joystick has 4 terminals V_{cc}, ground and two output signals (say x, y). As the knob of the joystick rotate the values of x and y change. And as the knob is moved in 4 different directions, gives 4 different values for x and y and the range of values of x and y lies between 0 and 1024.

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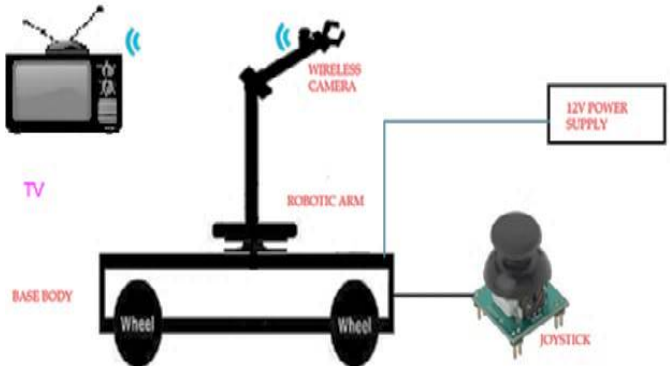

Fig. 5 Schematic Diagram

The output x and y of the joystick is connected to the input analog pins A0 and A1 of the microcontroller. The microcontroller is programmed in such a way that it sends corresponding signals to the motor driver. For an example if the knob of the joystick is moved forward the microcontroller receives two distinct values for x and y so the signals sent to the relay will cause the 2 motors to drive the robot forward. And when the knob is pulled in the opposite direction the microcontroller receives another distinct value for x and y and the signals sent by the microcontroller to the relay will cause the motors to turn in the opposite direction, so the robot will move backwards.. Sideways movement of the joystickgive another set of output values for x and y and similarly the microcontroller receives this and sends corresponding signals to the motor driver , this time in such a manner that one motor will rotate in clockwise and the other motor in anticlockwise direction, this results the robot to move left or right in direction.It can be concluded that the robot moves in a direction similar to the direction of motion of the joystick.

VI. RESULT

The robotic arm was implemented and checked in different terrains. During the testing procedure the robot could be controlled wirelessly within a range of 100 m without any hindrances. Since a belt drive was used to control the wire stripper it can cut thick wires up to 16 gauge.The implemented hardware is shown in fig.6

Fig. 6 Robot

VII. CONCLUSION

The project “RF BASED WIRELESS BOMB DEFUSING MANIPULATOR ROBOTIC ARM” is successfully tested. This robot can be used as a solution for working in extreme environments and conditions where humans find it difficult to operate. The working of the robot is checked within 100m in real environment. Currently the robot is a manually

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controlled robot. A wireless camera is used for the visual feedback which helps the operator to do the required operation. With the help of the joysticks the user can control the movement of the robotic arm.

As a future development of our project, it is possible to convert the robot into a fully automated robot which is capable of detecting and defusing the bomb. For this implementation artificial intelligence technique can be applied. It is also possible to use the robotic arm for various applications by replacing the stripper used with an end effector.

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