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Design and Fabrication of Wireless Robot

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ABSTRACT: Robotics is the most prominent field in the embedded systems helping humans in simple day to day chores as well as highly complex activities humans are unable to perform. These are the automated systems and if controlled wirelessly from a remote location, gives an extra edge to its applications. Wireless technology employed in robotics allow the robots to sense (see) and respond to its environment.

In modern days, tasks are divided among Robots to work together especially in industries. This requires not only instructions from computer but also communication links among them. Wired robots limited the number of interconnections between them and so, there was an inclination towards wireless Robots for effective communication. This has certain benefits like extended range for communication, smart efficient control and easy installation.

Here, we have built a wireless robot to participate in IIT KANPUR TECHKRITI 2015 in WILDSOCCER competition. We have made the chassis with iron and most of the fabrication work was done in our college engineering workshop and machine tools lab. The electronic parts like motor driver, transmitter, receiver and binding wires were purchased in Chennai.

KEYWORDS: Robot, wireless Robots, WILD SOCCER, electronic parts.

I. INTRODUCTION

Basically we can classify wireless robots based on the use of microcontrollers and way of communication employed. 8051 is the most common and basic microcontroller generally used for design of Robot.

1.1 8051 Microcontroller: Wireless robots employ the 8051 microcontroller to process the received signal from the receiver and control the dc motors. 8051 microcontroller consists of 4K program memory, 64K external memory and 128 bytes RAM.

It utilizes 4 I/O ports for external communication from Port 0 to Port 3. The lower byte of Port 0 is used for accessing external memory. If high voltage level (5V) is used, then P0 should be avoided because its pins do not have pull-up resistors, thus giving low logic level only. When using other ports, since pull-up resistors have a relatively high resistance, their pins can give a current of several hundred microamperes only.

1.2 Arduino Controlled Robots:

Arduino is an integrated programmable circuit board (often referred to as a microcontroller) and a piece of software or IDE (Integrated Development Environment) that runs on the computer which is used to dump the code to the physical board. Arduino basically uses a simplified C++ language. Arduino can be directly interfaced with the wireless receiver as well as L293D IC for controlling the movements of the robot.

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Ways of Wireless Communication with the Robot:

1.1 Infrared (IR)

This is the one of the simple and easy wireless control techniques available. It is invisible to the human eye since the wavelength of IR light is longer than that of visible light. A transmitter in the controller transmits IR light (or pulses) and an IR receiver on the robot receives the signal, which is decoded with the help of the microcontroller. However it is required to

1.2 Radio Frequency

This is the most common method of communication. RF signals can travel longer distances and penetrate most objects because of its longer wavelength. It has a frequency range of 3 KHz to 300 Ghz.

1.3 Wi-Fi:

It is referred as “IEEE 802.11” network. It is the modern way of communication in wireless robotics. Wi-Fi enables us to control the robot with Internet. Because of its higher data rates, video recorder could also be integrated in Robot.

1.4 Bluetooth:

It is also referred as “IEEE 802.16” network. It could only be helpful in short range communication, typically 8 to 10 meters. But the data rates of Bluetooth are very high.

Bluetooth could enable us to transfer data from mobile devices or computers.

II. PRINCIPLE OF OPERATION

Wireless Robot basically has the following modules: Transmitter, Receiver, DC Motor driver and other mechanical parts. The transmitter module takes the input from user, converts into digital form and transmits the data to the receiver in the form of electro-magnetic signals. The electromagnetic signal could either be Radio, IF or microwaves.

The receiver module which is attached to the robot converts the received electromagnetic signals into digital electric signals and then sends these signals to the Motor driver.

The DC Motor Driver contains an inbuilt microcontroller to process the data from receiver and with the help of actuator, sets the robot into mechanical motion. The microcontroller could be any of those mentioned in the introduction section. DC Motor works with the principle of Electromagnetic induction i.e. when current carrying conductor is placed in the magnetic field, force is experienced by the conductor such that it rotates either in clock-wise or anti clock-wise direction.

The force experienced can be given by the equation.

$$F = BIL \sin\theta$$

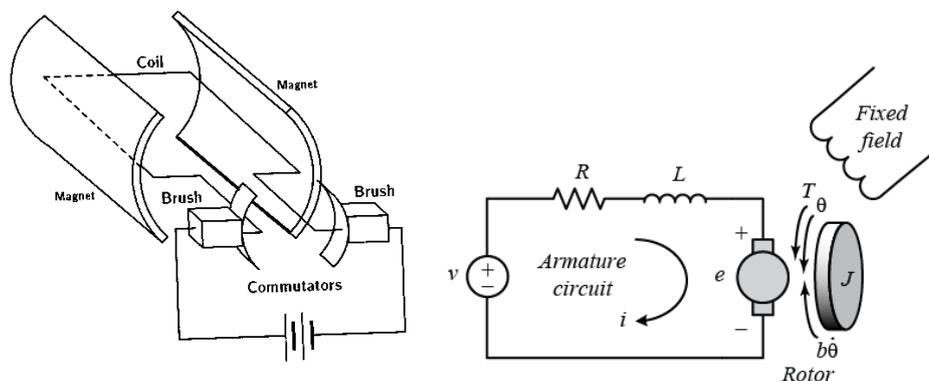


Figure 1 :- Circuit diagram of a DC motor

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Permanent-magnet DC motors require only two leads, and use an arrangement of fixed- and electro-magnets (stator and rotor) and switches. These form a commutator to create motion through a spinning magnetic field. The speed of the dc motor is given by the equation.

$$n = kn * (Vm - Rm * Ia) / \emptyset$$

where,

n = speed of DC Motor

kn = speed equation constant

\emptyset = machine's total flux (Wb)

Rm = motor resistance (Ω)

Vm = motor input voltage (V)

Ia = Armature Current(A)

III. PARTS INVOLVED

3.1. Chassis

A chassis is the physical frame or structure of an automobile, an airplane, a desktop computer, or other multi-component device. For wireless robot, chassis can be made of different materials like Iron, aluminium of different thickness.

3.2 Control systems: (receiver and transmitter)

Radio control system is required to control the Wireless Robot. Steering of the robot is taken care by a Remote Control set which consists of a receiver, transmitter and motor driver.

Receiver: The receiver is a small rectangular device mounted on the robot. It has a wire (usually 19") that acts as an antenna to receive signals from the transmitter. Wireless robots need either 3- channel radio control system. The specifications of receiver are:

- Channels: 3 channels
- Model Type: Car/Boat
- Frequency Band: 2.4G
- Modulation: GFSK
- Sensitivity:1024
- RF.Receiver Sensitivity: -100dbm
- Power: 4.5-6vdc
- Weight: 5g
- ANT Length: 175mm
- Size: 37.6*22.3*13mm
- Color: Black
- Certificate: CE FCC
- Package weight: 650g

Transmitter: The transmitter is the controller. Transmitters have control sticks, triggers, switches, and dials at the user's finger tips. The stick type used two "sticks". Fly Sky FS-GT2 2.4Ghz 2 Channel Radio Set – Transmitter or 4 channel is normally used for controlling robots wirelessly with a huge range and easy control. These transmitters should be compatible with PHONEIX OR WHIPLASH motor drivers. We have used 2.4Ghz 2 channel transmitter for our wireless robot.

The features of the transmitter are Active and passive anti-jamming capabilities; Very low power consumption; High receiving sensitivity; Servo reverse functions; Throttle & Steering trim adjustment; Steering dual rate settings; Work between 2.400GHz to 2.4835GHz frequencies, divide into 160 frequency points; Use a linear spread of fine paragraph by an excess antenna; It covers the entire band width of the antenna bandwidth range; Has its own unique ID, increase the anti-jamming capability and stability.

The specifications of transmitter are :

- Frequency: 2.4GHz
- Channels: 2 Channels

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- Model Type: Car/Boat
- RF Power: Less than 20dbm
- Modulation: GFSK
- Code Type: Digital
- Sensitivity: 1024
- Low Voltage Warning: Yes (less than 9v)
- DSC Port: Yes
- Charger Port: Yes
- Power: 12V DC (or 8x AA batteries)
- Weight: 328g
- ANT Length: 120mm
- Size: 159*99*315mm
- Color: Black + Orange
- Certificate: CE FCC



(a) (b)
Figure 2 :- (a) Transmitter) , (b) receiver

3.3 DC motor Driver:

A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. There are different companies of motor drivers like PHOENIX series, WHIPLASH series, FIREBLADE series of different specifications like 12v/10A,12v/30A,24v/30A etc. We have used PHOENIX series motor drivers of specification 12v/30A for high power.



Figure 3 :- Motor driver

3.4 Binding Wires:

Binding wires are designed to bind 11 inches of spine, with a 2:1 pitch. A 2:1 pitch means that the wires are made to be used with a hole-punch pattern of 2 holes per inch. Pitch is important, because if the pitch of the wire does not

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match the pitch of the holes, then the wire will not fit well in the book. Diameters below refer to the size of the wire when closed around the book.

3.5 Power window motors:

These are the motors which are used normally in the cars to lift the windows. These have a speed of 110 RPM. There are motors of different RPM used in different vehicles. We have taken power window motors of santro car for driving our robot.

3.6 Wheels:

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the main components of the wheel and axle. Wheels of different materials like plastic, nylon and of different sizes can be used. Wheels of different dimensions can also be used like 4 inch wheel, 5 inch wheel etc. We have used 4 inch wheels for our robot.



Figure 4 :- Nylon wheel with grips

3.7 Batteries:

It is a collection of one or more electrochemical cells in which stored chemical energy is converted into electrical energy. The principles of operation haven't changed much since the time of Volta. Each cell consists of two half cells connected in series through an electrolytic solution. One half cell houses the **Anode** to which the positive ions migrate from the **Electrolyte** and the other houses the **Cathode** to which the negative ones drift.

Batteries are classified into primary and secondary forms.

- Primary batteries irreversibly transform chemical energy to electrical energy. When the supply of reactants is exhausted, energy cannot be readily restored to the battery. Alkaline batteries, Mercury batteries, Silver-Oxide batteries, and Zinc carbon batteries are examples of primary batteries
- Secondary batteries can be recharged; that is, they can have their chemical reactions reversed by supplying electrical energy to the cell, approximately restoring their original composition. Lead-Acid batteries and Lithium batteries fall into the secondary battery's category.



Figure 5:- Battery used for wireless bot

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3.8) Tool kit

- Wrench : A wrench (also called a spanner) is a tool used to provide grip and mechanical advantage in applying torque to turn objects—usually rotary fasteners, such as nuts and bolts or keep them from turning.
- Screw drivers: A screwdriver is a tool, manual or powered, for turning (driving or removing) screws. A typical simple screwdriver has a handle and a shaft, and a tip that the user inserts into the screw head to turn it. The shaft is usually made of tough steel to resist bending or twisting. The tip may be hardened to resist wear, treated with a dark tip coating for improved visual contrast between tip and screw—or ridged or treated for additional 'grip'. Handle are typically wood, metal, or plastic and usually hexagonal, square, or oval in cross-section to improve grip and prevent the tool from rolling when set down.
- Hammer: It is mainly used for hammering the chassis to make it flat or to tighten the screws

III. FABRICATION

A 3 mm iron metal chassis was fabricated in CNC machining. The dimension of chassis and the dimension for drilling were feed to the CNC process through G code. Metal sheets for clamps were fabricated in CNC machining. Drilling was done in clamps with 10mm drill bit and hole was made to pass the shaft. Filing was done in chassis and clamps. A shaft is fabricated in CNC lathe machine which connects the motor and the wheel. A hole was made in one side of shaft to fit bolt in it. Threading was done in the hole of shaft to fit the bolt and hold the wheel. Locks were used to hold shaft on the motor. Bolts were used to tight shaft and the wheel. Nylon wheels are fabricated and rough filing is done to stick grip to it.

V. SPECIFICATIONS

Length of robot: - 30 cm

Maximum width of robot: - 30 cm

Weight of robot: - 5.5 kg

Speed of each wheel motor: - 110 RPM

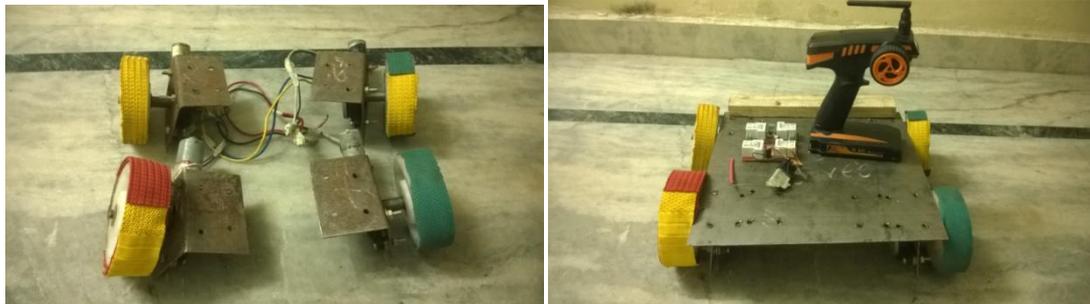
VI. ASSEMBLY

The wireless robot mainly comprises of chassis, wheels, motors for locomotion, switch box (remote), motor drivers, transmitters and receivers. The major assembly of a wireless robot starts from the chassis making. The movement of the robot is taken care by four power window motors withstanding a huge torque and thus rotating with 110 rpm speed, which are mounted to wheels. These motors are clamped properly and attested with the down part of chassis. The wheels used have a shaft which is attached to them using a key. Then the shaft, motor, and wheel is connected to clamp with nut and bolts. The wires of motor are connected to the motor drivers. The motor driver consists of semi-conductor diodes. These semiconductor diodes have a negligible electrical resistance thus they shouldn't have a direct touch with chassis or any other metal thus a substance with high electrical resistance is kept in between of chassis and motor drivers. Then motor drivers are attached so that its relative motion be restricted during the motion of robot. Then we attach the receiver to the pin-sets. We can connect the receiver in any pin-pair but this totally influences the frequency produced by transmitters. We select the first and the third pair so that the rotational controller in transmitter denote the rotation of robot in horizontal plane and the transverse controller in transmitter signals the front and back motion of the wireless robot. We have also used bat grips for wheels to avoid friction. A tin metal was attached in front of the robot to serve as a shield. This shield was attached to the chassis with the help of screws.

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(a)

(b)

Figure 6 :- (a) assembling process of wheels with clamp and wires connection (b) A set of assembled wireless robot

VII. TESTING

Detection of positive and negative terminal of locomotion motors is to be done first. For that, terminals of the motors are connected to the positive and negative terminals of the battery with the help of small connecting wires (of 5-10cm). We detect the correctness of connection by seeing the rotation of wheels. If all the four wheels are rotating in same direction then no need to change the connections or else connections need to be changed maintaining the motion of all 4 wheels in forward direction. Similarly, for the motor driver connecting the battery, initially 4 square mm wires are connected to the battery and terminals of the motor. Then we connect the motor drivers with the receivers. And binding of transmitter with receiver is to be done. This enables the transmitter to send electromagnetic signals into the receiver creating coordination between transmitter and motor drivers. Then we see the robot from backside and if the wheels connected to motor driver rotate in clockwise direction, the connections are correct. If not, we are required to change the combination of wiring.

We further test the battery voltage with the voltmeter. We connect a battery of 12V. The wires are taped with the help of electric wire. Individual motion of wheels is checked. Dry cell batteries were feed to transmitter as power input. There is a notch shaped button on the motor drivers which is the power button which are only opened during operation of wireless robot.

Also to increase the speed of the robot, we have placed two batteries in series and connected it to motor drivers. The bolts and nuts were tightened using the spanners.

VIII. CONCLUSION

The robot was fabricated successfully and we have participated in IIT Kanpur's technical fest TECHKRITI 2015. Unfortunately, we were not able to win the competition because our locomotion motors are not good enough. For this, we need to use bane motors or planetary gear box motors for locomotion which should be imported from Germany or USA. As, we do not have enough money we did not use these motors. Moreover, Participating in these competitions rather than just attending them gives all the participants an opportunity to think out of box; design their own robot; fabricate it using different mechanisms, materials etc which in total builds their technical skills, team work skills and also provides the students to get placed in any of the manufacturing industries.

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