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ECONOMIC SNAKE ROBOT FOR SURVEILLANCE IN UNREACHABLE AREAS

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ABSTRACT

The necessity of surveillance had increased due to variety of needs and purposes. So we concentrated on surveillance which is combined with the snake robot which makes it an ultimate weapon. Surveillance is done effectively by using a wifi IP camera so that we get videos lively in windows, android and iOS. The PIR sensor and ultrasonic sensor combination helps in differentiating humans and obstacles effectively and accurately sensing its distance. Arduino uno R3 serves in functioning of the robot. A detailed picture of mechanical, electronic parts is displayed in this paper.

Keywords: PIR Sensor, Snake Robot, Surveillance, Ultrasonic Sensor, Wifi IP Camera.

I. INTRODUCTION

This project is very essential as nowadays surveillance is very much needed especially in nation borders, enemy bases, and the areas where crimes taking place periodically. For these purpose we can use this robots for effective surveillance and we can reduce man loss and power. It can be used in areas where the arena is very difficult to enter in. The major components of this robot are the Arduino uno R3 microcontroller, PIR sensor, Ultrasonic sensor, Wifi IP camera, dc geared motor.

The programming is done in Arduino software. This robot is accurate in sensing and it fixes its target sharply, so that the job is done perfectly. The highlight is that it highly economic. Many kinds of snake robots are being developed by many scholars and researchers around the world. Each robot is unique and they have different types of links and characteristics. "AmphiBot II: An Amphibious Snake Robot that Crawls and Swims using a Central Pattern Generator" was published by Alessandro Crespi and Auke Jan Ijspeert. Their project deals with the snake robot which has the ability to swim and crawl.

Limbless Locomotion: Learning to Crawl with a Snake Robot" book which was written by Kevin J. Dowling, discuss briefly about snake robots. "Coordination of Action and Perception in a Surveillance Robot" was published by James L. Crowley which uses three sensors-an infrared sensor, an ultrasonic ranging sensor and a microwave radar sensor.

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II. DESIGN

The robot is designed in a way that it looks like a snake and it can crawl or climb even hard surfaces. The wifi IP camera is fixed on the second middle section of the robot to get quality video. The whole design is done in the manner to make the robot economical.

2.1 3-D Modelling

The 3-D modelling is done in Solidworks software.

2.1.1 Head section

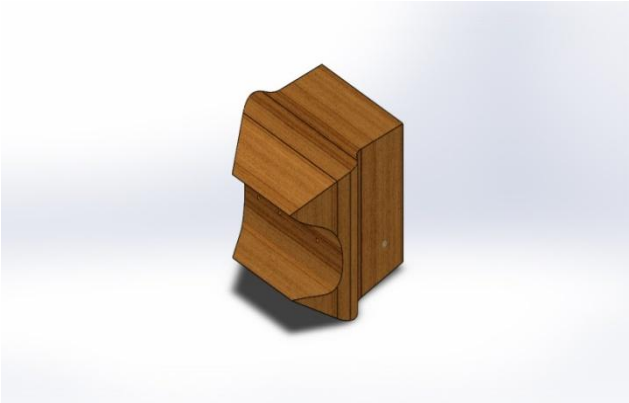

Fig: 1. head section

2.1.2 Middle section

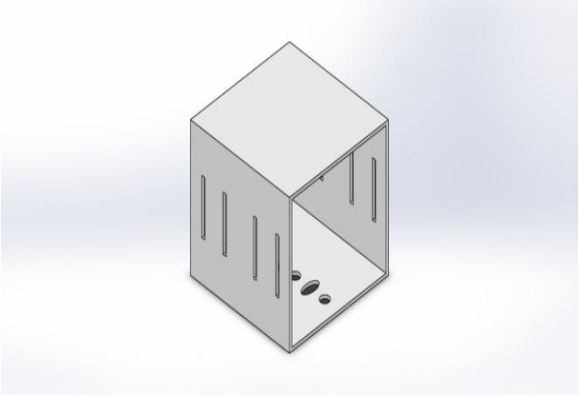

Fig: 2. Middle section

The middle section has small hole to reduce heat in means of air cooling.

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2.1.3 Linker

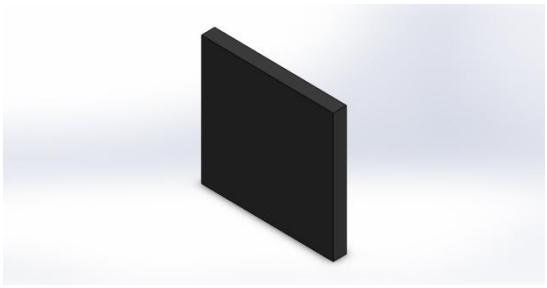

Fig: 3. linker

2.2 Assembled view – 2D

The 2-D modelling is shown below

2.2.1 Head section

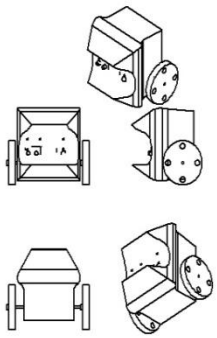

Fig: 4. head section

2.2.2 Tail section

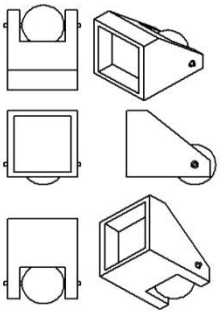

Fig: 5.tail section

2.3. Assembled view – 3D

The assembled view is shown below

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2.3.1 Head section

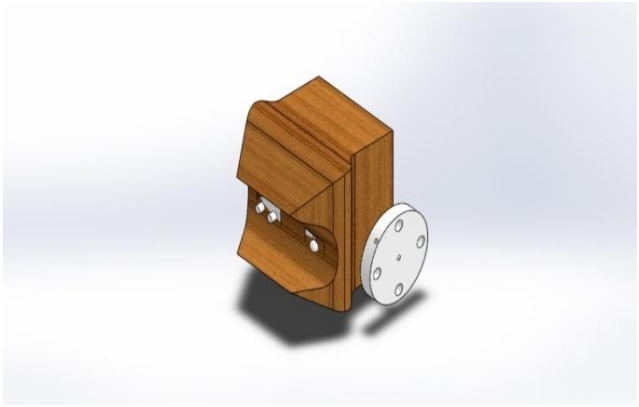

Fig: 6. Head section

In the head section- teak wood, plastic wheels, two sensors and two dc geared motors are assembled. The two sensors are fixed in a way that it is rigidly connected with the teak wood so that it doesn't fall down.

2.3.2. Middle section connected with a linker

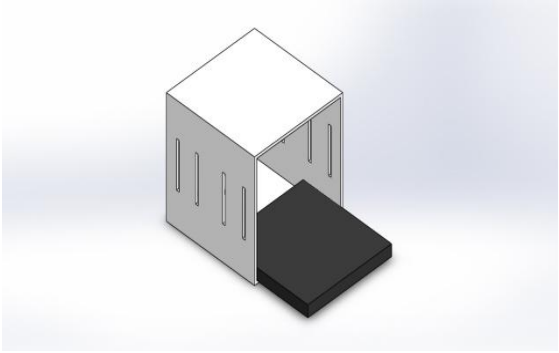

Fig: 7. one middle section connected with a linker

The linker is placed in between the middle section and this provides as a flexible link by connecting both wit glue.

2.3.3. Two middle sections connected by a linker

The two middle pieces are connected by a linker so that the robot moves freely as the link is flexible.

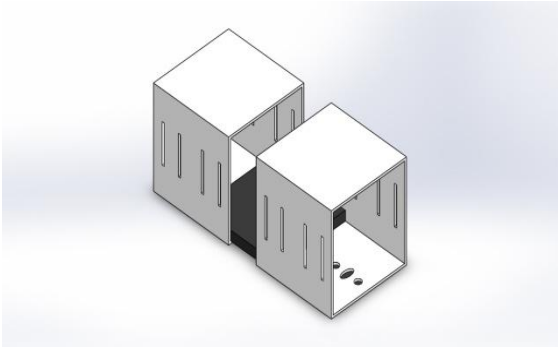

Fig: 8. two middle sections connected with a linker

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Likewise the rubber linker material helps in connecting all the sections together. That is- the head section, middle sections (3), tail section.

2.3.4 Tail section

Fig: 9. Tail section

In the tail section- the teak wood model, plastic ball and a shaft is assembled. The plastic ball provides extra support to the movement of the robot. Since the ball is plastic it is unaffected by water.

III. BILL OF MATERIALS

The bill of materials is shown below

Bill of materials

S.NO	COMPONENT	MATERIAL	QTY
1.	Head section	Teak Wood	1
2.	Middle section	PVC	3
3.	Tail section	Teak Wood and plastic ball	1
4.	Fasteners	Mild steel	As Need
5.	Linker	Silicon Rubber	4

IV. SELECTION OF COMPONENTS

The required components are selected on the basis that the robot must be accurate and precise as well as it should also be economical.

4.1. Selection of microcontroller

Arduino uno R3 is selected since it is small and also has the following characteristics.

- ATmega328 microcontroller
- Operating voltage: 5V
- Input voltage 7-12 V
- 14 digital I/O pins
- 6 Analog inputs

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- DC Current per I/O Pin: 40mA
- DC Current for 3.3V pin: 50mA
- 32k Flash Memory
- EEPROM: 1 KB
- 16 MHz Clock speed

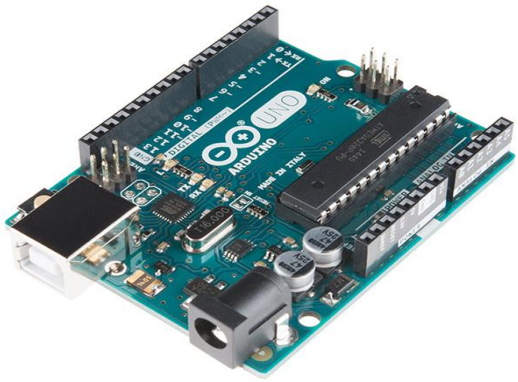

Fig: 10. Arduino board uno R3

4.2. Selection for surveillance camera

WIFI IP Camera is selected as it automatically sends live videos to the android or iOS which was connected to it by means of P2P master software. Therefore surveillance is more effective and it is easy for us to know the exact location of the robot. On comparing with other camera models this wifi IP Camera is far better for this type of surveillance application.

We can also pan or tilt the camera by using this software directly through windows, android and iOS.

Fig.11. WIFI IP Camera

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Our selected camera has these specifications.

- Image sensor: 1.3 Megapixel 1/4 CMOS Sensor
- Resolution: 1280x1080, 640x480
- Lens: f=3.6mm, F=2.0
- Image compression: H.264/ M-JPEG
- Frame rate: 30FPS
- Viewing angle: 60 Degrees
- 11x IR LED (Night Vision Distance 8 to 10 Meters)
- PT Angle: Pan: 270 Degrees, Tilt: 120 Degrees
- Basic Protocol: TCP/IP, HTTP, SMTP, RTSP, FTP, DHCP, DDNS, UPNP, NTP, ONVIF
- Wifi Protocol: 802.11b/g/n
- Two-way Audio Support
- Alarm Action: Email/FTP/SD Saving/Sending messages to the alarm server
- Ethernet Interface: 10Base-T/100base-TX
- Audio Output Jack
- Power DC 5V/2A
- Ethernet
- Dimensions: 125x90x110 mm (L x W x D)
- Weight: 335g

4.3 Selection of sensors

Sensors play a vital role in robot operating system. Choosing the correct sensor and embedding the accurate programming is a difficult task. Here we choose ultrasonic sensor and PIR sensor for our needs.

4.3.1 Ultrasonic sensor

The HC-SR04 ultrasonic sensor is selected. It helps in effectively tracking the exact distance of the opponent. It has a transmitter and receiver which are inbuilt. The transmitter sends 40 kHz square wave automatically and after hitting the opponents the waves are reflected back which was collected by the receiver. The time interval between the sending and receiving of the waves are used to calculate the exact location of the opponent.

Ultrasonic sensor main specifications are as follows

- Working Voltage : 5V(DC)
- Static current: Less than 2mA.
- Output signal: Electric frequency signal, high level 5V, low level 0V.
- Sensor angle: Not more than 15 degrees.
- Detection distance: 2cm-450cm.

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Fig 12: Ultrasonic sensor

4.3.2 PIR sensor

PIR motion sensor detector module HC-SR501 8051 is selected. The PIR (passive infrared) sensor module helps in sensing motion. It is very much effective in detecting the motion of a human body within the sensor's range. So that using this sensor we can easily detect the human occurrence and making the art of surveillance quiet easier. PIR sensor's main specifications are as follows

- Working Voltage Range: DC 4.5V- 20V
- Current Drain: <60uA
- Detection Range: <140°
- Detection Distance: 3 to 7m (can be adjusted)
- Work temperature: -20-+80°C

Fig 13: PIR Sensor

4.4 Selection of motors

DC Geared motors of 100 rpm are selected so that it runs in nominal speed and it has high amount of torque compared to other higher speeds. These motors acts perfect for this type of application. As it has a predefined shaft, the wheels are directly fixed with the motor. This saves the time and cost for machining the shaft. These motors provide excellent speed and torque to the robot at economical cost.

Important specifications of the DC Geared motor are as follows:

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- RPM – 100
- Shaft Diameter – 6mm
- Weight - 125gms
- Torque – 10kgcm
- Voltage – 6 to 24 (Nominal Voltage – 12v)
- Load current = 300 mA (Max)

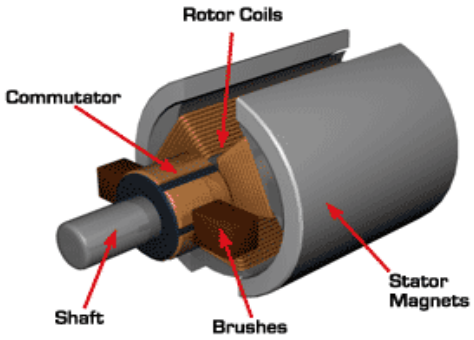

Fig 14: DC Geared motor

4.6 Selection of materials for frame

The material for frame is selected in the way that they provide good support and best insulation for the inner electrical components.

4.6.1 Material for head section

Head section holds the two sensors and two motors. Therefore strength of the head piece must be strong. So that teak wood is selected as material. It gives better structure and carrier.

4.6.2 Material for linker

Linker must be flexible and durable. So that silicone rubber material is selected. It provides necessary flexibility and best to connect the two sections.

4.6.3 Material for middle section

PVC (Polyvinyl Chloride) is selected since it is economical and it has many adorable properties like weathering stability, versatility, fire protection, longevity, recyclability and eco friendly.

4.6.4 Material for tail section

Tail section is also made up of teak wood and also it has a plastic ball at the end of the wood piece to provide free movement of the robot so that by reducing friction and traction.

4.7. Selection of battery

Lead acid battery of 12v and 7.5 AH is selected as it gives enough power at economical cost.

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V. PROCESS PLANNING

The head section of the robot is the main part. It holds the ultrasonic sensor, PIR sensor and two dc geared motor. The middle section holds the WIFI IP Camera, Arduino board and the battery. All the electrical components including the relay board is connected to the Arduino uno R3 microcontroller. Then the programming is embedded to it. The software used is Arduino. The tail section has a ball at the end so that it gives free motion to the robot. All the sections- the head section, middle sections, tail section is linked together by glue so that the robot is flexible. Castor wheels are connected at the bottom of the robot to provide smooth rotation so that reducing friction and traction.

The price of all the components is listed below:

Cost estimation

S.NO	COMPONENT NAME	PRICE IN RUPEES
1.	Arduino uno R3	500
2.	Wifi IP Camera	3000
3.	Ultrasonic sensor	130
4.	Infrared sensor	120
5.	Motors (2)	900
6.	Plastic Wheels (2)	100
7.	Castor wheels(16)	300
8.	Frame materials	450
9.	Relay board	400
10.	Battery	800
11.	Link material	300
12.	Wires, pins, clip, ball, diode, others	500
13.	Total	7500

VI. DISCUSSION

When the power is given to the robot, it searches for the target and the WIFI IP Camera starts to capture videos. The PIR sensor effectively helps in identifying the target. The ultrasonic sensor helps in measuring the distance of the target and so the robot maintains the distance from its target as given in the coding. If the given distance is lower than the target's distance then the robot tend to move forward towards the target and if the given distance is lower than the target's distance then the robot will come backward.

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VII. FABRICATED PHOTOGRAPHY

Fig 15: Top view

Fig 16: Front view

Fig 17: Side view

VIII. CONCLUSION

As explained in the above sections, this snake robot is perfect for the purpose of surveillance as it has multitasking. The highlight of this project is that it is economical and easy to fabricate. By this project a ultimately powerful surveillance robot is developed which can be used in enemy bases and unreachable areas. To make the robot invisible to others black or brown paint is coated. So that it is hard to find and we can use it for ultimate surveillance.

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