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Arduino based Surveillance and Bomb Diffusion Robot with Rocker Bogie Mechanism and Two-way Talk Feature using Hand Gesture control Robotic ARM

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Abstract - *In present day scenario of military and defence system of India, there is a lack of some technologies as we are still behind in the race of defence as compared to the world's most powerful countries.*

We know that the bomb detection is basically carried out by using a human bomb squad or dogs which carries the involvement of living beings and their loss can be very costly in order to just stop this mishap we have designed a robot that could actually defuse the bomb from a distance wirelessly as this robot will have a mechanical arm for itself which will be used for bomb diffusion using hand gesture control and will have a clipper to clip the wires as well as it is loaded with a Wi-Fi camera which is self-capable of capturing, live streaming and recording, at day as well as at night and can capture at 360 degrees in horizontal plane and 120 degrees on vertical plane which will be used for surveillance and identification purposes.

Also, this robot can be used as a medium of two-way communication over Wi-Fi on both the ends of the enemy as well as the military personnel's on a remote location from where the robot is being operated for getting onto a conclusion with them which will be mounted over the rover and will be controlled remotely and suited for different terrains and staircases as it uses rocker-bogie mechanism which we designed using microcontroller Arduino Uno.

***Key Words*: Surveillance, Bomb Diffusion, Gesture Controlled Arm, Crawler, Rocker-Bogie Mechanism, Staircase Climbing, Two-Way Communication, Military**

1. INTRODUCTION

We know "a robot is a machine that can carry out complex actions and movements automatically. Robots play important roles in society, intending to make the lives of humans easier". [1]

Robotics is a branch of science and technology that deals with the conception, design, construction, manufacture, and operation of robots. This field goes hand in hand with other fields, such as computer science, mechatronics, electronics, artificial intelligence, bioengineering, and nanotechnology. [2]

The word robot comes from the term, "*robota*", which means "forced labor or work". Typically, robots are machines that perform actions that are normally performed by humans, either through the remote control or automatically .[3]

Currently, the role of robots is to take over hard and dangerous jobs. Jobs that are repetitive and need great precision are the ones robots are good at. There's no room for human error in these jobs. Since robots are machines and computer-controlled algorithms, or human-controlled through different interfacing techniques all the calculations of each movement are accurate. [4]

Robots are used in factories to build equipment and devices, such as cars and electronics. Today, robots aren't just used for dangerous jobs, but also in various applications that help mankind. [5]

Also, we know that what importance the guardian's life holds in everyone's life. Losing them would cause us incomparable loss for us similarly, if we talk in respect to our project this is designed for such sting and bomb defusal activities which are carried out in defense mechanism adopted in India which will not only ensure us in no loss of any human life as well as the animal lives which we use while bomb searching such as dogs in bomb squad these living beings play a very vital role in everyone's life as they guard our lives by risking their precious life because if some mishap happens then they can lose their life or there can be a loss of limb which will make them handicapped for their rest of the life.

This project is a conglomeration of three concepts which is implemented together to serve a purpose the very firstly, the crawler which we have designed by getting inspired from the mars curiosity rover which was designed on the rocker-bogie mechanism and this mechanism is an important part in our project which we will discuss in detail further, secondly, a Full-HD camera with night vision capabilities which holds a virtue of detecting motion at all hours of the day, thirdly, a robotic arm which is controlled using human gestures wirelessly using transmission and receiving mechanisms on Arduino and embedded C programming which will be used to diffuse bombs or pick objects.

1.1 A PREVIEW OF THE PROJECT

This project has three different parts classified based upon its usability in various fields:

i **Crawler:** A crawler is a machine that is used for manoeuvring over a terrain or steps. As it has wheels that help it to climb at a variable speed or constant speed based upon the throttle provided.

ii **Surveillance Camera with two-way communication:** This camera is basically a device which helps us in object tracking with motion detection in horizontal plane and vertical plane of angles.

iii **Robotic Arm:** This is a mechanical arm constructed to imitate the hand gestures of the controlling person and helps to work for which is being designated.

1.1.1 CRAWLER

The crawler of the project is specially designed by getting inspired from the marsian crawler curiosity which was based on rocker and bogie mechanism this particular mechanism helps it to climb on various surfaces and staircases without getting stuck as in the conventional robots the major drawback is that they can't climb on elevated surfaces but this robot is capable to tackle these hindrance also this chassis design gives it a high ground clearance which not only ensures us giving us height for us to plant our camera to operate and capture everything completely also, helping it move without getting stuck on small to medium stones, pebbles etc.

We operate this crawler wirelessly using HC05 Bluetooth module as a receiver which is connected to the Arduino Uno board at Rx, Tx, GND, +5v pins which ensures it giving proper instructions received via the controller which is the mobile phone equipped with an application which can be easily accessed by Google play store (Bluetooth RC controller) and simultaneously getting the Power Supply. The structure is made using UPVC which helps it giving skeletal support. The range of this robot on its first test run was around 429 feet approx.

Fig. 1: Rocker-Bogie Mechanism

1.1.2 SURVEILLANCE CAMERA

The camera is used for surveillance in the areas where the situations aren't friendly such as the Naxalites and the Maoists areas here going for the military troops can pose danger and getting injured due to ceasefire violation. Thus, will help locating them with fewer risks involved. Also, this camera is inbuilt with 1080p FHD rec and live streaming which facilitates seamlessly clear viewing and this camera can be rotated at 360 degrees on horizontal plane of axis and up-to 120 on vertical plane of axis; also locate the bomb location or landmines.

This helps us in adjusting the camera and looks all the way round with ease. This camera also supports SD card support this means this camera can rec and save the data simultaneously. This is a Wi-Fi camera which means it works on internet at 2.5 GHz frequency band and can be easily connected to the mobile device using application made by the manufacturer.

This camera features night vision which helps us to rec and work at night time even, plus this camera comes with two way talk feature which makes this robot unique from traditional robots that were used since ages, this feature will help us to communicate with people on the other end we can speak to them and even listen to them through wireless mode of communication for coming onto a conclusion.

Fig. 2: Surveillance camera [6]

1.1.3 GESTURE CONTROLLED ROBOTIC ARM

The construction of this robotic arm is made using few 30 cm plastic scales or we can use cardboard strips which are affixed to four servo motors having a torque of 9.8 – 11 kg/cm and give it four degrees of freedom for movement in different directions and it's easier for it to imitate hand gestures.

This arm is basically controlled using a flex sensor which acts as variable resistance and helps adjusting the grapple, MPU 6050 is a 3 axis gyro sensor and with hand movements it rotates the arm, a Arduino pro mini which will acts as the decision making device on the transmitter end and this is connected to a transceiver NRF24L01 and acts and generates signals which is being transferred to this transmitter and on the receiving end it has another transceiver which receives

the signal and passes on to Arduino Uno for work and Arduino generates signals and passes onto to the servo motor to generate motion. The transceiver with antenna has a range up-to 1 km, whereas, one with micro strip antenna has a range up-to 500-800m approx.

Through this we will be successful in cutting the wires of a timed bomb circuit or pick objects/explosives if required.

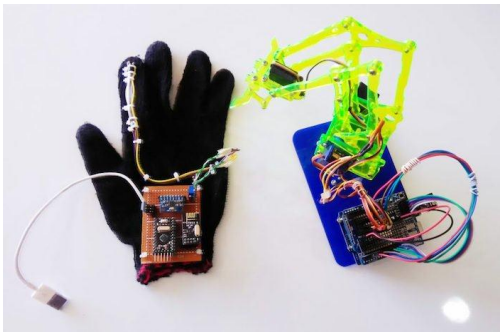


Fig. 3: Surveillance camera [7]

2. BLOCK DIAGRAM

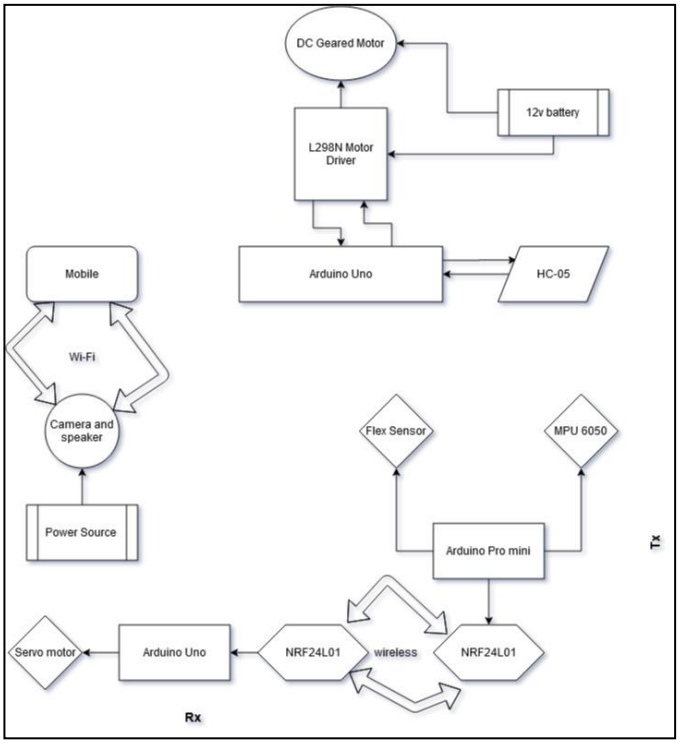


Fig. 4: Overall Circuit Block Diagram

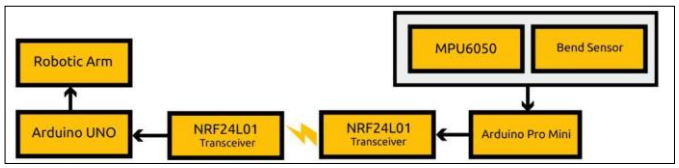


Fig.5: Robotic Arm

3. CIRCUIT DIAGRAM

Fig.6: Crawler Circuit

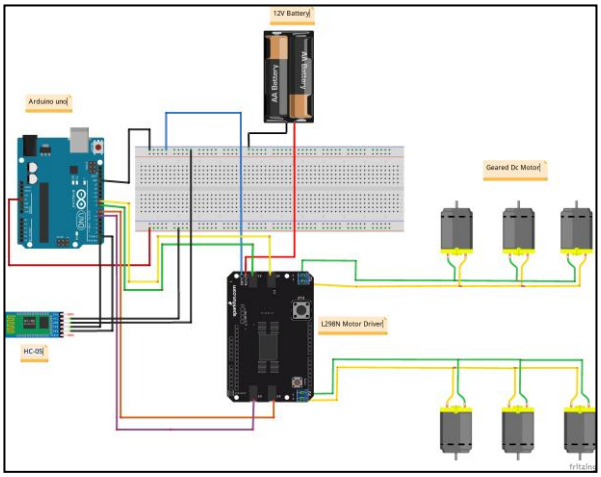
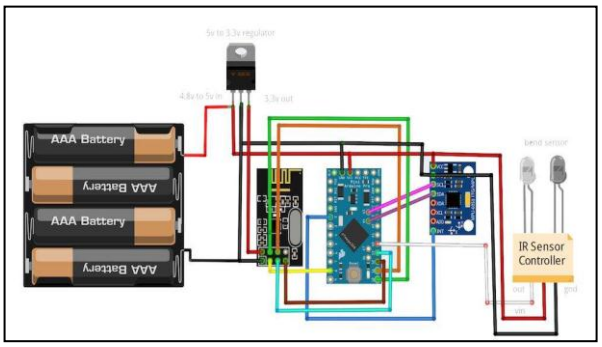


Fig.7: Flex Sensor Circuit



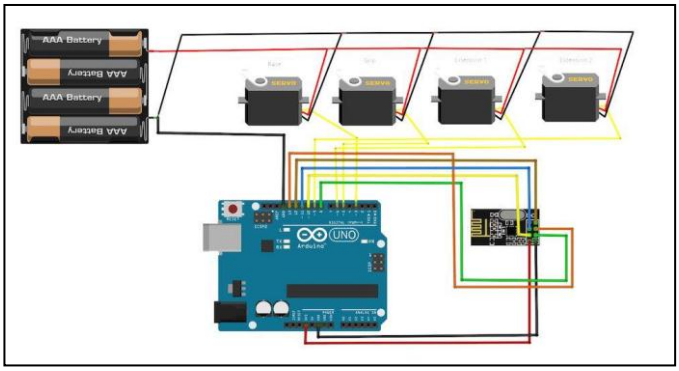


Fig.8: Robotic Arm Circuit

4. LITERATURE SURVEY

The authors D. S. Chinchkar *et al.* found that rocker bogie are important for conducting in-situ scientific analysis of objectives that are separated by many meters to tens of kilometers. Current mobility designs are complex, using many wheels or legs. They are open to mechanical failure caused by the harsh environment on Mars. Used because there are few obstacles on natural terrain that require both front wheels of the rover to climb simultaneously. A series of mobility experiments in the agriculture land, rough roads,

inclined, stairs and obstacles surfaces concluded that rocker bogie can achieve some distance traverses on field. This work shows how rocker bogie system works on different surfaces. A per the different weight acting on link determines torque applied on it. By assuming accurate stair dimensions, accurately dimensioned rocker bogie can climb the stair with great stability. The design and manufactured model can climb the angle up to 45˚. Also, we tested for the Web cam with AV recording mounted on rocker bogie system and found satisfactorily performance obtains during this test camera has rotated around 360˚. During stair climbing test for length less than 375 mm (15 inch) system cannot climb the stair. It can be possible to develop new models of rocker bogie which can climb the stairs having low lengths. [8]

The author Waseem Afzal *et al.* found that the design and implementation of a gesture control robotic arm using flex sensor is proposed. The robotic arm is designed in such a way that it consists of four movable fingers, each with three linkages, an opposing thumb, a rotating wrist and an elbow. The robotic arm is made to imitate the human hand movements using a hand glove. The hand glove consists 5 flex sensors for controlling the finger movements and an Accelerometer for the wrist and elbow movements. The actuators used for the robotic arm are servo motors. The finger movements are controlled using cables that act like the tendons of human arm. The robotic arm is controlled from a distant location using a wireless module. A prototype of the robotic arm was constructed and tested for various hand movements. The paper presents a Gesture Control Robotic Arm Using Flex Sensor with seven degrees of freedom. The robotic arm was made of low-cost materials that were readily available. The model of the robotic arm was constructed and the functionality was tested. The robotic arm can be controlled over the internet by using Ethernet connectivity and a camera for visual feedback. [9]

The authors Shalini K V *et al.* found that, robotic systems have been used with increased popularity for explosive ordnance (EOD) missions. Advances in robotic technology have made it possible for robots to per-form functions previously only possible by human workers wearing a blast suit as shown. The primary advantage to using robotic systems for explosive ordinance disposal is the reduced risk to humans. Currently, EOD robots are able to traverse a variety of terrain, collect and destroy certain explosives and provide improved reconnaissance capabilities to law enforcement and military agencies. Although far from perfected, these robots are saving lives by finding and disposing of explosives without the need for direct human contact reliable robotic platform. The key features of the robot include an intuitive user interface which provides additional sensor feedback and enhanced visual awareness compared to existing systems, an on board three degree of freedom manipulator arm providing an enlarged workspace, and a dexterous gripper allowing for the removal of detonators. The flexible and modular robot design utilizes commercial off the shelf components for ease of maintenance and repairs. The robot provides a safe distance threat assessment and increased capacity for explosive ordinance disposal, improving the effectiveness of bomb disposal teams. The robots low-cost, intuitive operation and ease-of-maintenance promote its widespread appeal, thereby saving the lives of both law enforcement personnel and civilians through this robot we are able to locate and detect and diffuse the bomb. [10]

The authors Alapati Sreejan *et al.* found that the flex sensor has multiple applications like most sensors. Even though it is widely used as a goniometer in rehabilitation research, its applications can be seen in different fields like, human machine interfaces, geology and musical instruments. In each application, the sensor identifies the flexure in terms of varying resistance that can be recorded digitally and the data is then used differently depending on application. With the advent of goniometer glove, measuring joint movements in rehabilitation research was simplified, which was earlier measured by mechanical goniometers. Later these gloves were used as human machine interfaces (HMI). Another type of HMI input device called a shape tape has been created to replicate shapes of real objects into CAD environment. In geology, the sensor was used to identify landslides remotely. Also flex sensor is used in creating a musical instrument that can be played by deforming and bending the instrument, to encourage experimentation to create interesting musical effects. Apart from these existing applications, this paper proposes another application to use the sensor to identify the dents on sheet metal panels, by recording flexure in two dimensions across the sheet. A large number of applications already exist for a flex sensor. The already existing applications show that the flex sensor has good repeatability. The sensor data can be wirelessly transmitted in different ways, and it can be effectively used in identifying the shape of objects. These applications mentioned, aided for using the sensor in a new application, i.e. to use a grid of flex sensors as an instrument to identify dents on sheet metal is proposed. [11]

5. FUTURE SCOPE

In the terms of the future scope of this project it can be improved by the incorporation of gps technology which will help us accessing the real time location over map, also we can implant a detection system which detects the emf fields or the radiation pattern radiated by the explosives, a turret system which will help it shoot bullets of less caliber so that if a enemy is trying to approach it we can shoot them and make them injured, machine learning algorithm can also be added to this system which turns it in making autonomous, these were few ways by which it can be improved in its future versions and serve different perspectives.

6. CONCLUSIONS

On finalizing and compilation of codes on the Arduino software and running it on the hardware we came across the results which are as follows:

- We have successfully compiled and executed the Arduino program for crawler and have successfully been able to control it using Bluetooth module.
- We have successfully mounted the camera over the setup but due to shocks some noise in video is been observed.
- We have successfully compiled and executed the Arduino software for the robotic arm Tx and Rx circuit and have successfully been able to operate it wirelessly.

On finalizing the connections and on complete operation of the hardware all together, we found that there can be certain modifications in the project which can improve it in being stable and work longer in future if improved such as mechanical body, suspension, battery, Kerb weight, connection hardware, gps navigation etc. This project is a conglomeration of three concepts the rocker bogie mechanism, the surveillance camera and a robotic arm which earlier were used for different purposes in different fields but through our project we have been able to combine all these together and serve a purpose in military for bomb diffusion and surveillance activities which will help us ensuring saving lives of people at low cost and is able to help countries by advancing in the concept of defence mechanism so, adopted till date. As, it can be controlled wirelessly hassle free in its range and continuous data transmission and receiving was done and objective was fulfilled by diffusing the time bomb by cutting the wires and carrying it away from its source.

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