"Spiro" a walking Hexapod rescue robot for multi-specialty operation with a camera for live stream video.

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**Spiro a walking Hexapod rescue robot for multi-specialty operation with a camera for live stream video**", submitted by Md. Jahidur Rahman and Nusrat Jahan and Rasel Uddin Babu to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 11/26/2020.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Amit Chakraborty Chhoton, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

It can be said that the 21st century is the time and century of robotics because we are more eager to do every project or task by a computer rather than humans, because of its brilliance and the tremendous power of doing tasks incessantly and sharply. The exact combination of AI(Artificial Intelligence) has made this sector more flourishing and dynamic .Robots can act like human.they can make decisions and can solve a problem on their own using previous data. so the relationship between people and robots in the working sector has become more friendly. In every sector like medical, garments industry, education, home, and in rescue the uses of robots are increasing simultaneously. The task that is as tough for humans is sometimes much easier for the machine. that place where humans don't dare to think to go, but a robot can easily pass away. the narrowest path or deepest area on the ocean, access to robots in all cases are worth mentionable. So the work which is difficult and hazardous to do for a human, in that case, we can use the robot as a human representative. Like other sectors, a robot can be used in the rescue sector as a result life risk of rescuer will be reduced and the rescue process will be faster, easier and perfect.

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CHAPTER 1
Introduction

1.1 Overview:

In the age of globalization, problems are being successfully redefined in all developmental stages. And the most important topic of this is the external development of housing and employment. New buildings are built every day for the purpose of housing and employment. And these buildings are centered and not planned for the city. And in this unorganized city, people are living a normal life, risking their lives in dangerous structures.

On average, 75 percent of Bangladesh's building collapses are caused by earthquakes each year, and the remaining 25 percent is man-made. Many people die every year from building houses to fires and many accidents, and in these accidents, people are injured physically, financially and mentally. The biggest challenge after these accidents is the rescue operation which continues as usual. Rescue work slows down about 15 to 20 days after an accident and sometimes beyond that. And because of the slow pace of this unconfirmed and unplanned salvation, the death toll continues to rise day by day. About 25 percent of accident victims die after accidental rescue operations.

Spiro hexapod robots will help speed up rescue and crash lives. Spiro can easily enter when people are unaware and able to inform you about nature through live video video. The 3D map will show you where the injured people need immediate rescue. And be able to connect with their location and needs through the audio system. The simple road rescue task will be powerful in a short time with a 3D map

1.2 Problem statement:

Before we go further steps of the build rescue robot we find some problems. The main problem in any disaster environment is the environment itself. No one can ever say what a catastrophic environment will be like or how difficult that environment will be for rescue work. So a rescue worker has to work in those types of situations. But sometimes a human rescue worker can't think of going to some kind of risky places where his own life is also at risk. But if a human or any kind of animal trapped that place and that human or that animal needs to be rescued. To solve this problem and to speed up the rescue work we have to find a solution. Because sometimes time becomes a huge factor between life and death. So that's why we build a robot. As the environment of a disaster place is not a normal place as we think so our robot needs to be able to do these things.

1.3 Objective:

The main aim of this project is helping rescue workers. Others objectives of this project are to rescue the largest number of people in the shortest time. Reducing the life risk of rescuers. Identify the exact location and observe the current status of injured people. Observing the environment around the disaster area. And collecting the data needed for the rescue by using multiple sensors.

CHAPTER 2
Literature Review

After studying multiple types of rescue robot working processes in multiple fields we found that each of them are doing well in their field. But each of them have some limitations. Some of them are Ground Rescue Robot, some of them are Flying Rescue Robot and some of them are Underwater Rescue Robot. Each type of rescue robot has some special features which are giving advantage in those robot work.

One of them is a ground rescue robot which is a bio inspired robot. This robot can slither, roll over, or even slide its magnetized frame straight up a metallic door, sending records from its cameras and sensors again to a remote operator. [1]

Another one is like a four legged animal. This one is a nimble robot that climbs stairs and traverses rough terrain with remarkable ease, yet is small enough to apply interior decoration. Built to be a rugged and customizable platform, Spot has an enterprise track report in far off operation and independent sensing. This one also can do Site Documentation, Digital Twin Creation, Gauge Reading, Leak Detection, Noise Anomaly Detection, Thermal Inspection, Radiation Detection. [2]

To support firefighters another robot is created and this one not only helps firefighters this one also can First-responders in dangerous missions. With an excessive-stress water cannon and powerful all-terrain treads, it is able to assist extinguish fires, clean away debris, and evacuate sufferers. [3]

Disaster as like the Fukushima nuclear coincidence, truly confirmed that the skills of disaster response robots have been now not enough at all for offering the wanted guide to rescue workers. For handling this type of moment some creators create a robot which is a Human-robot symbiotic machine wherein a human operator is telepresent with its entire body in a Centaur-like robotic, that's able to robust locomotion and dexterous manipulation within the difficult terrain and austere situations characteristic of screw ups. [4]

After studying about those robots we have found some points which are very important for a rescue robot. Those points will be very important for our proposed robot. Also we have found some issues which need to be handled in our proposed robot model. As we plan for a ground rescue robot some of those robot working processes will be a key point for our robot. Considering the overall thing, we've decided that we are able to make multi legged rescue robots. For this we determined we are able to make a hexapod robot a good way to have 6 lage and the shape of this robot will be like a spider. We are essentially making this type of robotic for better performance in a complex environment.

CHAPTER 3

Background Study

The biggest challenge for rescue robots is knowing about the environment at the crash site.Because every accident is different, there is a big difference between the two.So guessing about the environment in advance becomes a lot more challenging and this is more complicated in the case of walking robots.Because the ground at the accident site is never flat and smooth.There can be a variety of obstacles starting from the hole which is a big challenge for a walking robot to deal with.The second and most important thing is the power supply of the robot,and it is not possible to supply power from any source other than batteries.So managing the power problem for 24 hours is a big challenge.So only after working in a real environment can one know about the limitations and requirements of a rescue robot.

3.1 why we need rescue robot:

The death toll from natural disasters and building collapses in the last few decades has been around 14,000.This number has almost tripled in the last ten years.Government and non-government organizations spend a lot of time and money on reducing and repairing these accidents.Many people lost their lives due to the traditional style of rescue work,Because where every second is valuable, rescue work is carried out only on the basis of conjecture with a great deal of time.Spiro can make this slow rescue more dynamic.This robot is capable of working 24 hours continuously.It uses all the existing features to quickly identify and rescue accident victims.

3.2 The value of better rescue robot:

The faster the rescue operation, the lower the death toll,And the fastest rescue robot is needed to speed up this rescue, Which can easily penetrate inaccessible environments and give an idea about the surrounding environment.And be able to reach people who are stuck in the shortest time.

3.3 Concluding Thoughts on Search and Rescue Robots:

Not only rescue work, Spiro is able to help government and private development in risky work and in many other ways.It is possible to use robots as the opposite of army and police members in risky tasks ,By doing so, it is possible to reduce their risk of death.In addition to this, it is possible for robots to perform risky tasks such as finding criminals and defending bombs.and as a rescue robot spiro is Able to play an important role in these risky jobs.

CHAPTER 4

Methodology

4.1 Hardware Design in Robot:

In our hexapod robot we use a lot of components. We used nrf24 Radio Module to create communication between robot and controller. With the help of nrf24 Radio Module we can also control the robot from a distance of 600 meters.

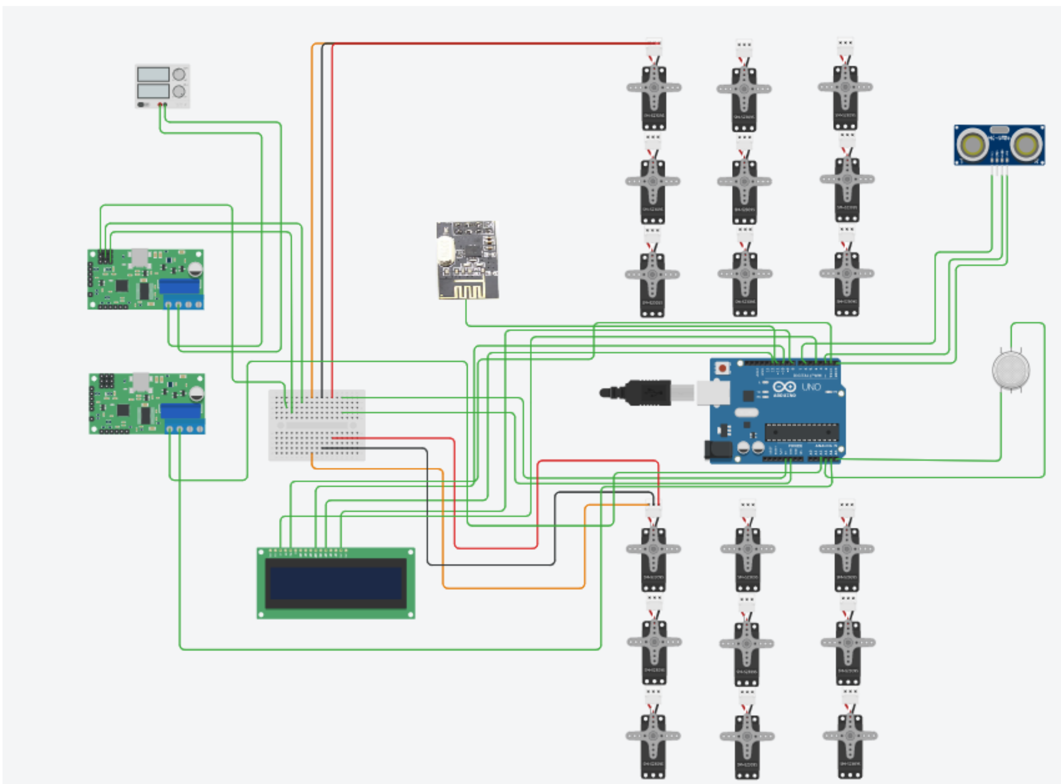


Figure 4.1: Hardware Design of SPIRO

In our robot we use 18 servos for the total 18 moving points of our robot. We used mg996r servo for better performance. To control those servos we used two 16 channel servo controllers which are also known as PCA9685. We create a parallel connection between those controllers because we have to move 18 servos and a single PCA9685 controller can control 16 servos that's why we used 2 PCA9685 controllers. We used an Arduino UNO REV3 as a main microcontroller. The nrf24 Radio Module and servo controllers are connected with this Arduino UNO REV3. Using Arduino UNO REV3 we easily get 32 KB (ATmega328P) Flash Memory and it's enough for our work. To give power to this Arduino

UNO REV3 we used a Lm2596 Dc To Dc Step Down Converter. Because we used a 12V, 20A DC Power Supply (SMPS). This 12V, 20A DC Power Supply (SMPS) is enough to give power to all the components in the robot. But since the Arduino UNO REV3 needs 9v as input we convert the 12v power to 9v using that Lm2596 Dc To Dc Step Down Converter. Using this Lm2596 Dc To Dc Step Down Converter the input power of Arduino UNO REV3 will be always stable. As we used 18 mg996r servo we need extra power for the controllers to run those servos. The mg996r servos need +5V as input power.

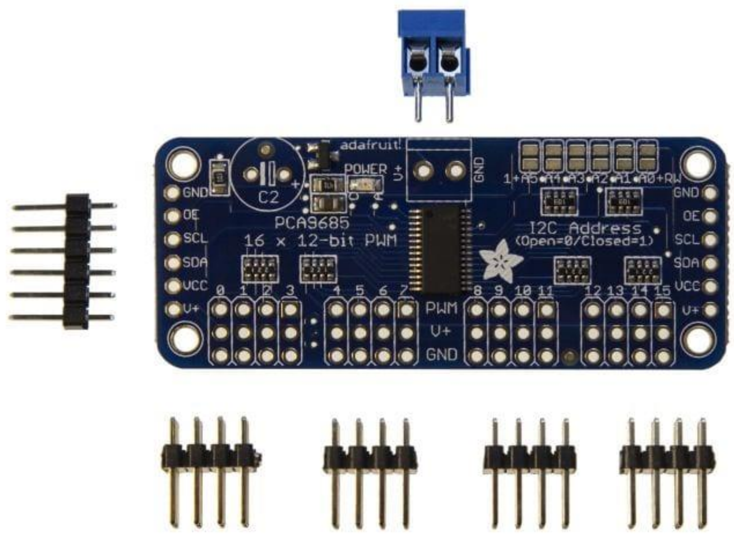


Figure 4.2: PCA9685 controller

But our PCA9685 controller can handle less than 10v as input voltage so we used Hobbywing 2-3S External 8A MAX 15A UBEC Switch Mode using this UBEC we can give 6v 15A input to those 2 PCA9685 controllers. And after using Hobbywing 2-3S External 8A MAX 15A UBEC Switch Mode our 18 servo easily gets enough power to run. To see the output power of Hobbywing 2-3S External 8A MAX 15A UBEC we used a single Digital VoltMeter LED 3 Digit Display. When the UBEC and Step Down Converter run and they get loaded they become overheated to keep them cool we use a single 5v DC cooling fan.

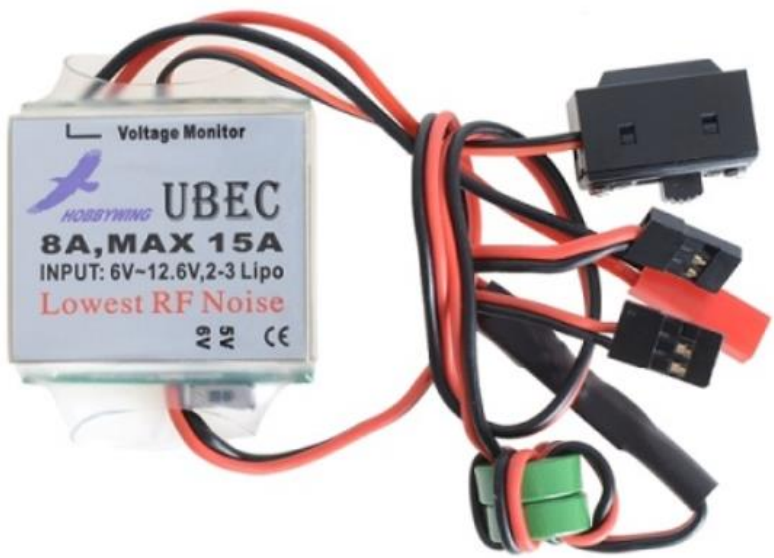


Figure 4.3: 2-3S External MAX 15A UBEC

As a Distance sensor we used Ultrasonic Distance Sensor (HC-SR04). Using this sensor we can measure the distance of any obstacle and with the help of this sensor robot can overcome the obstacle. MQ-4 Natural Gas Sensor used in our robot for detecting Gas of the environment.

4.2 Hardware Design in Remote:

In our remot we try to make it as simple as possible. That's why we kept very few things in our remote.

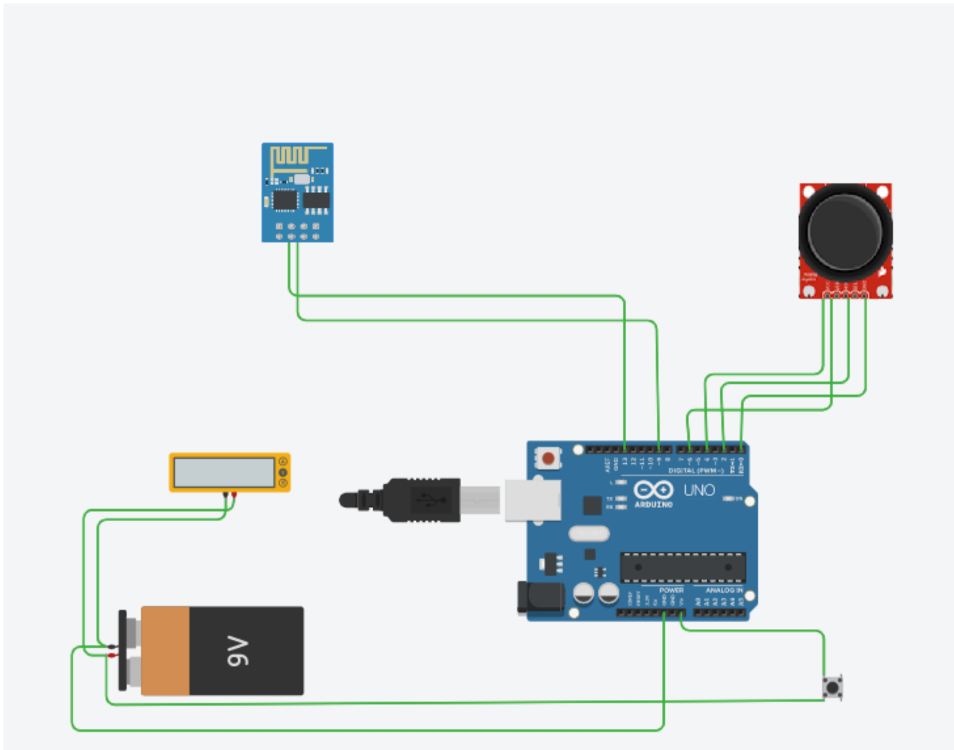


Figure 4.4: Remote Hardware Design

In our Remote we also used nrf24 Radio Module. With this nrf24 Radio Module we can send commands to our robot from the remote location. The nrf24 Radio Module is enough to maintain communication between the robot and remote. This nrf24 specially superior immoderate-strength and immoderate sensitivity wi-fi module 2.4G ISM band NRF24L01P + PA + LNA wi-fi module to work within the license-unfastened band that can be used in component-to-thing programs or be composed of a star network. This nrf24 Radio Module uses voltage: 3-3.6V for run and with this stable power this nrf24 Radio Module can send max output power: +20 dBm data. The nrf24 Radio Module Receiver sensitivity -92dBm in 2Mbps mode, -95dBm in 1Mbps mode, -104dBm in 250kbps mode and this is enough for our robot and our remote. So we can send strong signals to our robot from our remote.

Figure 4.5: NRF24L01 Wireless Module With Antenna

In our robot we use Joystick Module 2-axis to get directional commands for our robot. This 2-axis joystick module has 10k potentiometers which control 2D movement by generating analog signals. Using those signals we can calculate the pointed direction and after getting those pointed directions we can send a direction command to our robot. To make them work together we used a single Arduino UNO REV3. To power up all those components we used a 12v lipo battery. But Arduino UNO REV3 and other components can't handle more than 9v that's why we used a Lm2596 Dc To Dc Step Down Converter. Using this converter we convert that 12v power to 9v power. And for seeing the output power of that Lm2596 Dc To Dc Step Down Converter we used a Digital VoltMeter LED 3 Digit Display. And after all of that we also add a power button in our remote.

4.3 Hardware Overview:

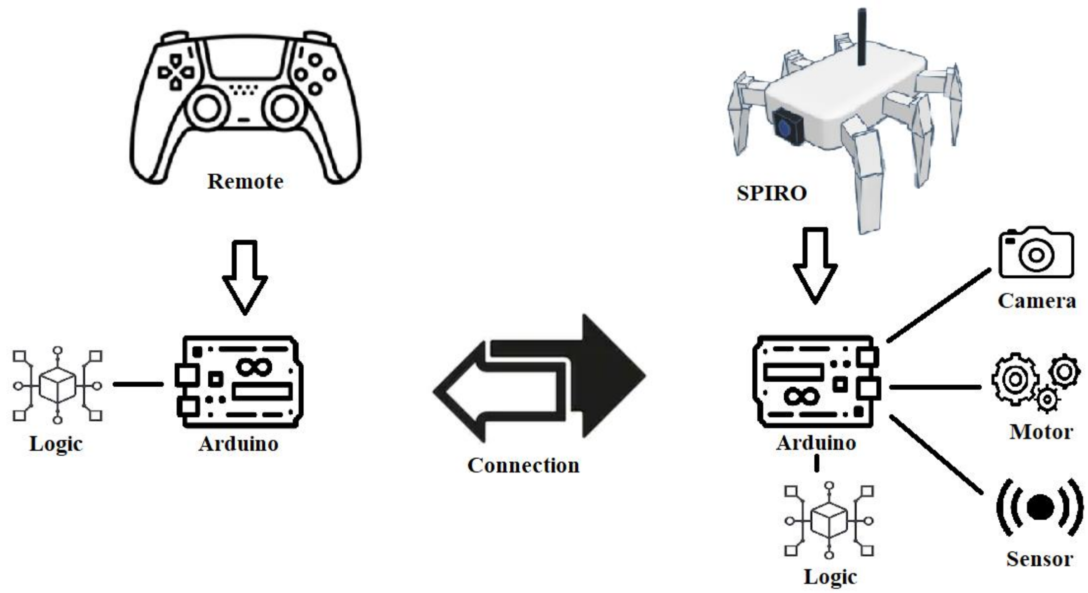


Figure 4.6: Hardware Overview of SPIRO and Remote

4.4 Software Design:

As our robot will be a rescue robot so we need dynamic layer software. We planned that in our software there will be an option which will show us robot current location. Since our robot will stream live video with the camera, our software will have the ability to watch that live-stream video. Not only that, our software also can detect more than 80 types of objects including humans and also track any human movement in real time video.

How It Works:

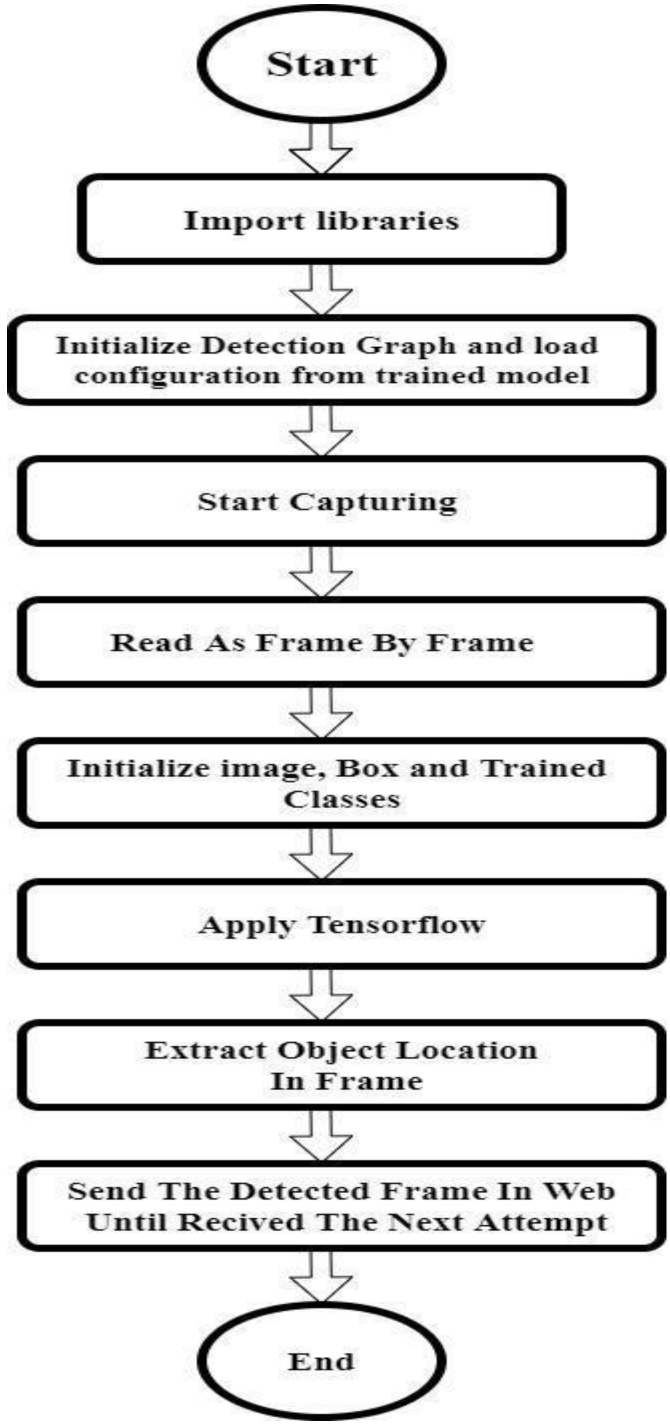


Figure 4.7: Software Working Procedure

To deploy our software we select Flask. It's a web framework for python. Using this we can build our system as a web application. Using Flask we can attach our detection API in our web application. We use IP webcam for live streaming video , in our application we can easily get that live stream using an IP address of our IP webcam. In our application we add some functionality to control the camera Contrast and Exposure. With the help of this function dedicated button we can control Contrast and Exposure of live streaming video. Also we add camera ON/OFF and object detection ON/OFF button for controlling the application more easily.

4.5 Project Detection Experiment Result

We test object detection model and get those output.

Figure 4.8: Person Detection-1

Figure 4.9: Person Detection-2

Figure 4.10: Person Detection-3

CHAPTER 5

Developing Process

5.1 Planed 3D model:

Before making the robot we create a 3D model for our robot. And in this 3D model we planned what our robot would look like.

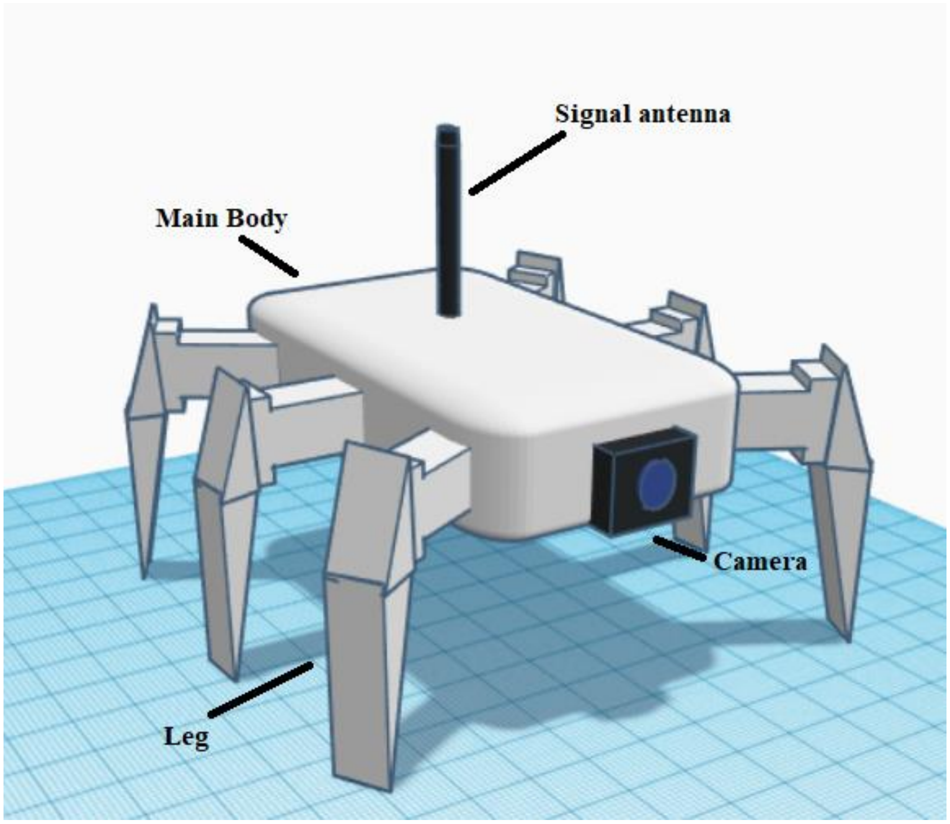


Figure 5.1: Planned 3D model

As we planned our robot will look like a spider that's what we designed our robot as spider hexapod. As the primary plane we add 6 legs in this model and a single camera and also a signal antenna for communication with the base receiver.

5.2 Demo Robot:

Before moving on to the final project, we plan to create a demo project. Because we wanted to understand how it would be better to build our final robot. That’s why we create a demo robot.

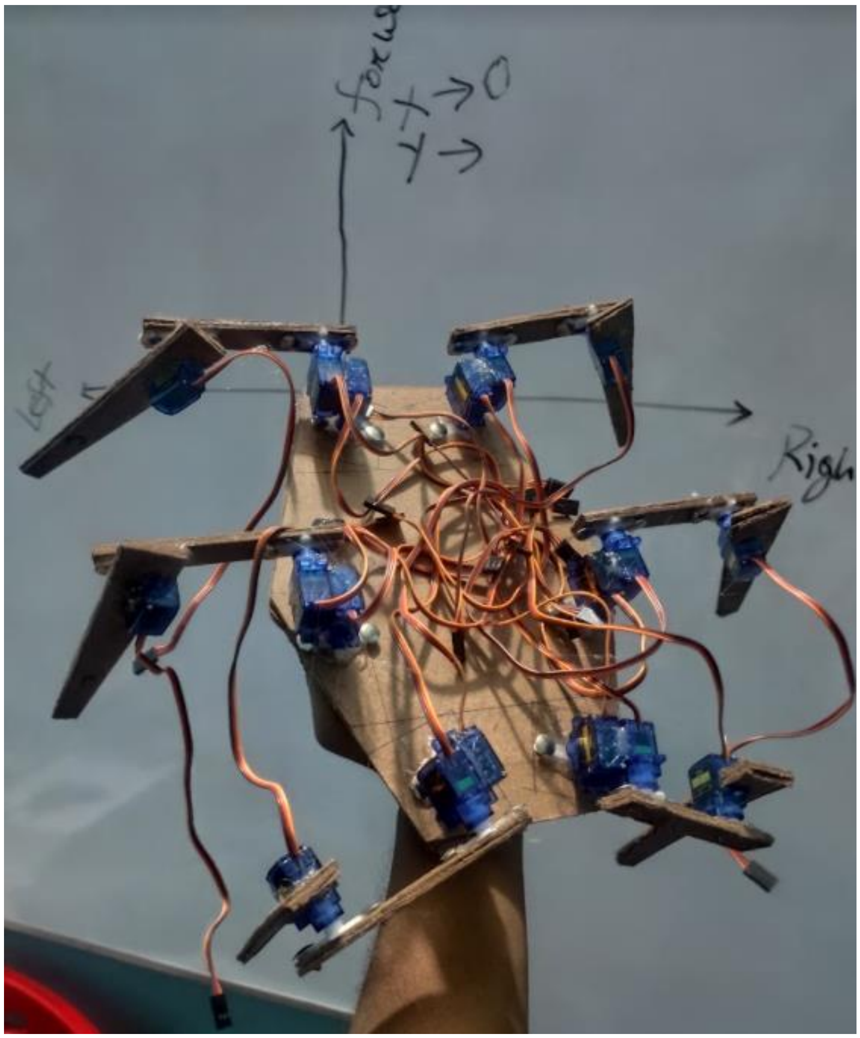


Figure 5.2: Demo model phase-1

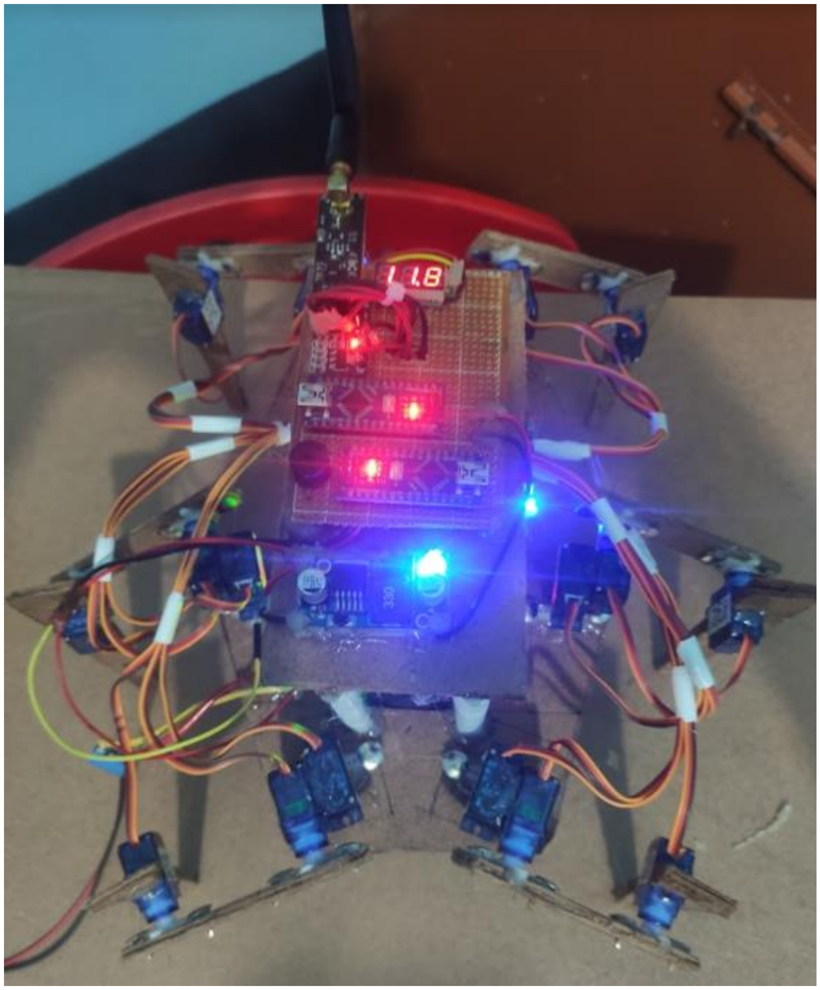


Figure 5.3: Demo model phase-2

5.3 Final Robot:

After completing our demo robot now we moved to create our final robot process. And this time we used a 3D printed plastic body. And using this type of body our robot becomes very lightweight and strong enough to move flexibly.

Table 5.1: 3D Printed Body Parts

Name	Quantity
Body Bottom Plate	1
Body Risers	6
Body Top Plate	1
Femur Bracket End Caps	12
Femur Brackets	12
Servo Bearing Centers	18
Tibia Base Plates	6
Tibia Bracket End Caps	6
Tibia Brackets	6
Tibia Foot Plates	6
Tibia Sides 1	6
Tibia Sides 2	6
Tibia Spacer Tubes	6
Receiver Holder	1
SBEC Holder	1
Servo Mounts	18
Wire Guides	6

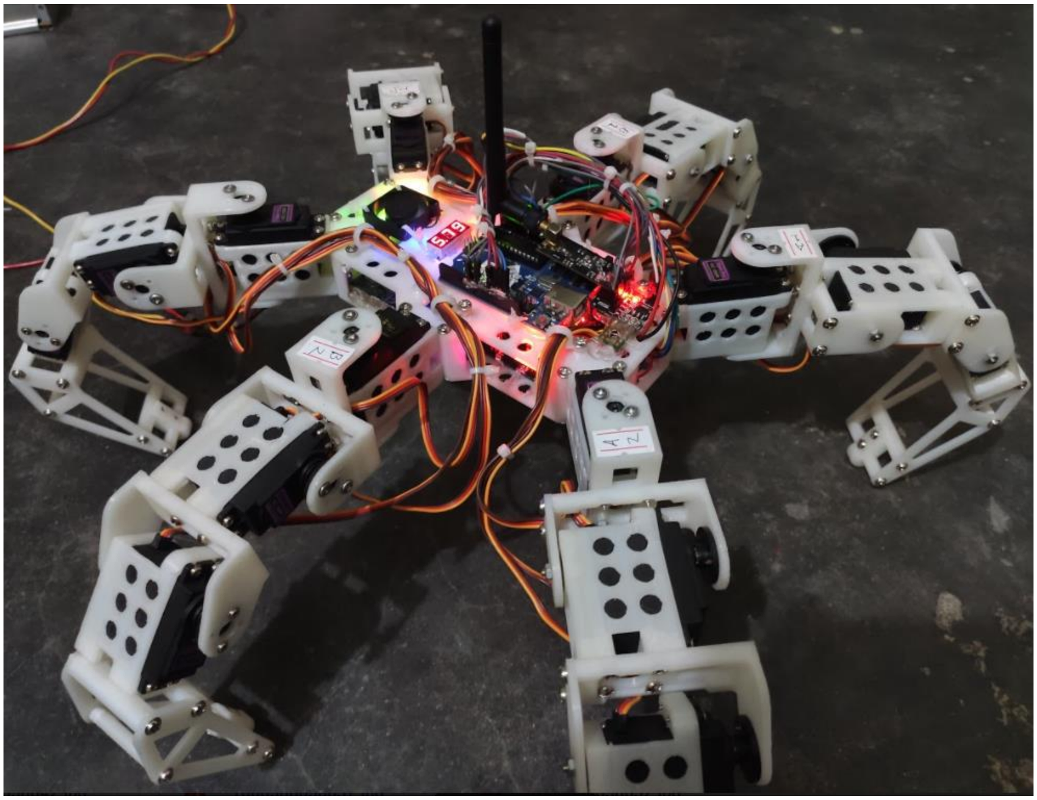
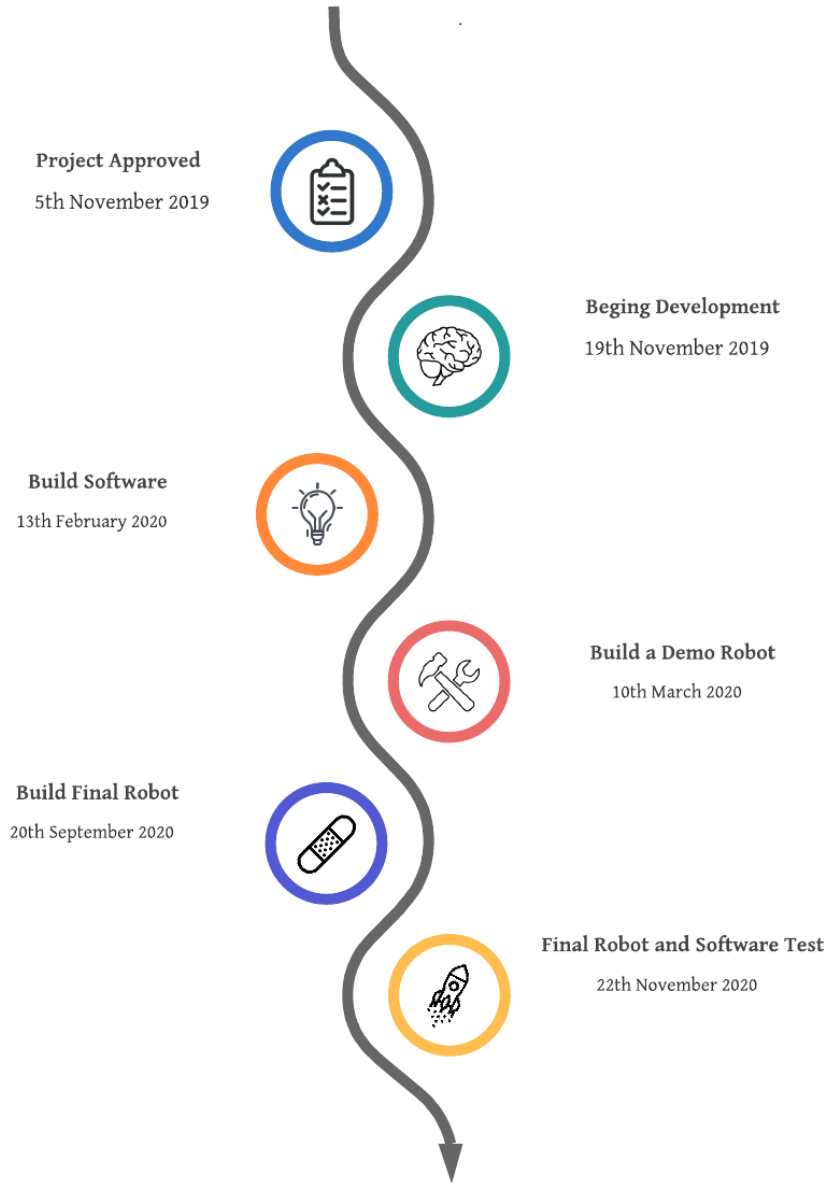


Figure 5.4: Final model

APPENDIX : Project TimeLine

Process :



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