Hexapod Based Automated System for Disaster Management

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***Abstract*— This paper proposes a survivor robot model inspired by the physique of a spider which can be used in the cases of search and rescue operations. The navigation of the hexapod has been implemented based on a six-leg system, which will be very convenient in rough terrains. Each of the legs has been designed using three servo motors controlling the limbs from different joints. It can detect life the number of people present and sense the environment. A prototype has been developed for experimental purpose. This paper focuses on aiding and assisting the affected people and the rescuer team to get to trapped people in buildings. We have here a robot which can be easily installed and produced and is efficient.**

Keywords*— *Hexapod, Servo Motor.

I. INTRODUCTION

Smart robots play a significant role in such missions, including search for life under earthquake hit buildings, searching for people in a building on fire and many other situations. We have selected Hexapod robot. We are focusing on how to navigate the robot and help the people in disasters. A hexapod robot is a mechanical vehicle that walks on six legs. Since a robot can be statically stable on three or more legs, a hexapod robot has a great deal of flexibility in how it can move. If legs become disabled, the robot may still be able to walk. Many hexapod robots are biologically inspired by Hexapod a locomotion. Hexapods may be used to test biological theories about insect locomotion, motor control, and neurobiology.

Hexapods are also superior to wheeled robots because wheeled robots need a continuous, even and most often a pre-constructed path. Hexapod robots however can traverse uneven ground, step over obstacles and choose footholds to maximize stability and traction. Having moveable legs allows hexapods to turn around on the spot. In comparison to other multi-legged robots, hexapods have a higher degree of stability as there are can be up to 5 legs in contact with the ground during walking. Also, the robots centre of mass stays consistently within the tripod created by the leg movements, which also gives great stability. Hexapods also show robustness, because leg faults or loss can be managed by changing the walking mechanism. This redundancy of legs also makes it possible to use one or more legs as hands to perform dexterous tasks. Because of all of these benefits, hexapod robots are becoming more and more common, and it will be interesting to see what modifications robot cists come up with to further improve and develop their form and function. Unpredictable occurrences like natural disasters, terrorist attacks may cause damage to the building structures and many lives may be trapped inside who may need assistance from outside. It will take a long time to send human assistance. So sending robots to the affected area might be a good solution. But in order to do that, wheeled based rescue robots will face difficulties moving in those irregular surface and obstacle-rich area. So a flexible six-legged robot will be more effective on these challenging situations.

Six-legged robots can be used as search and rescue robots, space robots and discover robots. In these fields, hexapod robots present opportunities as having small size and practical mobility. When viewed from this perspective, six-legged walking robot can be easily scroll by produced algorithms in all types of terrain is an advantage. The acceptable number of legs and the ability to move provide more controlled balance to the robot when compared to the majority of multi-legged robots.

II. METHODOLOGY

We have focused on two scenarios the robot will first identify the hazard either earthquake or fire using different sensors. When the robot has identify the hazard it will detect number of people stuck or need help using camera or ultrasonic sensors. Robot will be able to communicate with the rescuers and provide major information about the disaster like number of people stuck, where are they located and how are the conditions.

Robot can be controlled manually this helps the rescuers as hexapod can go in places where humans are not able to and find a better way to reach the people stuck. This helps in coming up with a rescue plan and even executing it quickly. The faster we executing the plan more chances to saving lives.

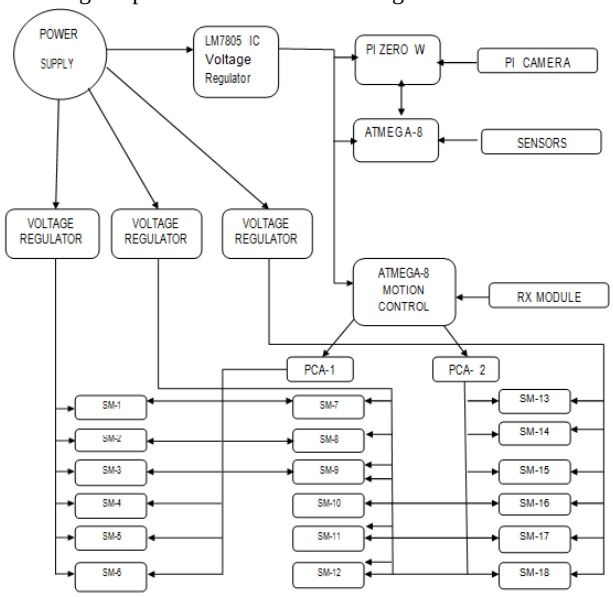

Fig. 1. Block Diagram Of Hexapod

This block diagram represents the structure of the hexapod.

- Power supply- The voltage regulators are being supplied by this power supply.
- Voltage regulators – These voltage regulators regulate the voltage to 5v and a maximum current output of 3Amps. This regulated voltage is used to supply the microcontrollers, the raspberry pi 3B, the motor drivers and the servo motors.There are 3 voltage regulators, each connected to give power supply to 6 servo motors.
- Raspberry pi zero w- Raspberry pi is used here for image processing and updating the sensor values on a html page.
- Atmega-8A – We are using two atmegas here. One atmega is used to update the sensor values to the pi.The second atmega is used for motion control .It has a receiver module attached to it which is receiving data from the tx module connected to the wireless remote control. Also this atmega has two PCA boards attached to it which controls the servo motors on the hexapod.
- PCA Board- There are 2 PCA boards connected to the atmega . Each PCA board gives logic to 9 servo motors. Therefore we use 2 PCA boards for 18 servomotors.
- Servo motors – There are 18 servo motors , 3 for each leg which gives each leg 3 degrees of freedom(DOF).These 18 servo motors are labeled SM1 ,SM2
- Raspberry Pi Camera v2- A pi camera module is connected to the raspberry pi for image processing for human detection
- Sensor-The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output thevalues of temperature and humidity as serial data. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%.

III. RESULTS

Temperature and Humidity sensor values are read from arduino and these data are sent to raspberry pi's terminal through i2c connection. These sensors could have been directly connected to pi but they draw more current and camera which is connected to pi wouldn't get enough current. Connection could be done through serial and through usb

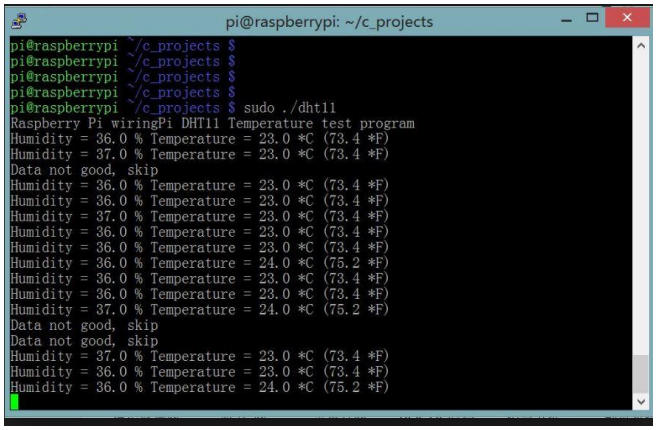

Fig: 2 DHT11 sensor values from Raspberry pi

Camera take pictures to live streaming on raspberry pi terminal. It detects the number of people and even sends a mail of the live streamed video. It sends frame 1ms so it's a bit late which can be improved by webcam but due to cost issue pi cam v2 is used.

Fig: 24 Camera detecting humans

IV. Conclusion

In this paper we have proposed a search and rescue robot that would be efficient in crawling through narrow holes and spaces over rough and unfriendly terrains. The walking algorithms used in the robot have been field tested properly and has an average rate of efficiency when compared to other such robots in related fields. To control the hexapod we have successfully made use of ps2 controller and have implemented this through radio frequency module and is also automated with the help of ultrasonic sensor. In many accidents that need inspection of the ground, and in cases where it is impossible for a human being to properly look for any evidence that might help to save lives, the hexapod can come in handy, and the functional algorithms implemented would be quite efficient in helping the robot move under extreme conditions. The robot has worked tremendously and can display gas and temperature value in ppm and degree Celsius and can also send a mail of live streaming video. It is hoped that small amount of modification to our proposed system will transform it into a fully functional and ready-to-use robot in real life scenario.

V. Future Scope

Our robot is able to walk through rough and irregular surface which open up several window of opportunities. In the future, robot can be functioned in such a way that it will have the ability to climbing walls or gliding down to destination so that, it can be deployed to the disaster area from air support as helicopters or planes. Moreover, if the size can be minimized, it can be used as a spy robot which will help to stop terrorism acts. A better version of camera would give a better quality of image and a voice module of higher range would help in detecting the affected people when camera would go off or dies. A bulb or IR module can be used to detect people in dark condition but all of this should be done keeping the weight and power consumption of the hexapod in consideration.

VI. Applications

- Hexapod robots have a large number of real life applications, from crossing potentially dangerous terrain to carrying out search and rescue operations in hazardous and unpredictable disaster zones.

- Wheeled robots are faster on level ground than legged robots, hexapods are the fastest of the legged robots, as they have the optimum number of legs for walking speed.

- Hexapods are also superior to wheeled robots because wheeled robots need a continuous, even and most often a pre-constructed path. Hexapod robots however can traverse uneven ground, step over obstacles and choose footholds to maximize stability and traction.

- Having maneuverable legs allows hexapods to turn around on the spot. In comparison to other multi- legged robots, hexapods have a higher degree of stability as there are can be up to 5 legs in contact with the ground during walking.

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