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Design & Development of vision controlled snake robot

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Abstract : *A snake is the only reptile which has the ability to conquer harsh terrains like rock and sand with apparent ease. This project highlights the design, development and testing of a snake-like robot prototype. The snake robot offers high stability than any other wheeled devices. It simulates the serpentine motion of a snake and is controlled by the keyfob transmitter and receiver. The motion commands to snake robot are delivered by four button remote control. The brain of the snake robot is an Arduino microcontroller board which has a wireless camera connected with the board which is placed in the front head portion of the snake and therefore it possesses the ability to map and navigate in its surroundings and also to find the possibility of human life. The applications of these kinds of robots are mainly in space exploration, disaster management, surveillance, etc.*

Keywords – *Arduino Mega, GPS module, remote control, serpentine motion, Wi-Fi camera.*

I. INTRODUCTION

The Scientific innovations in modern times have been helping the mankind to explore the new technologies and achieve the avenues beyond our imagination from simple tools to advanced spaceships, satellites. With ever growing innovations & inventions man has achieved more in small duration of time. There are common items such as pen to advanced computerized technology which has helped humans to achieve beyond the human capabilities. The project tries to mimic a snake and to take inspiration of their body shape and their neuronal control mechanism to develop novel type of robot. Robotics is the branch which combines mechanical engineering, electrical engineering and computer science to deal with the implementation, construction, and application of robots, as well as computer systems [3]. A snake robot is significantly different from a wheeled robots because of the ability to be more mobile with high redundancy. The multi-joint flexible structure design gives the snake robot an advantage of a multi-gait motion and also provides the ability to adapt a complex environment and can be widely used in disaster rescue, underwater survey, industrial testing and other special environments that traditional robots or humans cannot enter and hence there is an increasing attention is development of the snake robots [8]. The snake robot's advanced navigation and positioning is the key feature of the autonomous movement in complex environments. In the present time the most research is related to the snake robot's structure, the movement gait and the gait control method [5].

II. LITERATURE REVIEW

We have searched and read different papers from Google and other sources and also we have referred other conference papers to gather more information which would help us in designing and developing our project.

Table.1

Sr.no	Title	Authors	Methodology
1	Modelling and simulation of a wheel - less snake robot.	Yesim.A.Baysal, Ismail.H.Altas	In this paper, kinematic and modelling of a wheel-less snake robot that has more potential for adapting to the environment is implemented in Matlab and effect of friction between its bodies with the ground, which plays a highly important role in snake robot locomotion. The snake robot can move faster in environments which has more friction according to the simulation results. The friction property is used to achieve forward locomotion. Passive wheels are usually used to imitate the friction property while in the equation motion of the robot, nonholonomic constraints are used. The snake robot simulator is obtained using the dynamic model of the snake robot and a simple PD controller is used to follow the reference trajectories generated. Lateral undulation from these motions is the most common gait seen in most biological snakes and it is developed by modelling the snake body as a continuous curve known as serpenoid curve. In Matlab, by applying the reference trajectories to the modelled snake robot, the velocity of the CM, the forward velocity and the CM positions of the snake robot are obtained.
2	Perception Driven obstacle-aided locomotion for snake robots: The state of art, challenges and possibilities	F.Sanfilippo, J.Azpiazu, G.Marafioti, A.A.Transeth, O.Stavdahl, P.Liljebäck	In this paper, the state of art, challenges and possibilities of the snake robots are presented. The different levels of anatomy such as environmental complexity, mission complexity and external system dependence. The snake robot is designed as an unmanned ground vehicle systems with the aim to achieve perception-driven obstacle –aided locomotion by using the ALFUS framework. The proximity sensors are used for the obstacle avoidance purpose and the LiDAR sensor is used to provide dense information about the environment. The ToF camera provides direct 3D measurements. The laser triangulation provides high accuracy measurements and the radar is used to sense through obstacles.
3	Arduino based snake robot.	Prof.S.S.Punde, Ahire Megha, Bhamare Ajit, Patil Prathamesh	In this paper, an overall design of a robot is developed inspired from the biological snake. The snake robot consists of a RF trans receiver, arduino board, DC motors, wireless camera, IR sensors and the battery as power supply i.e. overall mechanism of the snake robot. The wireless camera is working on 9 volt separate battery. Each link includes pair of wheels and also the joint. This type of snake robot is flexible in all types of structure and also in operation. The control of locomotion of the robot is also eased due to its wireless connections.
4	Dynamic analysis of the three snake robot gaits.	R. Ariizumi, F. Matsuno	In this paper, a dynamic analysis is presented by comparing three snake like robot gaits which are lateral undulation, sidewinding locomotion and sinus-lifting motion. Sinus-lifting motion is the commonly snake gait for when a snake is moving at high speed. The snake robot makes contact with the ground at two or three points in sidewinding locomotion. If the speed of the snake robot is lower than that critical value, lateral undulation is more energy efficient than sidewinding locomotion. If the overall friction is relatively large, the sinus-lifting motion is more efficient than sidewinding locomotion. Simulation results show there are speed energy efficiency tradeoffs in both sidewinding locomotion and sinus-lifting motion gaits.

5	Modular snake robot with mapping and navigation: Urban Search And Rescue (USAR) robot	Pramod Chavan, M. Murugan, E.V.Vikas Unnikkannan, Abhinavkumar Singh, Pallavi Phadatare	In this paper, a hyper redundant snake robot is developed which possesses the ability to map and navigate in its surroundings and also find the possibility of the human life. The robot consists of the ultrasonic sensors, PIR sensors and a ZigBee module is used to send real time data from the sensors to the user. The ARM 7 processor (LPC2138) is used to which the sensors and the servo motors are connected. The servo motors are used to provide degrees of freedom to move the snake according to the user requirement. The readings are taken using graphical user interface designed in visual basic.

III. METHODOLOGY

An overall design of a robot is developed inspired from the biological snake. It consists of Arduino Mega board which acts as the brain of the snake robot as it gives the command functions, dual shaft servo motors which are used for the movement purpose where each dual shaft servo motor is attached to a C bracket using nuts and bolts and then attached to a wheel set below the C bracket with a wire clip on top of the servo. Two long brackets are attached with each other to hold the Arduino board and the battery which acts as a head and tail of snake robot. An ESP 32 Wi-Fi camera is used as the eye of the snake robot for obtaining the live stream of whatever the snake robot is able to see. A remote control which acts as a transmitter and the receiver is connected to the arduino board which controls the movement of the snake robot. The NEO-6M GPS module is used to receive the longitude and the latitude of the positions of the snake robot in order to track the robot based on its location. The servo motors work on the principle of degrees of freedom in order to move forward, backward, left or right.

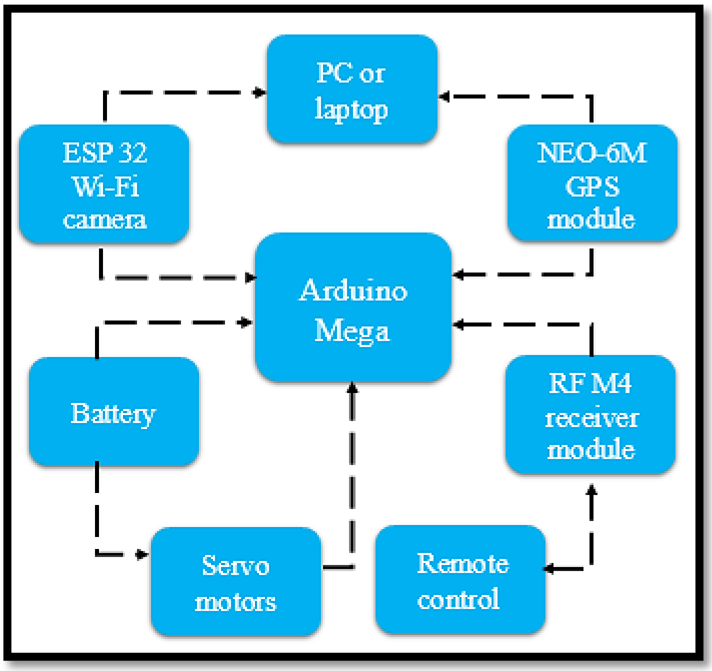

fig.1

The block diagram shown in "Fig. 1" of the snake robot consists of ESP 32 Wi-Fi camera which is used to provide the live stream of the snake robot, NEO-6M GPS module which is used to provide the longitude and latitude to find the location of the snake robot, RF M4 receiver module which is used to connect with the remote control to control the movement of the snake robot, battery which is used to provide power to the servo motors and the arduino board, servo motors which is used to move the snake robot in forward, backward, left and right direction and the PC and mobile application is used for monitoring live stream and controlling the movements of the snake robot respectively.

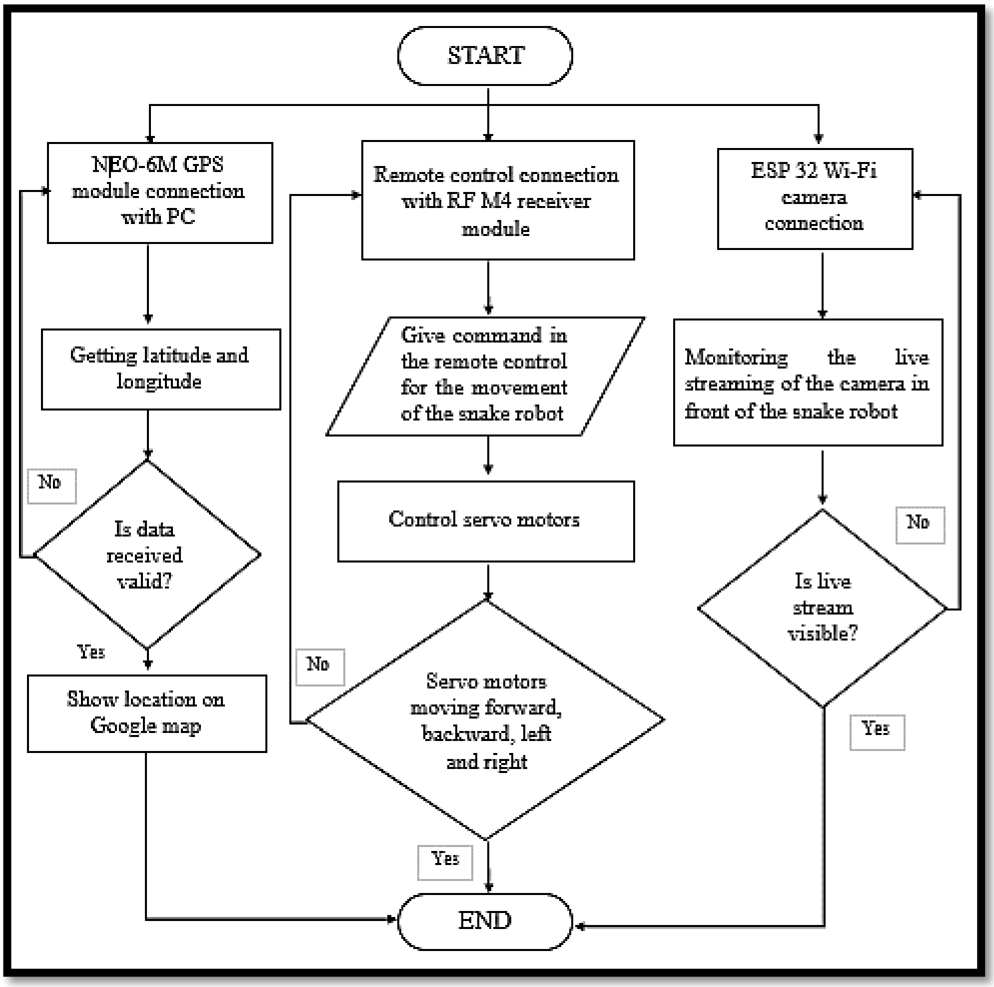

fig.2

The starting process of snake robot is described by the flowchart in the "Fig.2" where firstly the NEO-6M GPS module, the ESP 32 Wi-Fi camera is connected with the PC and RF M4 receiver module is connected with the arduino. After the connection, the GPS module sends the latitude and the longitude to the user and if the data i.e. longitude and latitude is valid then the location is shown on the Google map or else the data is received again by the GPS module. Similarly using the remote control, commands for the movements of snake robot are given to the servo motors to move the snake robot forward, backward, left and right and if the movements are not performed commands are given again using the remote control.

IV. RESULTS

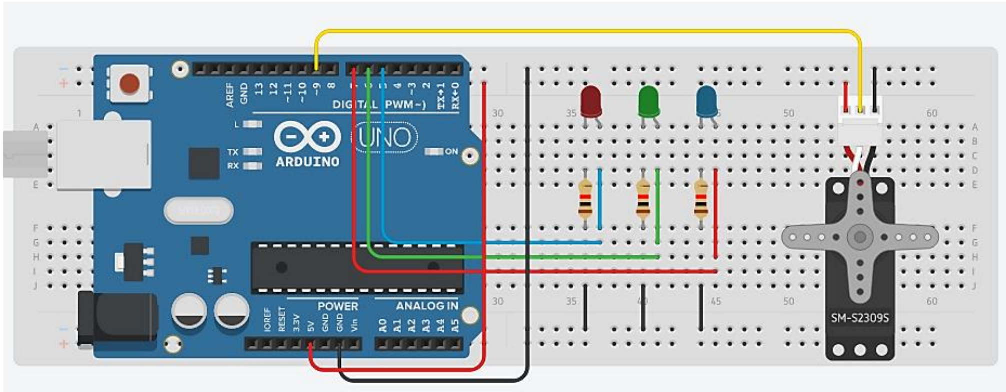

fig.3

When angle is less than 90 degrees, then the servo motor moves in left direction as shown in “Fig.4”.

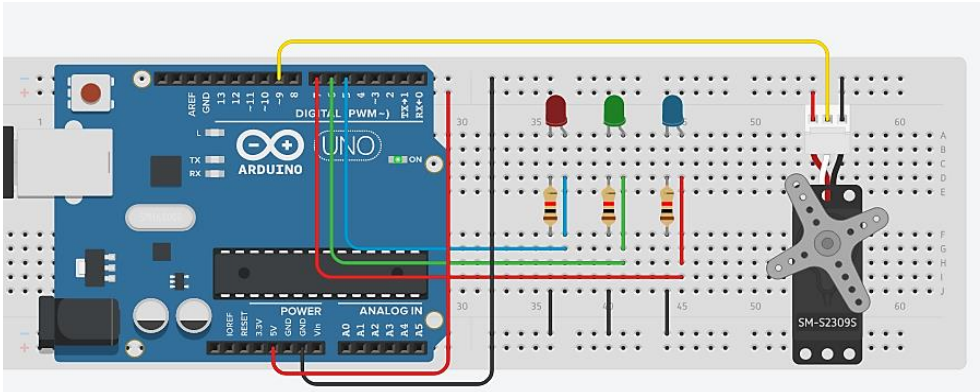

fig.4

When angle is more than 90 degrees, then the servo motor moves in right direction as shown in “Fig.5”.

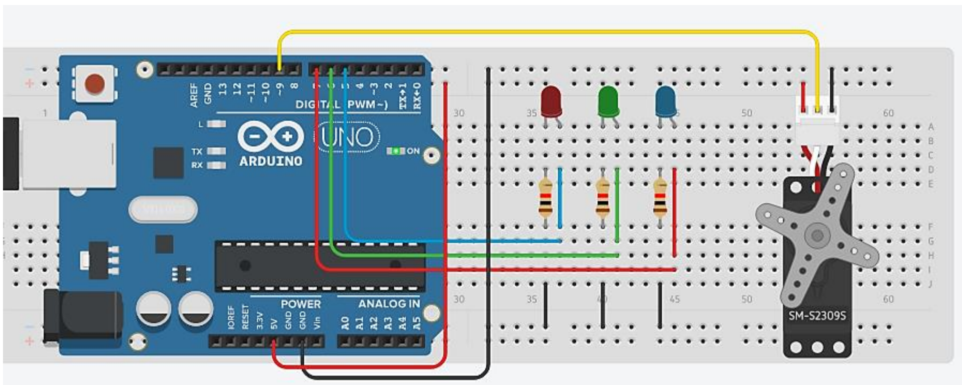

fig.5

The red led represent the remote control i.e. when led is on remote control is connected. Similarly, the blue led represent the GPS connection and the green led represent the camera connection. We expect the servo motors to move as shown in the above figures for the movement of the robot.

V. CONCLUSION

In this paper, an overall design of a biological inspired snake robotic implementation has been described. This snake robot is dynamic and a helpful tool for the rescue operations in the clustered areas. This snake robot can also be used in other fields like, fire fighting, surveillance and maintenance of complex and possibly dangerous structures or systems such as nuclear plants or pipelines, research activities, education, military, disaster management. In future, the snake robots can be equipped with advanced sonar technologies to detect landmines for military purpose. Further innovations can be made to improve the power efficiency of the snake robots for longer use. Similarly high precision navigation system can be implemented in snake robots for getting accurate co-ordinates in order to locate the snake robot precisely and faster.

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