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DEVELOPMENT OF GESTURE CONTROLLED HEXAPOD USING WIRELESS TECHNOLOGY

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Abstract - *Modern robotics enables humans to explore things without human intervention. Robots may be used to perform tasks that are too dangerous or difficult for humans to implement directly. It isn't very often that a robot ends up beating nature at its own game evolution is a very intelligent designer, and roboticists are going up against a half billion years of trial and error. Robots can be used to perform tasks that are too dangerous and difficult for humans to implement directly. To save human effort, automation plays an important role in the system. This project mainly confers the theoretical and particularized design and development of a Hexapod Robot accompanying a minimum degree of freedom. Higher requirements are put forward for the adaptability of a robot in an unstructured environment with the progress of foot-type robot research in recent years. The hexapod system primarily consists of two parts, the receiver, and the transmitter. In the transmitter section, the motion of the human hand is perceived by the robot through the sensors and it follows them. The accelerometer moves according to the hand sensor displacer and transmits the signals to the receiver part and obtains the corresponding movement. It will allow the user to control the forward, backward, left, ward, and rightward mots while using the same accelerometer sensor to control the throttle of the hexapod. If legs become disabled, the robot may still be able to walk. The main advantage of this mechanism is the hexapod with this mechanism can take sharp turns without any difficulty. The principal theory which is used in the hexapod robot is elaborated, and the control system of the robot is designed, simulated, optimized, and developed.*

***Key Words*: HEXAPOD, ATOM ESP-32 Pico, GESTURE Control, GYROSCOPE, Accelerometer, LED Display, IMU Module**

1. INTRODUCTION

This "Development of Gesture Controlled Hexapod using Wireless technology" uses ATOM ESP32 Pico as the transmitter and ATOM LITE as the receiver. Compared to the methods of controlling robots by means of physical devices, the method of gesture control is becoming very popular in recent years. The gesture means movement of hand and gesture control means recognizing and interpreting these movements controlling a robotic system without any physical system. Hexapod robots are used where stability and flexibility are demanded. Robot mechanics are usually designed specifically for the applications and tasks they are assumed to perform. In manufacturing, manipulator's arms are the most commonly used as their main tasks are linked to assembly and handling. The legs will have two degrees of freedom each. The hexapod robot has redundant degrees of freedom due to its multiple joints whose control method defines the pace ensuring a balanced movement of the whole body. This robot will serve as a platform for basic surveillance purposes in industries. As the robot has six limbs, the robot can be easily programmed to configure many types of gaits. The purpose of the hexapod robot with the maneuverable wheel is to ease the movement either on the flat surface or on the inclined surface. The objective of this project is to develop a gesture-controlled robot. The components used are ATOM ESP32 Pico, ATOM LITE, accelerometer sensor and Gyroscope in IMU, Motor Driver PCA9685, and Servo motor SG90. Higher requirements are put forward for the adaptability of a robot in an unstructured environment with the progress of foot-type robot research in recent years.

1.1 Objective

The objective of this paper is to build a six-legged walking robot with the ability to crawl forward and backward is the goal of this research. Wherever stability and flexibility are required, hexapod robots are deployed. Robotics is one of the most cutting-edge and evolving fields of technology today. Three degrees of freedom will be available for each leg. This robot will act as a platform for simple industrial surveillance needs. The robot's six limbs make it simple to program to create a variety of gaits. The hexapod robot's movable wheel is designed to make moving easier, whether the surface is level or sloping. The robot will move on a flat surface using its steerable wheel, and it will climb using its legs on inclined terrain.

1.2 Motivation

A robot is used by military men to carry their loads. The other application entails travel to far-off locations where human interventions are exceedingly taxing. When traveling from one place to another, a military soldier must transport all of his belongings, including his weapons, food, and clothing. The traveler is free to move around, load his baggage onto the robot, and control it on his own. The hexapod can be made to operate at remote locations during cardiac operations. Da Vinci's creations of today's robots incorporate the same.

1.3 Applications

Da Vinci's creations of today's robots incorporate the same. Hexapods are primarily employed in astronomy to realign the secondary mirror with respect to the primary mirror in order to correct for mechanical deformations of the telescope structure brought on by variations in temperature and gravity throughout the course of the night. Hexapods with precise placement are especially well suited to the unique and rigorous requirements of synchrotrons. Component alignment for optics is made possible by the hexapods' precision and several degrees of freedom. Fieldbus interfaces allow modern hexapod controllers to communicate directly with a PLC or CNC controller. Hexapod robots can be both large enough to move a car body and small enough to place a probing head for a silicon wafer thanks to the adaptability of flight simulation systems.

2. LITERATURE SURVEY

Controlling a Hexapod using a depth camera proposed by Michal Tölgyessy, Peter Hubinský, Jozef Rodina [1]. The algorithm, which is described in this paper uses a library called nestk, which gives the programmer a chance to use both of the previously mentioned drivers. Hexapod has six legs, each having three joints, and consequently three servos. The upper firmware layer unravels orders from remote correspondence messages to the servo administration layer dealing with the more complicated strolling.

Design and Simulation of Casino Hexapod Robot proposed by Carbone, Yatsun, and Ceccarelli [2]. In this paper, the Casino Hexapod Robot is presented by discussing its design features and operational performance through simulation results. Assuming a couple of legs become crippled, the robot is as yet ready to walk. The automated leg has been made of economically accessible parts, which have been gathered into one spot to give the last type of the leg.

Proprioceptive Control of an Over-Actuated Hexapod Robot Developed by Marko Bjelonic, Navinda Kottege, and Philipp Beckerl from the University of Zurich [3]. The motion of wheeled robots is restricted by the outrageous landscape. For legged robots with in excess of six legs, the improvement turns out to be fundamentally more modest, and the equipment cost increments. Without explicit control calculations, an oscillatory way of behaving might happen during ground contact.

Simulation and GUI Control of a Hexapod Walking Robot A. Bouachari, A Haddad, L. Ghalem, A. Babouri from Abu Bekr Belkaid University [4]. Hexapod robots are considered more stable than quadrupled and bipedal robots. They coordinate six legs and comprise a mechatronic framework. A hexapod comprises six legs and legitimate development of the robot is conceivable by appropriately synchronizing.

3. Methodology

The hexapod body is 3D printed using Poly Lactic acid (PLA) plastic which is best suitable for robotic construction. The hexapod is designed in such a way that the dimension of the torso depends on the length and width of the ESP 32 microcontroller. Each of the six legs of the hexapods is provided with three joints with 180 degrees of rotation and two degrees of freedom. Each joint is incorporated with one servo motor SG90 9G. The servo motors are controlled by the PCA9685 motor driver which works in synchronization to establish the movement. The servo motors are provided with three wires, the ground, the VCC, and the PWM signal pins which are represented in brown, red, and orange respectively. These three wires of each servo motor are connected to the 16-channel PCA9685 motor driver which works in synchronization with the servo motors to establish the movement.

4. BLOCK DIAGRAM

The Hexapod robotic system block diagram is displayed in Figure 1 describing the transmission of the signal from the transmission and the receiver.

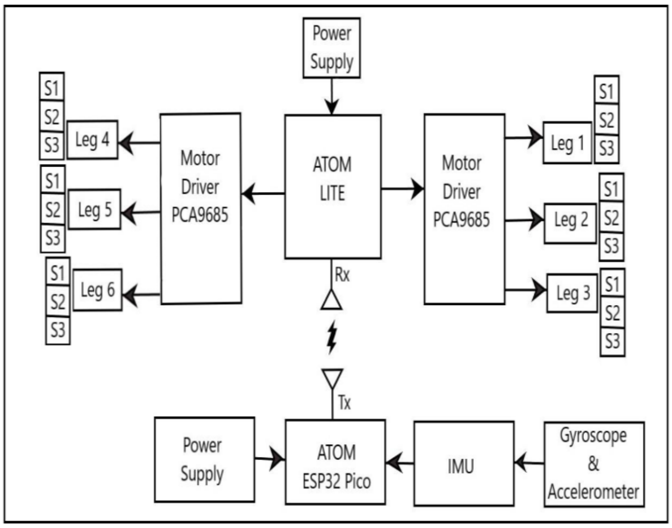

Figure 1 – Block diagram of the Hexapod robot

The hand part (Master) acts as the transmitter whereas the Hexapod robot (Slave) acts as the receiver. The hand glove consists of Atom ESP32 Pico which consists of an in-built Inertial Measurement Unit (IMU). The IMU consists of a Gyroscope that measures the angular movement and sends the signals to the Hexapod through the antenna. The

Hexapod body moves its legs corresponding to the signals received from the Hand glove. The instructions from the microcontroller will help to run the motors. There will be a wireless ATOM LITE transmission between a remote controller and robot. The ESP32 microcontroller forwards this signal to the motor driver IC which controls the server motors. The motor driver IC operates on the pulse width modulation principle and sends a signal to the servo motors. To achieve such, it relies on the functionality of Accelerometers, Gyroscopes. The Gyroscope and the Accelerometer in the IMU measure pitch and roll. Initially, the ESP32 Pico is connected to the battery and the legs are initialized to the standard working positions. The ESP32 microcontroller forwards this signal to the motor driver IC.

4.1 Hand Glove Block Diagram

The block diagram of the hand glove having the IMU interlinked to ESP 32 Pico and Antenna is represented in Figure 2. The ESP32 Pico is embedded in the hand glove. The IMU consists of an accelerometer that calculates and reports the exact direction of the body by measuring pitch and roll. The ESP32 Pico microcontroller is programmed and interfaced with Atom LITE using Wi-Fi technology and by initializing the ESP 32, Pico.

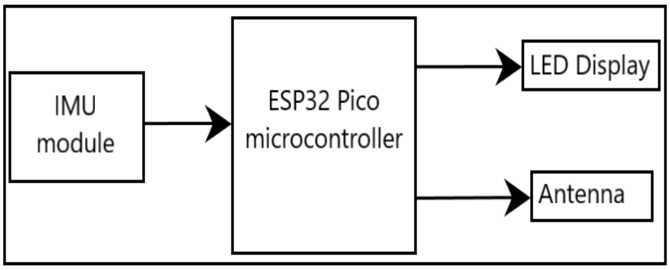

Figure 2 – Hand glove Block diagram

The control systems of recent hexapod robots are distributed hierarchical systems composed of a host computer, an onboard controller, and various actuators and sensors. The user will set the desired position and walking gait, which is the input for the trajectory generator. The trajectory generator sends the leg coordinates to the inverse kinematic model for each leg.

4.2 Hexapod Robot Block Diagram

An external antenna is added to the glove and Hexapod in addition to the Wi-Fi components present in the ESP32 and IMU is represented in Figure 3. The IMU module in the glove sends a signal to the ESP32 which is received by the ESP32 Wi-Fi component in the hexapod body based on the gesture of the glove which acts as input signals.

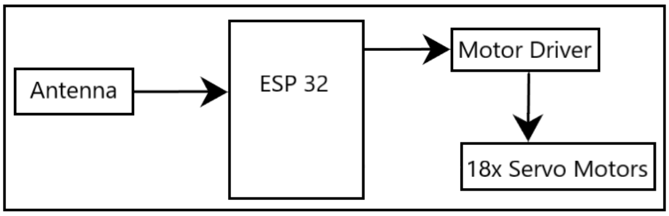

Figure 3 – Block diagram of the Hexapod robot

5. Flow Chart

The flow charts of the Hand glove and Hexapod robotic system are represented in the below figures. The hand glove flow chart depicts the initializes the IMU and gets the data and transmits the signals to Hexapod. Whereas the Hexapod receives the signals and adjusts the corresponding motors.

5.1 Hand Glove Flow Chart

The block diagram of the hand glove having the IMU interlinked to ESP 32 Pico and Antenna are represented in Figure 4. The ESP32 Pico is embedded in the hand glove. The IMU consists of an accelerometer that calculates and reports the exact direction of the body by measuring pitch and roll.

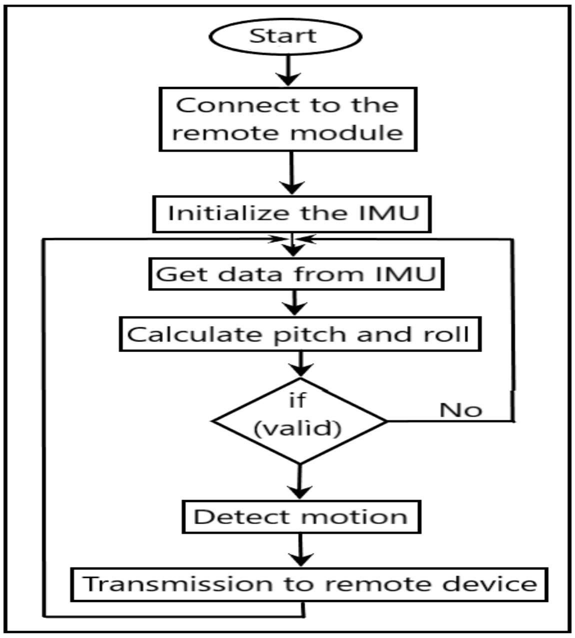

Figure 4 – Hand glove flow chart

The ESP32 Pico microcontroller is programmed and interfaced with Atom LITE using Wi-Fi technology and by initializing the ESP 32, Pico. The microcontroller sends the signals to the hexapod through the antenna at the rate of over 1000 messages/minute, which may create interference or misbehavior on the robot side.

5.2 Hexapod Robot Flow Chart

First, a Wi-Fi signal is sent from the IMU in the hand glove to the ESP32 Microcontroller in the hexapod body as shown in figure 5. The IMU itself acts as a router and doesn't need external routers in order to establish a Wi-Fi connection. The mac address of the hexapod is fed to the IMU so that it establishes a connection only with the device bearing that mac address. In this way, the IMU acts as a master, and Hexapod acts as a slave. Once the connection is established, the microcontroller waits for an input signal that is a gesture determining the motion of the hexapod.

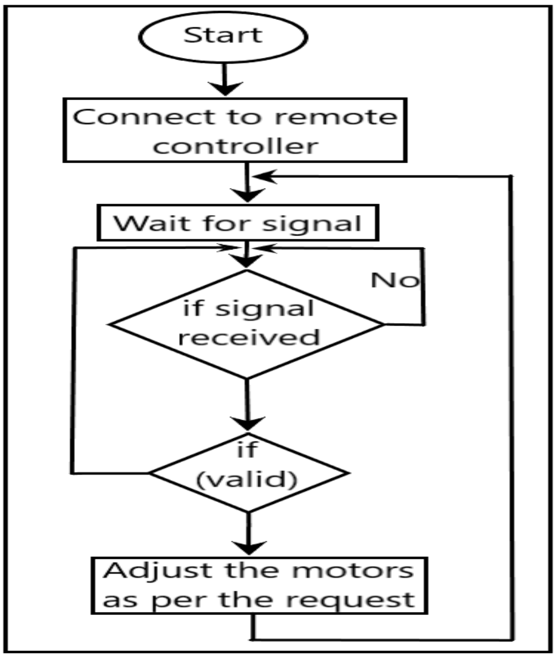

Figure 5 – Hexapod robot flow chart

The IMU module in the glove sends a signal to the ESP32 which is received by the ESP32 Wi-Fi component in the hexapod body based on the gesture of the glove which acts as input signals. The ESP32 microcontroller forwards this signal to the motor driver IC which controls the server motors. The motor driver IC operates on the pulse width modulation principle and sends a signal to the servo motors.

6. RESULTS

The proposed algorithm was tested in an indoor environment and proved to be robust and effective. The complete hexapod model is shown in Figure 6. The Hexapod robotic system is successfully implemented after the prototype is tested on rugged terrain. The Hexapod robot successfully runs for ten minutes provided the battery is charged. The Hexapod robot can change the angle of its legs in two different angles as they are provided with two degrees of freedom.

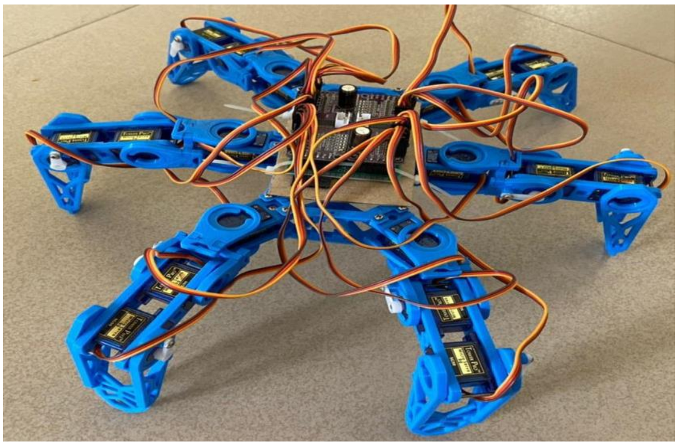

Figure 6 – The hexapod final result

7. CONCLUSION

This project mainly discusses the conceptual and detailed design and development of a Hexapod Robot with a minimum degree of freedom. Electronics architecture and control algorithms are briefly described. The project finishes with a discussion of the current results and identifies some future works. The principal theory which is used in the hexapod robot is elaborated, and the control system of the robot is designed. Analysis shows that: The mechanism has the characteristics of a compact body, easy control, and good move characteristics. DC servo motor helps the robot to move forward, backward, left, right, and stop.

8. REFERENCES

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