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MID-AIR GESTURE FOR MULTI-FINGER CONTROL SYSTEM USING LEAP MOTION ROBOT

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ABSTRACT

In our work, the main aim of a making human hand tracking system is to create interaction between human hand and Robotic Module. Human-machine interaction gives the relation between human and computer. The Robotic system is to be controlled using Leap motion controller in X, Y and Z direction. The Leap Motion Sensor is a small device able to sense human hands above it and try to keep track of them. Hence, when controlling the robot, the user can use touch-free control experience. A mobile robot can be controlled by translating the multi-finger gestures into commands via leap motion controller. In this work the hand gestures are observed and transferred to the computer. Then by translating the input leap motion signals into commands we can control the robot. The main technology behind leap is normal user interface, gesture recognition and motion control. However, we cannot achieve the capability of a human hand completely, this system can be used in all the areas where robotic hands are manually controlled and reduces much of effort and being used while handling with traditional controllers.

Keywords: Leap Motion Sensor, Hand Gesture Recognition, Man-machine Interaction, Natural user Interface.

1. INTRODUCTION

Mid-air interaction is an emerging spatial input mode which has been used in many areas of interaction, e.g., mid-air keyboard typing, interaction with large displays, virtual and augmented reality, and touchless interaction. Recent progress in hand tracking using affordable controllers such as leap motion Nimble VR and MS Kinect boosted research and development on precise hand tracking, especially in the area of computer games. Breakthroughs were also made in predicting self-occluded hand, e.g., which, until recently, was a serious obstacle for using optical tracking devices [1-5]. Thus application of mid-air gesture for exact 3D object manipulation in virtual environments, such as virtual archetype, assembling and various shape modelling operations, still remains a challenging research problem. Actually, with 27 degrees of freedom for the hand, only one gesture can be classified into 33 variants[6],[11-12]. we make less weight ,shape ,and size for natural and productivity. For various simulations and training,

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professional motor skills in virtual environments, such natural gestures, should be recognized and implemented by the interactive modelling system. In this work, we perform a feasibility study on using Leap Motion controller for virtual assembling and shape modelling operations mimicking real life gestures rather than using artificial, however possibly more efficient for capturing, gestures[7,13-17]. We examine the existing progress with multi-finger tracking in these areas, as well as what has been achieved in multi-finger tracking with Leap Motion controller. Next, we examine and classify the hand gestures which are used in real life multi-finger based desktop constructions, assembling, and modelling operations[8-10]. We come up with just a few algorithms that allow for recognition of many possible hand gestures. Next, we implementation and describe the user tests which we conducted to verify our idea and the design algorithms.

2. RELATED DOCUMENTS

Daniele Esposito, Gaeta no Dario Gargiulo et al., proposed the paper titled "Improvements of a Simple Piezoresistive Array Armband for Gesture Recognition" that was published in the year of 2020 by International Conference on e-Health and Bioengineering (EHB). In this, they insist on the study presents a simple Human Machine Interface (HMI) for gesture recognition purpose, based on a wireless piezoresistive armband. The armlet implant three sensors based on Force Sensitive Resistors (FSRs) applied on specific forearm muscles, which provide signals comparable to the electromyography linear envelope. The system aims to recognize in real-time some multi-finger gestures, appropriately processing the force signals. The HMI control system is based on Arduino platform and tools a Linear Discriminant Analysis (LDA) classifier to perform real-time gesture recognition. The HMI, by means of a Bluetooth system can wireless connect to a computer and provide directive to custom graphical interfaces or other applications as videogames. The Advantage of the paper lies in the fact that force sensors greatly simplifies the acquisition of signals related to muscle activation: it does not require electrodes, provides a signal very similar to the electromyography linear envelope and is proportional to the force exerted by the muscle. These features are advantageous with respect to Electro Myography (EMG) for long recording. The aim of the presented HMI device in the preceding study, was to recognize eight hand gestures in function [1].

Kyaw Sett Myo, Weng Xian Choong et al., proposed the paper titled "Multiple Screen Control Application with Facial and Gesture Recognitions in a Manufacturing Control Room" that was published in the year 2020 by IEEE Conference. In this, they insist on the age of Industry 4.0, the operators in a manufacturing control room require to work with digital content such as factory Key Performance Indicator (KPI) dashboards, live dashboards and controls on many displays. Control and organizing the displays and their layout with a user's face and hand gesture could be more natural, automatic and interactive for the control room operators. Therefore, a display control framework is developed in the Manufacturing Intelligence Control Room (MICR) at the Advanced Remanufacturing and Technology Centre (ARTC), using the open-source Face Net facial recognition and Open Pose hand feature recognition algorithms and integrating with the display control system. Nerve Centre from Mezzanine system of Oblong Industries. With the application developed in Python framework using source libraries such as Flask and OpenCV, it provides flexibility for users to customize how they want to interact with the screens. The advantage of the paper lies with the application

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developed in Python framework using open-source libraries such as Flask and OpenCV, it provides flexibility for users to customize how they want to interact with the screens [2].

Mihai–Bebe Simion, Dan Selişteanu et al., proposed the paper titled "DC Motor Control using Hand Gestures" that was published in the year of 2020 by IEEE Conference of Control and Computing .In this, they insist on the gesture is a form of non-verbal communication in which body actions communicate some particular messages. Due to the high processing capacity of today's computers, multi-finger gesture recognition systems can be used to simplify interactions with electronic devices. In this, a multi-finger posture recognition system was implemented, which is able to recognize five posture of a hand. The five position consist of more fingers are shown, and then, this information is used to control the position of a DC motor. Multi-finger gestures are recognized by an image processing system that uses a neural network execute on a microcontroller. In this, the advantage introduced a multi-finger gesture-based interface for navigating a car-robot. A user can control a car-robot directly by using hand motions. In the future, they will directly implement in a mobile phone with an accelerometer and control a car-robot. They also want to add many multi-finger gestures (such as the curve and slash) into the interface to control the car in a normal and effectively way [3].

3. PROPOSED SYSTEM

In this, the main aim of a making human hand tracking system, is to create interaction between human hand and Robotic Module. Human-machine interaction gives the relation between human and computer. The Robotic module is to be controlled using Leap motion controller in X, Y and Z direction. The Leap Motion Controller is a small device able to sense human hands above it and to keep track of them. Hence, when controlling the robot, the user will feel an fascinating touch-free control experience. The main technology behind leap is normal user interface, gesture recognition and motion control. It will be 200 times more sensitive than Existing touch-free technologies. We can control robot through simple multi-finger gestures. A robot can be controlled by translating the hand gestures into commands via leap motion controller. In this work the hand gestures are observed and transferred to the Personal Computer. Then, by translating the incoming leap motion signals into commands we can control the robot. The Figure 3.1 shows the block diagram of Leap Motion Control Robot. Leap motion device is connected to a particular port of Personal Computer (PC). The value from leap motion device will be got from the com port by using Python.

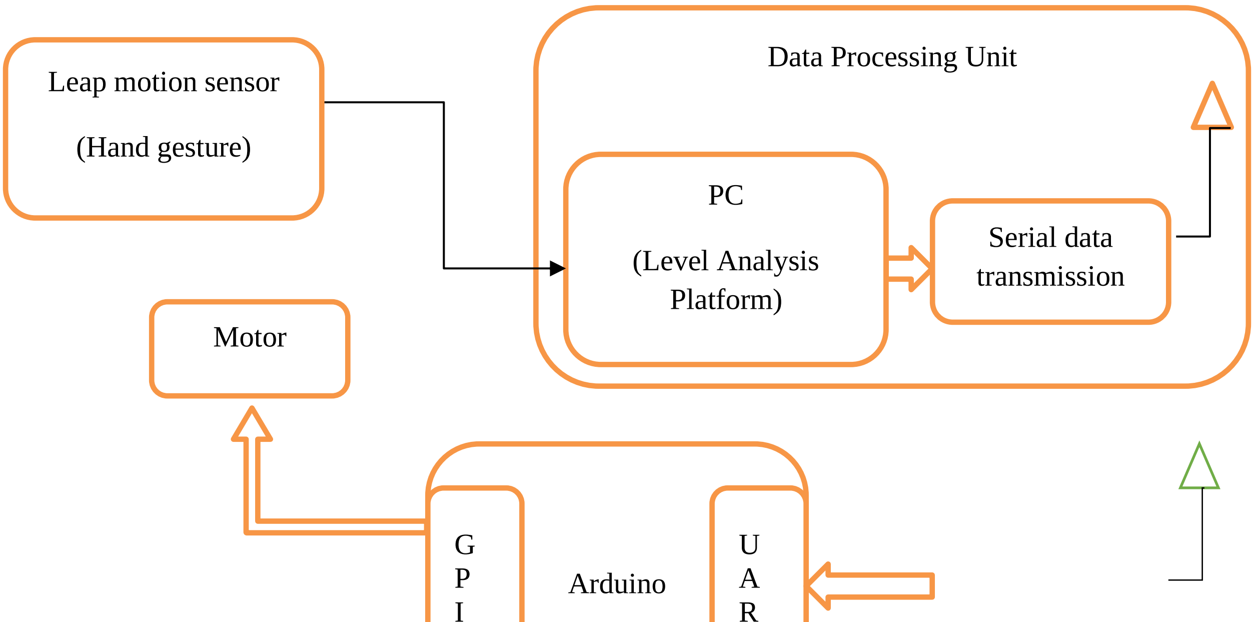

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Figure 1 Block Diagram of Leap Motion Control Robot

Then the value is sent to the controller through Serial transmission. The controller receives the values from the PC via Universal Asynchronous Receiver Transmitter (UART). According to the values the Robot module will be driven. A robot can be controlled by translating the hand gestures into commands via leap motion controller. In this work the hand gestures are observed and transferred to the computer. Then, by translating the incoming leap motion signals into commands we can control the robot. The main technology behind leap is normal user interface, gesture recognition and motion control.

The Leap motion controller is sleek, light, and small - just 3 inches long. It takes up hardly any room on their desk, but has a wide 150° field of view, and transforms the space above into a 3D interface for their hands. It works alongside their keyboard, mouse, stylus, or trackpad for a richer and more natural 3D computing experience. With the Leap motion software running, just plug the device into the Universal Serial Bus (USB) port on their Personal Computer (PC), and they are ready to start exploring. Legacy support for Media Access Control Address (MAC) is also available. The Leap motion controller uses infrared cameras and highly complex mathematical algorithms to translate hand and finger movements into 3D input. This distinctive approach allows Leap motion technology to be significantly more accurate than other motion-control technologies - and it's constantly improving. With free, automatic software updates, there can always have access to the latest features and enhancements.

The Leap Motion Controller as shown in the figure 1 senses their hands and fingers and follows their every move. It lets them move in all that wide-open space between their and their computer. So, they can do almost anything without touching anything. It's the tiny device that just might change the way their use technology. It's a superlative-wide 150° field of view and a Z-axis for depth. That means they can move their hands in 3D, just like their do in the real world. The Leap Motion Controller can track their movements at a rate of over 200 frames per second.

Universal Asynchronous Receiver Transmitter (UART) as shown in the Figure 3.1 is a dedicated hardware associated with serial communication. The hardware used for UART can be a circuit integrated on the microcontroller or a dedicated Integrated Circuit. This is dissimilarity to SPI or I2C, which are just communication protocols. A UART is normally an individual (or part of an) integrated circuit (IC) used for serial communications over a computer or peripheral device serial port. One or more UART peripherals are often integrated in microcontroller chips. UART is often used as a "serial port" on computers or in microcontrollers. UART is accountable for sending and receiving a sequence of bits. At the

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output of a UART these bits are generally represented by logic level voltages. These bits can set off RS-232, RS-422, RS-485, or perhaps a few proprietary spec. UART with data bus. The transfer UART is connected to a controlling data bus that transmits data in a parallel form. By this, the data will now be transmitted on the transmission line (wire) serially, bit by bit, to the receiving UART.

Arduino is an open-source electronics platform found on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and revolve it into an output - activating a motor, turning on a Light Emitting Diode (LED), publishing something online. The Arduino uno as shown in the figure 3.1 is programmed using the Arduino Software, our Integrated Development Environment (IDE) common to all our boards and running both online and offline. Arduino Uno Rev. 3 Microcontroller Board is based on the Microchip Technology ATmega328 8-bit Microcontroller Unit (MCU).

A DC motor as shown is some of a class of rotary electrical motors which converts Direct Current (DC) electrical energy into mechanical energy and here two motors are used in the Robotic Module which is connected from the General-Purpose Input/Output (GPIO) of the Arduino as shown in the figure 3.1. The most usual types rely on the forces produced by magnetic fields. Nearly all types of DC motors have a few internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motor commonly used, as they could be powered from existing direct-current lighting power distribution systems[17-19]. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by interchanging the strength of current in its field windings. Compact DC motors are used in tools, toys, and appliances[20-21].

The Leap Motion Controller Robot can be used in the field of Gaming and where the Leap Motion sensor was used to capture the users' hand movements and different virtual environments were created for Gaming. It is also used in the Robotics in which the leap motion sensor controlled robotic arm system is designed to be used in areas where humans cannot reach. Thus the robotic hand is used to perform certain tasks and the control is achieved using leap motion controller. This permits us to perform tasks using natural human movements and achieve desired results. The Leap Motion Controller Robot is used in the art and designing sector which makes the way of designing simpler, easier and more hygiene since it is a Hand touch-free technology for controlling robot through simple hand gestures.

The Leap Motion controller used here is a small inexpensive device that allows for the tracking of the user's hands and fingers in three dimensions. The leap Motion Controller is a Hand touch-free technology for controlling robot through simple hand gestures. The leap Motion Controller used for controlling the robot is a Portable Device which makes more advantage among all other. Wireless Connections are made for controlling the robot by using the Leap Motion Controller device.

4.RESULTS AND DISCUSSION

The Robotic module is controlled using Leap motion controller in X, Y and Z direction. The Leap motion controller is a small device able to sense human hands above it and to keep track of them. Hence, when controlling the robot, the user will feel an fascinating touch-free control experience. The main technology behind leap is normal user interface, gesture recognition and motion control. It will be 200 times more sensitive than existing touch-free technologies. We can control robot through simple hand gestures.

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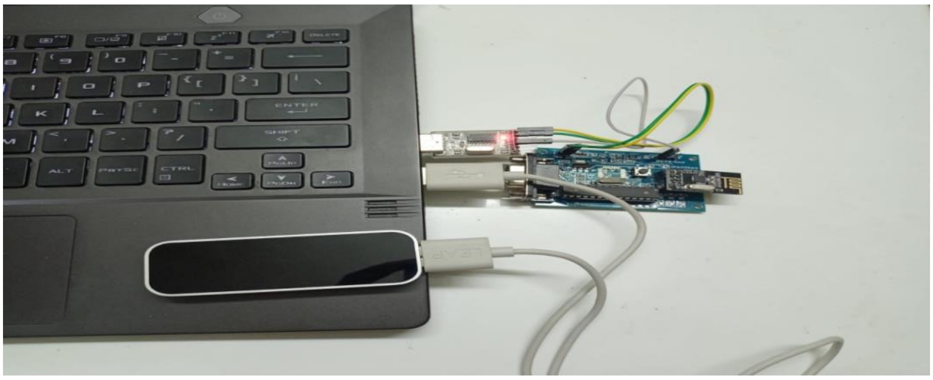

Figure 2 Leap Motion controller and Transmission Module

The Figure 2 shows the leap motion sensor and transmission zigbee module connected to the Personal Computer (PC) for fetching the incoming leap motion signals to commands by hand gesture from Leap motion Sensor. The converted commands by python programming language will be transmitted through transmission zigbee module to the receiver zigbee module present in the robotic module and we can control the robot.

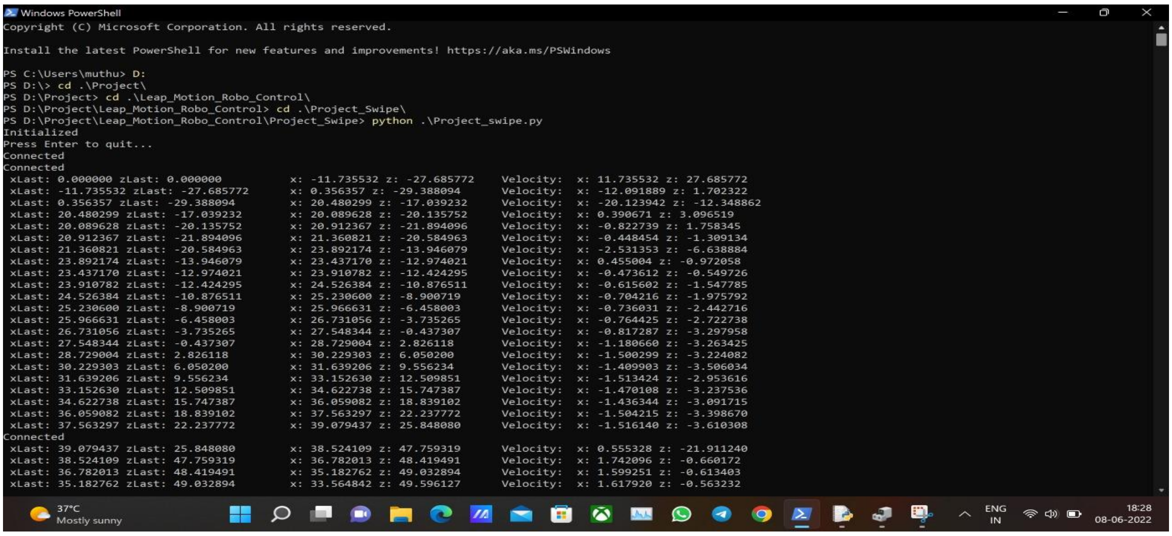

Figure 3 Power Shell Window

The Figure 3 shows the power shell window used for initiating the leap motion sensor path.

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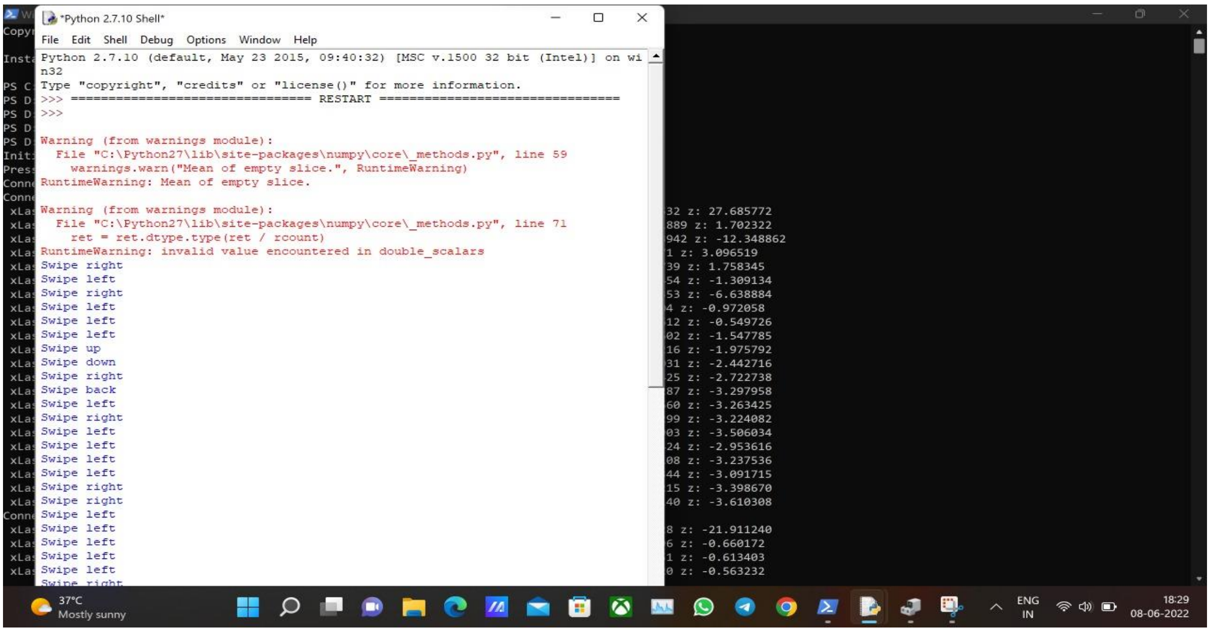

Figure 4 Execution of Python Program

The Figure 4 shows the execution and the output of python program in the python IDLE. It will print "swipe left" for swiping towards left direction, "swipe right" for swiping right direction, "swipe back" for backward direction, "swipe up" for upward direction, "swipe front" for swiping forward direction and "swipe down" for downward direction which makes the leap motion controller robot to stop the movement and wait for next command.

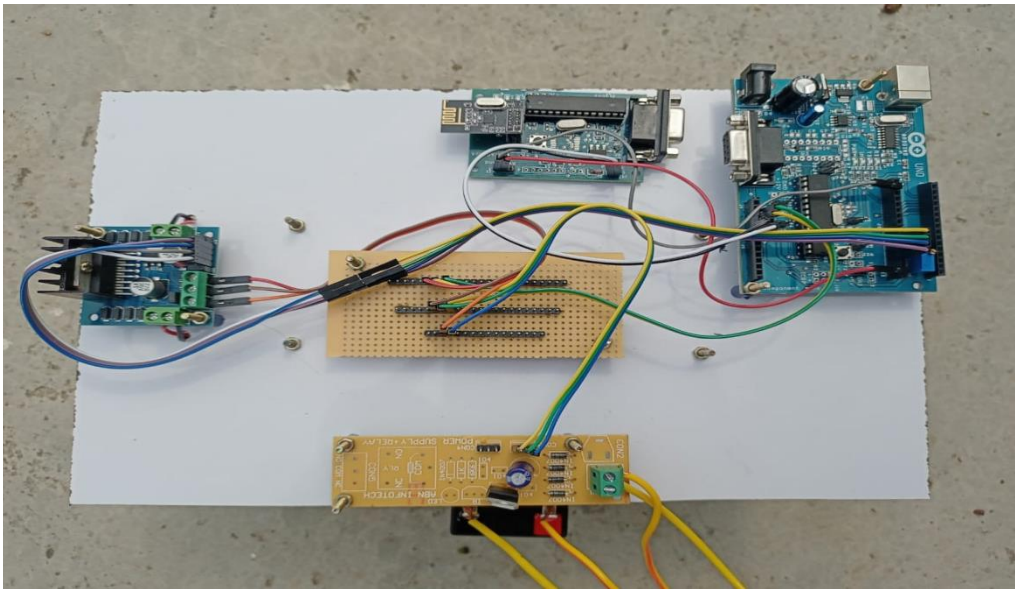

Figure 5 Top View of the Leap Motion Control Robot

The Figure 5 shows the top view prototype of the robotic module. This includes receiver ZigBee module, Transformer, Arduino microcontroller and Rechargeable battery for the power supply of the robotic module.

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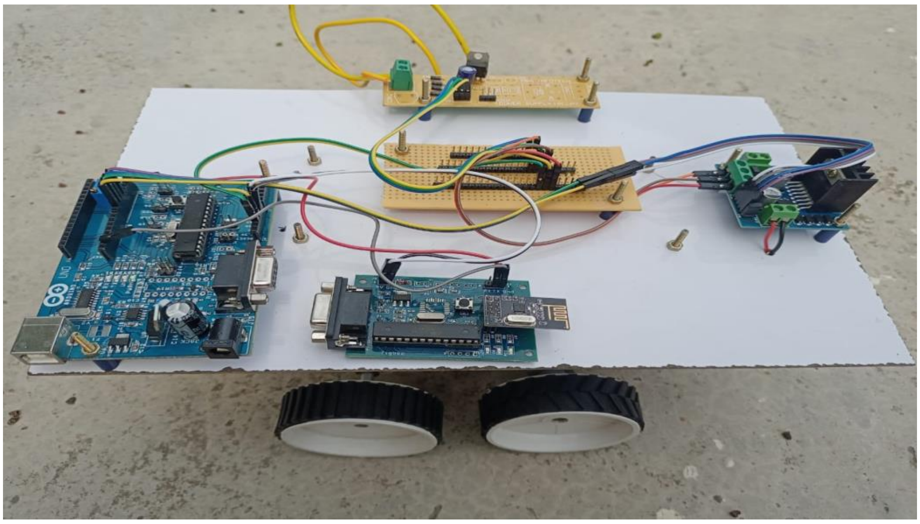

Figure 6 Overview of Leap Motion Control Robot

The Figure 6 shows the overview prototype of the robotic module as per connections made and the movement of robotic module like left, right, forward, reverse and stop using leap motion sensor can observed as the output of this work. Leap motion device is connected to a particular port of PC. The value from leap motion device will get from the com port by using Python. Then the value is sent to the controller through Serial transmission. The controller receives the values from the PC via Universal Asynchronous Receiver Transmitter (UART). According to the values the Robot module will be driven. A robot can be controlled by translating the multi-finger gestures into commands via leap motion controller.

5. CONCLUSION

Gesture control is doubtlessly the simplest way to control a complex robot, with the help of a sensor called as Leap motion and with few mathematical equations we are able to achieve seamless synchronization between human hand and a robotic arm. The Leap motion controller used here is a small inexpensive device which allows for the tracking of the user's hands and fingers in three dimensions. The leap motion controller is a hand touch-free technology for controlling robot through simple hand gestures. The leap motion controller used for controlling the robot is a portable device which makes more advantage among all other. Wireless connections are made for controlling the robot by using the leap motion controller device. The Leap motion controller is a small device able to sense human hands above it and to keep track of them. Hence, when controlling the robot, the user will feel an interesting touch-free control gesture. The main technology behind leap is normal user interface, gesture recognition and motion control. It will be 200 times more sensitive than existing touch-free technologies. We can control robot through simple hand gestures. However, we cannot achieve the dexterity of a human hand completely, this system can be used in all the areas where robotic hands are manually controlled and reduces lot of effort and being used while handling with traditional controllers.

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