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Development of Dual Arm Telerobotic System Based On Color Identification and RFID Tag

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Abstract: ***This project presents a dual arm tele-robotic application with color object and tag based sensing. The control of a robotic arm is very useful in the industry, because in today's consumer world only robotic arms can do all the tasks precisely and with high speed. The robotic arms need to be automated as much as possible, because this way, they can do even more tasks with less human intervention, which will lead to higher productivity. Human rights issues that arise due to poor working conditions are becoming a significant problem in modern manufacturing systems. Industrial dual-arm robots are being developed to eliminate the effects of these social issues. A dual-arm robot can work in place of human workers. We present a system to achieve coordinated task-based control on a dual-arm industrial robot for the general tasks like color object sorting with RFID tag sensing. It has advantages such as a single controller for both arms and human-sized body and arm. At the transmitter end RF transmitter module is used as the remote application. Commands are sent to the receiver to control the movement of robotic arm either to pick up Red, Black, White boxes with RFID tag. At the receiving end seven motors are interfaced to the raspberry pi processor where four of them are used for the gripper movement and two for arms movement of the robot while the other is used for the base movement of the robot.***

Keywords: Dual armr,RF module,robotic arm, RFID tag,sensor,Tele-robot,motor.

I. INTRODUCTION

The rapid growth of industry and advancement of technology has resulted in reduction of human efforts, the main reason for which being machines!! Machines are playing an important role in our life. A machine might be anything, be it a cell phone or a bike or even a robot. Robots have found an increasing demand in a wide range of applications in our life. Their use in defence has increased by the day. Our paper includes one such instance of how a robot can be of use to human race in general. Robots ensemble human beings in many ways be it looks or functioning, but previously robots were not controlled by computer programs or electronic circuitry. Telerobotics is the area of robotics concerned with the control of semiautonomous robots from a distance, chiefly using wireless network or tethered connections. It is the combination of two major subfields, teleoperation and telepresence. Mostly in the industry, robotic arms are blind; they don't have sensor vision system. Sensor vision system adds artificial intelligence and more autonomy to a robotic arm. Mostly in the industry robotic arms are programmed previously, they know exactly all the movements which need to be executed. This way, the robotic arms are not very flexible for today's dynamic world. If the robotic arm has a sensor vision system added, than it can change its tasks during execution, this way there is no need to stop a production line. A sensor vision system can also make auto calibration for the robotic arm, this way the robotic arm can make small adjustments during execution, this way there is no need to stop the production line and this will save money and time. In this experiment a robotic arm detection and control method was made. The robotic arm has glued colored box sorter, the sensor has applied color filters and RFID tags read with readers. According inputs Dual ARM works. Multi-arm industrial robots and tele-robots are not common due to their mechanical and system level complexity. When multiple arms jointly hold a load, in addition to the motion of the load, the internal force within the load needs to be regulated for stable grasping while avoiding damaging the part. In the case of force-reflecting tele operation, synchronization and stability issues are even more severe, since the human operator needs to regulate both the force of interaction between the load and the environment and the internal squeeze force in the load. Here in this project we are providing sensor based operation of sorting with dual arm. . Dual arms allow handling of more complex and peculiar objects. We have developed a human-sized, dual-arm, easy-to-use industrial robot with high payload. In this Project, we aim to introduce the development of our robot and its applications with color and tag sensing. The hardware component include RFID reader, RFID tag,

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color sensor, servo driver, servo motor. This project uses Raspberry Pi 3 processor for controlling the dual robotic arm. The system use RF module for transmitting and receiving the command.

II. BLOCK DIAGRAM

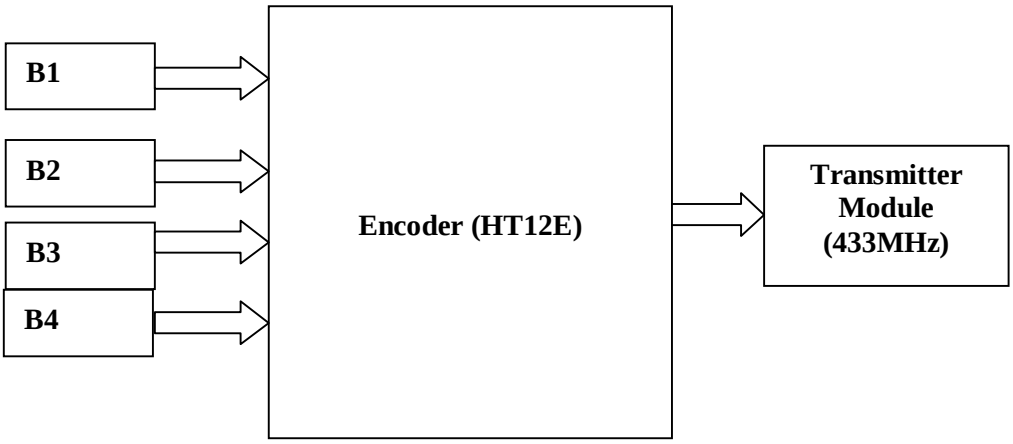


Fig.1: Transmitter section

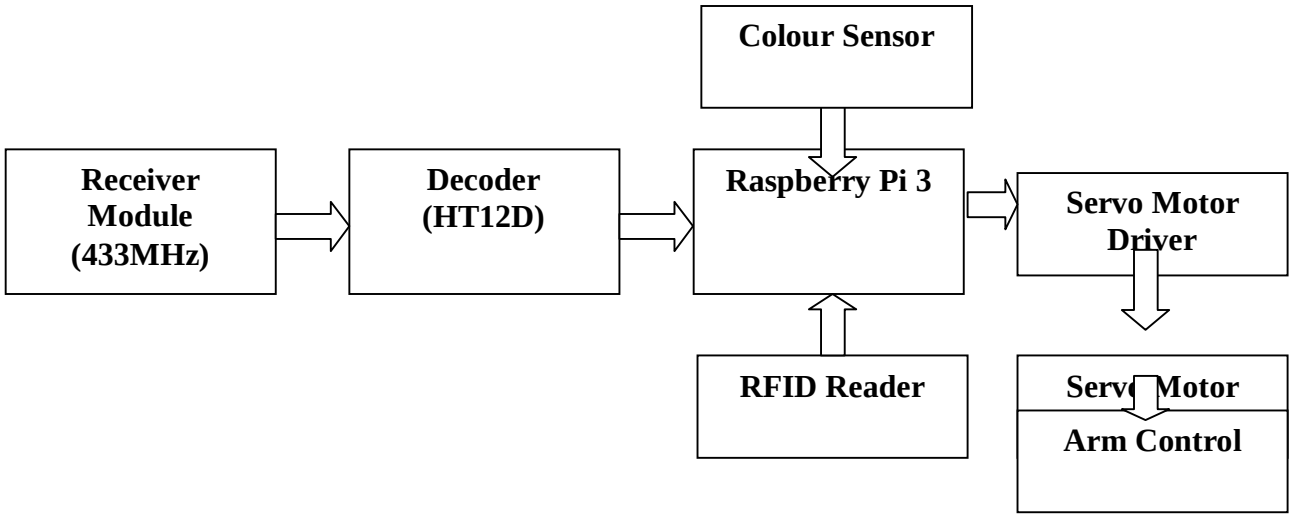


Fig 2: Receiver section

III.SYSTEM DESCRIPTION

A. Working

It is clear from the above Fig.1 and Fig.2 that the project is consisting of two parts: 1) Transmitter and 2) Receiver

Transmitter is act like controlling key, where we can put digital signal for selecting the object and will encoded by the encoder (HT12E) and transmitted via RF Transmitter at the working frequency of 433MHz.At the receiver end, the receiver will receive the digital signal and transmit it to the decoder (HT12D) for converting it into original signal. The decoded signal will be processed by the raspberry pi for material selection. When user will put the Object on the RFID receiver end, it will be scanned and compare with their color combination, Once it will be authenticated by the raspberry pi, it will provide PWM signal to the servo motor for arm control and material separation.The receiving end of the system consists of RFID Reader, Color Sensor, seven servo motor with servo motor driver and power supply. The dual arm tele robotic consists of robotic arm for pick and placed. The arm is able to move along with RGB type of color object. It uses one motor for the based movement operation and six motors for dual arm operation. The dual-arm tele robot uses seven motors for the operation of the system, two for the operation of shoulder and 4 for the pick and place operation. The dual-arm tele robotic consists of an arm assembly with a jaw, which is only able to move in up and down direction. There are two motors are for the arm assembly, one forth up and down motion and other for jaw opening and

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closing. The maximum upward and downward motion is limited by mechanical joints. It breaks the motor circuit when the arm is at its maximum position beyond which the motor does not rotate. If color is matched and RFID tag also detected robotic dual arm pick the objects and place it in particular axis that given in program.

B. Robotic Arm

It should have three rotational joints along with a gripper. The gripper will open and close by means of the gear wheels. The base rotates in circular direction and the other two joints for upward, downward and forward, backward motion respectively. There is a limit to the movement each joint can produce since each joint is controlled by a servo motor.

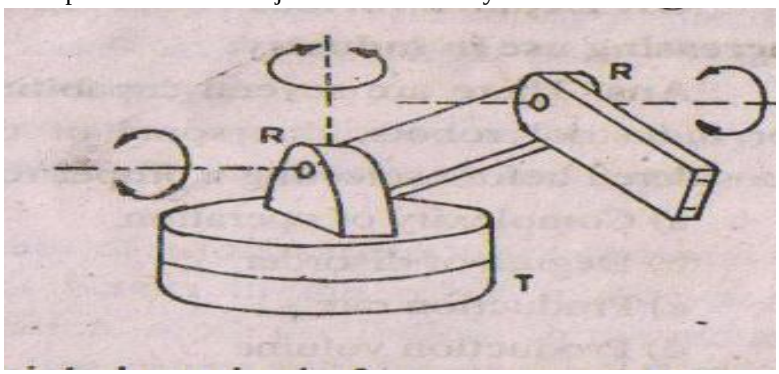


Fig.3:Joint Arm Robot.

This robot manipulator has the general configuration of human arm consist of a vertical column that swivels about the base using T joint. At the top of the column is a shoulder joint his output link connect to an elbow joint.

C. Robotic Arm Grippers

Gripper is an end-of-arm device often used in material handling applications. Generally, the gripper is a device that is capable of generating enough grip force to retain an object while the robot performs a task on the part such a pick-and place operation. Any gripper must be capable of performing the task of opening and closing with a prescribed amount of force many years of daily operation. The most commonly used grippers are finger grippers. These grippers generally have two opposing fingers or three fingers like a lathe chuck. The fingers are driven together such that once gripped any part is centered in the gripper as shown in Fig.4 This gives some flexibility to the location of components at the pick-up point. Two finger grippers can be further split into parallel motion or angular motion fingers. Angular jaw gripper open and close around a central pivot point, moving in an arcing motion. An angular gripper is used when there is a need to get the tooling out of the way. The advantage for an angular gripper falls on its simple design and only requires one power source for activation. However, it has several disadvantages including jaws that are not parallel and a changing centre of grasp while closing. Meanwhile, parallel jaw gripper moves in a motion parallel in relation to the gripper's body. A parallel gripper is used for pulling a part down inside a machine because the fingers fit into small areas better. An advantage of parallel type gripper is that the centre of the jaws does not move perpendicular to the axis of motion. Thus, once the gripper is centered on the object, it remains centered while the jaws close. Space constraints might lead to the use of parallel over angular.



Fig.4. Gripper Design.

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D. Tele-robotic System.

Telerobotics is perhaps one of the earliest aspects of robotics. Literally meaning robotics at a distance, it is generally understood to refer to robotics with a human operator in control or human-in-the-loop. Any high level, planning, or cognitive decisions are made by the human user, while the robot is responsible for their mechanical implementation. In essence, the brain is removed or distant from the body. Here in the term tele, which is derived from the Greek and means distant, is generalized to imply a barrier between the user and the environment. This barrier is overcome by remote-controlling a robot at the environment. Besides distance, barriers may be imposed by hazardous environments or scaling to very large or small environments. All barriers have in common that the user cannot (or will not) physically reach the environment. While the physical separation may be very small, with the human operator and the robot sometimes occupying the same room, telerobotic systems are often at least conceptually split into two sites: the local site with the human operator and all elements necessary to support the system's connection with the user, which could be joysticks, monitors, keyboards, or other input/output devices, and the remote site, which contains the robot and supporting sensors and control elements. To support this functionality, telerobotics integrates many areas of robotics .At the remote site, to operate the robot and execute the human's commands, the system may control the motion and/or forces of the robot.

IV. DESIGN AND IMPLIMENTATION

A. Raspberry pi 3

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. All models feature a Broadcom system on a chip (SoC) with an integrated ARM compatible central processing unit (CPU) and on-chip graphics processing unit (GPU).Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+; on-board memory ranges from 256 MB to 1 GB RAM .Secure Digital (SD) cards are used to store the operating system and program memory in either SDHC or Micro SDHC sizes. The boards have one to four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm phono jack for audio output. Lower-level output is provided by a number of GPIO pins which support common protocols like I²C. The B-models have an 8P8C Ethernet port and the Pi 3 and Pi Zero W have on-board Wi-Fi 802.11n and Bluetooth. Raspberry Pi is used for making robot wireless and web based. The user can conveniently control the robotic dual arm movement. Raspberry pi is connected with the dongle which enables raspberry pi to transmit over the web network. Raspberry Pi uses an SD card for booting and for memory as it doesn't have an in built hard disk for storage. Raspberry Pi requires 5 volt supply with minimum of 1000 mA current and it is powered through micro USB cable.



Fig.5: *Raspberry pi 3*

B. RF Module

In general, the designer of wireless systems has two overriding limitations: it must work over a convinced distance and transfer a convinced amount of information within a data rate. The size of the RF modules is very small and have an extensive range of a operating voltage that is 3V to 12V.Basically, these modules are 433 MHz RF TX and RX modules. The transmitter (TX) draws no power when transferring logic zero while fully destroying the carrier frequency, thus consume considerable low power in battery operation. When logic1 is sent carrier is fully on to about 4.5mA with a 3V power supply. The information is sent serially from the transmitter (TX) which is received by the receiver. Transmitter (TX) and the receiver (RX) are duly interfaced to two Microcontrollers for transferring the data. RF modules can be applied for various types, sizes and shapes of electronic circuit boards. It can also be useful for modules across a vast variety of capacity and functionality. These modules typically include a PCB, TX circuit or RX circuit, antenna and serial interface for communication to the main processor. The types of RF modules mainly include

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RF transmitter module, RF receiver module RF transceiver module and SOC module. There are 3-types of signal modulation techniques commonly used in RF transmitter and RF receiver modules such as ASK-amplitude shift keying, OOK-On-Off Keying and FSK-frequency shift keying.

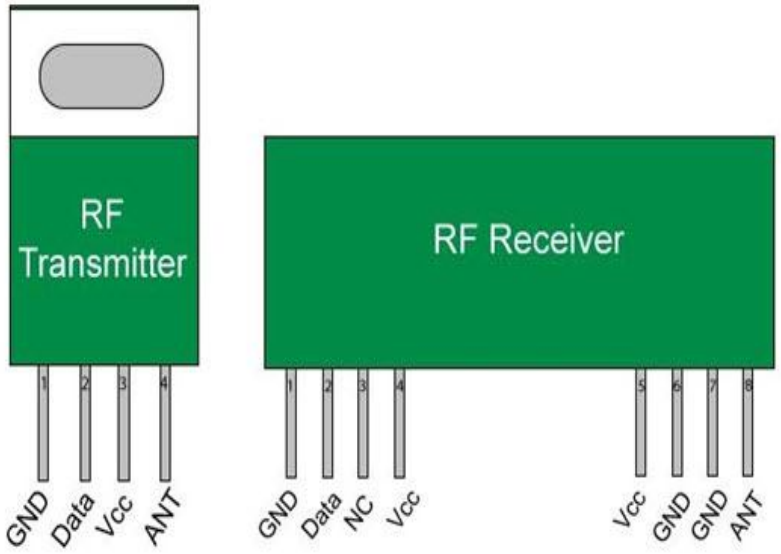


Fig.6:RF Module

1) *RF Transmitter:* An RF transmitter module is a small size PCB capable of transferring a radio wave and modulating radio wave to carry data. RF transmitter modules are usually applied along with a micro controller, which will offer data to the module which can be transmitted. These transmitters are usually subject to controlling requirements which command the maximum acceptable transmitter power o/p, band edge and harmonics requirements
2) *RF Receiver:* An RF receiver module takes the modulated RF signal to demodulate it. There are two kinds of RF receiver modules, namely the super-regenerative receivers and super-heterodyne receivers. Usually, super-regenerative modules are low power designs and low cost using a series of amplifiers to remove modulated data from a carrier wave. These modules vary, generally inaccurate as their operation of frequency significantly with power supply voltage and temperature. The main advantage of Superheterodyne receiver modules is a high performance over super-regenerative. They offer increased stability and accuracy over a large temperature and voltage range. This stability comes from a stable crystal design which in turn leads to a relatively more expensive product

C. Encoder And Decoder

The RF modules can also function without the need of Encoder and Decoder modules. simply power on both the modules with the corresponding voltage mentioned above. Now, make the Din pin on transmitter high and you will find the Dout pin on receiver also goes high. But there is a big drawback in this method. You can have only one button on the sender side and one output on the receiver side. This will not help in building better project so we employ the encoder and decoder modules. The HT12E and HT12D are 4 bit encoder and decoder modules .This means that we can make 16 different combination of input and outputs. These are 18 pin ICs which can operate between 3v to 12v input power supply. As said they have 4-data bit and 8-address bit, these 8 address bit has to be set same on the encoder and decoder to make them work as pair.

D. RFID Reader Module

This board is based on the EM-18 RFID Module. Using the board with Raspberry Pi to read a card's data is very simple and requires just a serial connection. The board has a bridge rectifier and 5V voltage regulator so it can be powered by 9~12V AC as well as 9~15V DC adaptor. Module can also be powered through header wires (+5V & GND) from other interfacing board. The board has an onboard power switch (Labeled PWR SW), power indication LED (Labeled PWR) and to indicate the detection of Card/Tag, it has a LED (Labeled DTCT) and Buzzer.

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Fig.7:RFID Reader Module

E. Features

1) Low-cost method for reading passive RFID transponder tags.
2) 9600 bps serial interface.
3) 125 KHz Operating Frequency
4) Read Distance up to: 6~10cm for cards, and 5cm for key-tags.
5) On board LED (Green) for Pass indication
6) On board Buzzer for Pass indication

F. RFID TAG



Fig.8 RFID Tag

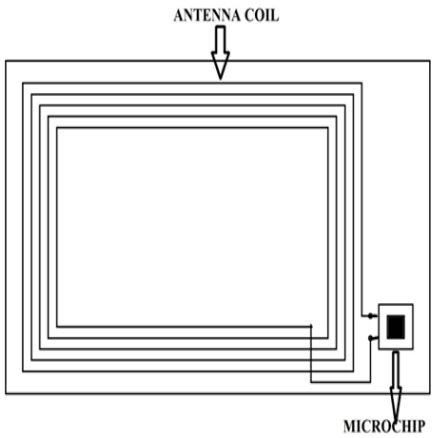


Fig.9: RFID Tag Internal Structure

RFID TAGS are mainly divided in to two types passive RFID Tags and active RFID tags. Passive RFID tag are the tags with no internal power source and active RFID tags are tags with their own power source .In passive RFID Tags we have generally two main components .One is antenna coil and another is microchip .As shown in fig. there is no battery or other active power here. With no power source the usually Tag stays ideal. The whole process starts with RFID transmitter .the transmitter generates the electromagnetic radiation through its antenna .When tag gets in range of transmitter, the tag antenna coil gets energized through electromagnetic induction. This energy act as power source for the microchip in tag .This microchip uses this energy to provide a

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feedback response for the transmitter. The transmitter receives this response which is unique to the tag and provides the corresponding output.

G. Servo Motor



Fig.10: servo motor

Servo motor works on PWM (Pulse width modulation)principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism .If motor is used is DC powered then it is called DC servo motor ,and if it is AC powerd motor then it is called AC servo motor. We can get a very high torque servo motor in small and light weight packages. These features they are being used in many applications like car, RC helicopters and planes ,robotics, machine etc.

H. Color Sensor

It is developed using IR and Photo Receiver, in which IR is act as transmitter whereas Photodiode is act as a receiver. Generally the Photo receiver will detect the intensity of light which is reflect back from the object which will be further digitally converted by the controller attached with the module. The controller consisting of 7ADC input in which sensor is attached, whereas we are using single sensor for color detection in which different analog values will be detected and converted into digital by Microcontroller from their PORT B pins.

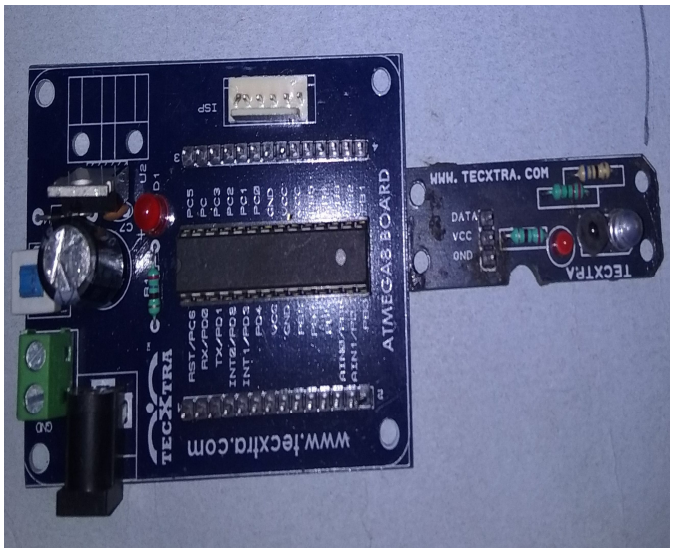


Fig.11: color sensor

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V. RESULT

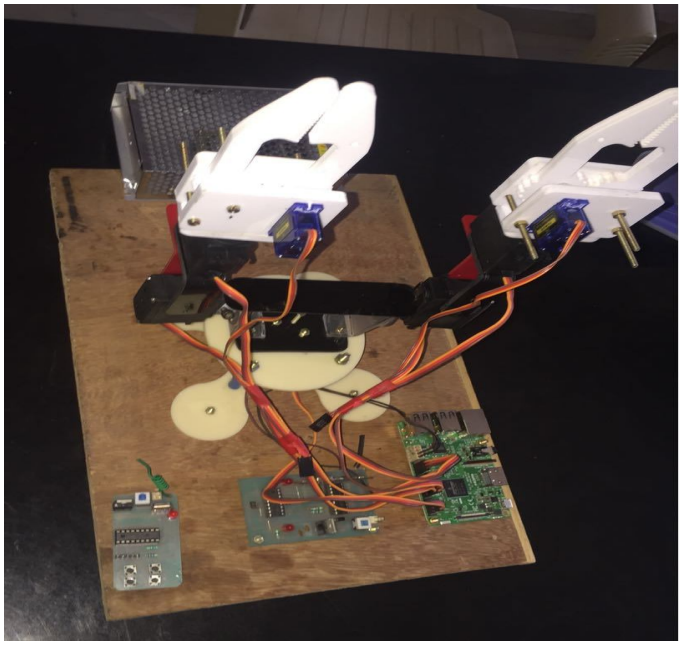


Fig. 12: Hardware part

we have successfully completed the real time implementation and working of Tele-Robotics. It is successfully pick and place the object to their desired location controlled using RF transmitter module. The Colour sensor attached with the system will detect the color and perfectly distinguish the object placed in the RFID reader module. .As the input command is given the dual arm selected red box with RFID tag and place it .According to color and RFID tag all boxes are sorted .By using the system time required for the work decreases than conventional separation system. It is also helpful to minimize labour cost ,time, power and improves the accuracy.

VI. FUTURE IMPLIMENTATION

The main components of the system is tele-operation, coordination, synchronization and sorting, in future we will enhance the system with adding vision camera, multiple functions switching mode. We can go for Internet of things for product supply management based on RFID technology. In future by adding of active RFID technology, the range of detection will increase for material tracking. Controlling range will be increased using Zigbee Technology.

VII. CONCLUSION

As per the above research analysis and design, it is proved that we have successfully completed the real time implementation and working of Tele-Robotics. It is successfully pick and place the object to their desired location controlled using RF transmitter module. The Colour sensor attached with the system will detect the color and perfectly distinguish the object placed in the RFID reader module. The above result shows that the raspberry pi attached with the system will act as a main controlling using for making all the decision and control. In future we can remotely access the object based on Internet of Things.

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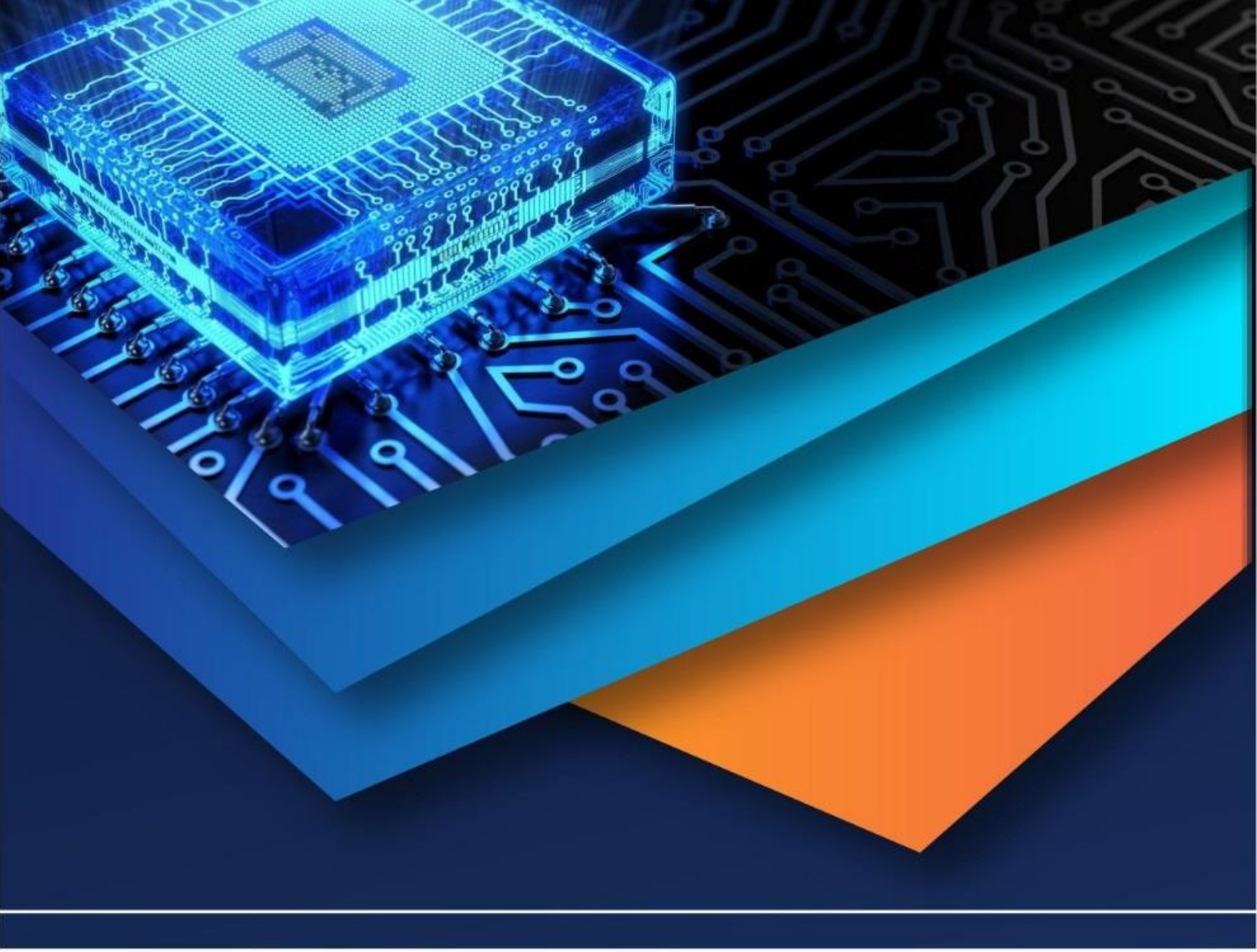
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