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Robotic Arm using IOT and Raspberry pie

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Abstract: ***In today's world, there is an immense increment in need to create artificial arms for complexity in human situations where human interaction is difficult or impossible. This may involve taking readings from an active volcano to diffusing a bomb. Here I propose an easy mechanism by which a robot can be controlled by using our computer science domains such as Python, Adafruit remote and Raspberry pi. The development of this arm is along with a personal computer for signal processing, which will all be interfaced with each other using serial communication. Finally, this prototype of the arm may be expected to overcome the problem such as placing or picking hazardous objects or non - hazardous objects that are far away from the user. Robotics is now playing a big role in several Automation Fields for a few days. In the coming year's robotic behaviour will become more effective***

Index Terms **– Remote, Controller, Artificial Arm, Smart arm, Raspberry pie, Internet of things, Adafruit.**

I. INTRODUCTION

The current Internet revolution along with the increasing robotics in many day-to-day operations of the Internet of Things has taken over all the heavy loads from the person to itself. The Internet of Things (IOT) is essentially an interconnection of several devices. Robots are used to support human beings in different situations if we combine the robots and the Internet of things then we can do more than we would imagine. This project addresses technical implications, open problems, and IOT-assisted robotics applications. The paper's main objective is to introduce a device with one robot used for selecting and putting applications in industries. This system has Robot-Control-Communicating Modules. There are basically four modules that need to be discussed here.

1) Raspberry pi Laptop System
2) Development of an account for Ada-fruit IO Remote.
3) Formulation of operating python code software.
4) Robotic arm link with pi, servo motor, motor driver and checking.

The robotic arm is a kind of mechanical arm which can be programmed to behave like a human arm. An anthropomorphic robotic arm is developed and implemented in this work, and is operated from a remote location using adafruit programming software and python. This can find application on a wide scale where direct human presence is a concern such as operating in a toxic environment or during the disposal of bombings.

In the past some works were done to imitate the movement of human hands, but some of the designs were complicated and often expensive. A very basic concept is used in this work, and low-cost materials readily available are used for producing the robotic arm. The arm is made from sheets of aluminium. Using servo motors, the finger movements are controlled by pulling them using cables which function as human hand tendons. Considered Robotic ARM has one base rotation which contains a servomotor of 180 degrees and all remaining are DC motors with proper delay.

Current System:

In the actual device, the radio frequency-based robotic arm is based on one servo Arduino UNO microcontroller and 3 DC motors are attached depending on the signal it is going to operate. In this device information is transmitted to the Robotic Arm and Micro controller in the form of Wired Communication.

Proposed System:

In order to resolve the difficulties in the current system, we need to improve the whole system by using different modules to relay the information in the form of wireless. Using adafruit front end configuration with four buttoned controller, Raspberry pi is interfaced with Robotic arm and Client Server python software.

II. LITERATURE REVIEW

[1] In this paper, Dr. A. Brintha Therese1 and Prashant Gupta2 Robotic arm with real time image processing, a Robotic Arm with Real-Time Picture Processing using Raspberry Pi which can be automated or can be automated hand managed. A Robotic arm can use camera and image processing in raspberry pi to determine the object based on colours such as Red, Green, and Blue.
The project's main goal is to build a robot that can select a pre-specified object and position it in separate colour-based divisions.
Raspberry Pi has made its way into many useful and modifiable robotic systems implementations. Linux based Raspbian Kernel is used for manipulating the hardware in raspberry pi. The code is written in python, to define and detect the object and its colour. Simple CV libraries enabled the image processing, called image processing, to be enhanced or processed. Which required to classify an object's colour and control the robotic arm to pick and position pre-specified operations of an object.
The code also has a local web page so that you can monitor the code using a slider Robotic arm location.
The proposed work implementing method is performed in three stages.
1. Image processing techniques to classify the colour of an object (RGB).
2. Control and assembly of Robotic Arm.
3. Integrate the vision system with a Robotic arm to monitor a pre-specified target for pick and position.

[2] The proposed work in this paper was closely related to our proposed project. The author in this paper proposed a real time security surveillance system using Iot. In this system raspberry pie and camera were used to detect the motion detection, in this system camera captures the images and sends to the user through email server and it also sends SMS alerts to the user mobile automatically through GSM modem. The recorded video through surveillance camera will be automatically uploaded to cloud server through email server and it also sends SMS alerts to the user mobile automatically through GSM modem. The recorded video through surveillance camera will be automatically uploaded to cloud server. When cloud server is not available then the data will be locally stored in raspberry pie and when the server is available then the data gets automatically uploaded into cloud server. Since the model is based on the Iot platform, the author used the Iot platform for the movement of the surveillance camera for better coverage of that particular area where the camera was placed for surveillance.

[3] By installing the surveillance robot, it can monitor the area where it was fixed. The users have to just login to the raspberry pie. Webcam and can view the live feed. Cost effectiveness and remote controlling features of the robot made it an easy usage.

[4] This study is focused on IOT based robotic car that builds this robotic car setup using raspberry pi, USB camera, two dc motors, and robotic chassis. It has a web camera installed on it, from which we can get live video feedback and an important aspect is that we can use the internet to access it from the web browser. A page that has left, right; backward, forward links is built in HTML
One can shift it in any direction by clicking on the links. Using python to drive the robotic vehicle, two words are used for one motion and another flask motion to get live video signal from USB camera and flask for sending commands to raspberry pi**.**
The web cam will capture the live data and then send it over the internet to the desired user control to end users. The motor driver L298N can handle two dc motors at a time so it's easy to use. SSH is protected shell, without which windows will not detect raspberry pi. The range of operation of the robotic car is not limited with the aid of o raspberry pi, it can delete large areas. One can monitor easily, as just as well as tracking robotic unit operation**.**

[5] This paper is a rescue robot that can operate on any rough surface like stairs. It can also float on water and submerge under water. Rescue robot based on IOT uses modern technologies which makes it special. Since it is based on IOT, and can be easily controlled by android or computer. In it different sensors are mounted for sensing climate. The modular structure allows it to be changed and updated to extend for use in different applications. There are six wheels in total, constructed from ebonite sheet (wheels), using V-belt as tank tracks. Three servo motors and six dc motors are used. Controller Arduino is used to power the motors.
To communicate with the smart phone a Bluetooth module HC-05 is attached to the Arduino controller. To feel the climate, temperature sensor, pressure sensor, humidity sensor, and gas sensor are connected to the Arduino controller. Two Li-Po batteries are used to power the Arduino controller and one for driving the motor. Two cell phones are used inside the device, one positioned at the front and another. Smart technologies are used in this amphibious robot for communication through internet. It can run on the rocky terrain, stairs, underwater and on water.

[6] Robot is operated by a mobile phone which makes a call to the robot's attached mobile phone. In this call if any key is pressed the corresponding tone will be heard at the other end of the line using multiple frequency dual tone (DTMF). With the help of a phone stacked in it, the robot perceives the DTMF sound. The tone obtained is processed by the microcontroller atmega32 with the Support DTMF MT8870 decoder. Decoder decodes the DTMF tone into its binary digit counterpart, and this binary digit is sent to the micro controller. The microcontroller is pre-programmed to take decisions for forward, backward or return motor drivers for any input or output. The main function of the mobile controlled robot with DTMF decoder is to move certain places where it is difficult for man to travel. The robot uses a phone stack to interpret the DTMF sound in the robot.

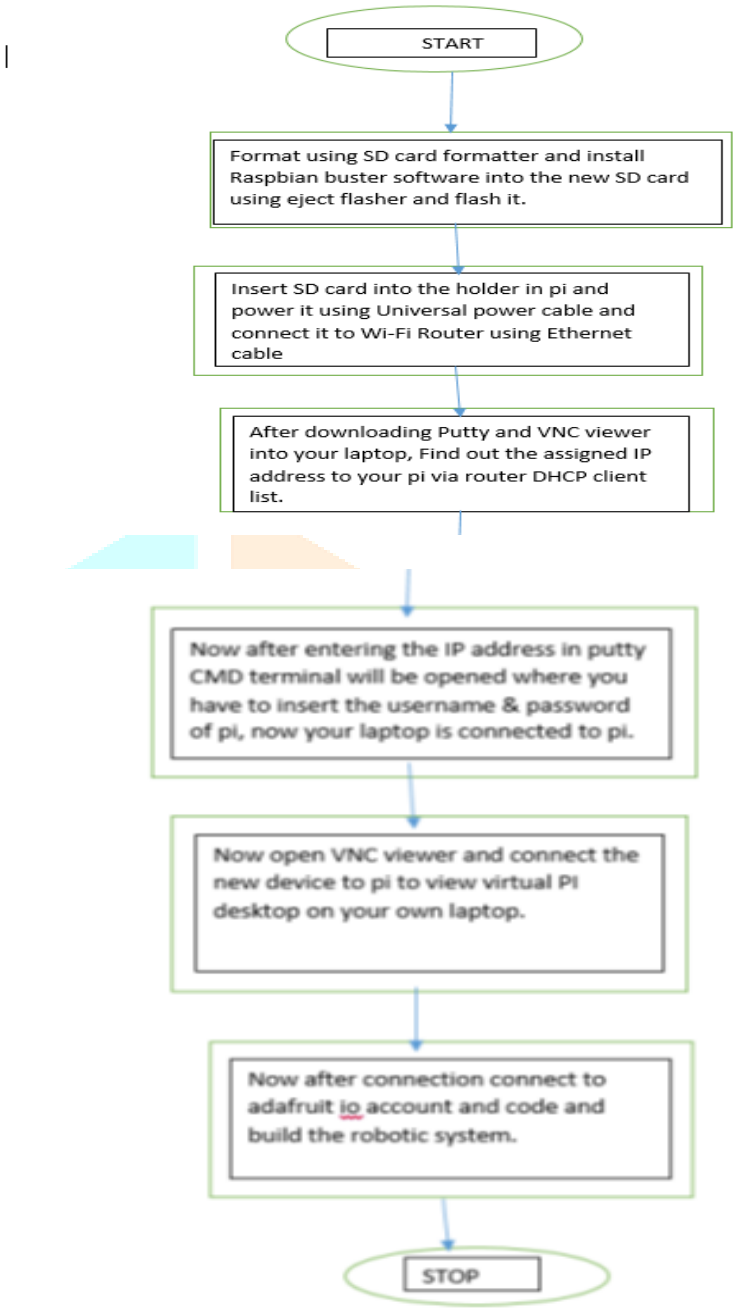
III. THEORETICAL ANALYSIS

This framework is composed of specifications both for hardware and software. The hardware requirement is raspberry pi model b, Servo motor, motor driver, laptop, Robotic arm, power cable, keyboard and mouse, SD card, connecting wires. The software requirements Raspbian OS buster, Python, Windows, VNC viewer, Putty, Eject flasher, SD card formatter, Adafruit Io, Python programming language. Raspberry Pi is connected to the laptop with the help of a Router. In the PC, the Free SD card is inserted via card reader and is formatted with SD card formatter later Raspbian buster software is flashed into it using flasher software. The Raspbian operating system is installed. Raspberry-pi works only on the Raspbian operating system, Linux, Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the collection of core programs and utilities that will power your Raspberry Pi. But Raspbian offers more than a mere OS: it comes with more than 35,000 packages, pre-compiled software Raspberry Pi 3 7 You can program the pins to communicate with the real world in incredible ways.1; pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi. Putty

configuration and VNC viewer are needed to install Raspbian OS. Putty configuration is SSH and Telnet client. It is open-source software that is available with source code. Now the step by step procedure is given below.

- **Step-by-step procedure**

Flowchart of work: Connecting Pi to Laptop:



- **Project Software and Hardware Description**

Project Hardware Requirements:
1) Laptop
2) Raspberry pi
3) Robotic Arm
4) Servo Motor
5) Universal USB cable
6) Ethernet cable
7) Motor Driver
8) Connecting wires
9) Wi-Fi Router (Internet)
10) Keyboard &Mouse
11) SD card

- **Project Software Requirements**:

1) Raspbian buster
2) Putty
3) VNC Viewer
4) Windows or IOS
5) Python IDLE
6) Flasher
7) SD Card Formatter
8) Adafruit IO

- **Descriptions:**

Raspberry pi:

Raspberry Pi is a single board device equipped with low cost credit card. It packs enough power to run sports, word processor such as open office, image editor such as Gimp and any similar magnitude programmer. Pi is based on a Large Com Soc (Chip System) with an ARM processor, a GPU and 256 to 512 MB RAM. It uses SD card to boot because it doesn't have a storage hard disc, SD Card reader for illustration of the OS. Use USB cable, 5V power supply displays TV / monitor information with DVI / HDMI port, HDMI cable or HDMI to DVI converter cable is used as display connector, USB mouse / keyboard is used as input, Ethernet cable is used as a network connector.
Raspberry Pi-3 is 3rd Raspberry Pi version. It replaced raspberry pi template Pi2. It has the following features built in:
Wireless LAN * 802.11n
* 1.2 GHz Processor with ARMv8
* Bluetooth
* RAM: 1 GB
* GPIO PINS * 40
* Ethernet Port
* Port full with HDMI
* Interface Camera and Display
The raspberry pi 3 has identical frame variable to the previous pi2 (pi1model b+), and finishes with pi1 and pi2 similarity. We recommend the pi3 module b for use in schools or for any large use those who wish to mount their pi in a venture may be inclined to pi zero or model A+ that are more useful in inserted activities and tasks requiring low power.

Robotic Arm

It should have a gripper and three DOFs. Via gear wheels the gripper will pick and position. Both the base and the other two joints rotate in circular motion for upward, downward and forward movement, respectively. There is no limit to the movement, since each joint is operated by a DC motor.

Servo Motor

A servo motor is a rotary actuator or motor that enables the angular direction, acceleration and velocity to be controlled accurately. It essentially has some capabilities that no normal motor has. It then uses a normal motor and combines it with a sensor to feedback on location.

Motor Driver

This circuit consists of the IC l293d motor driver used for running the DC motors. These DC motors are used for robotic vehicle control. L293D is an Integrated Circuit (IC) Dual H-bridge motor driver. Motor drivers act as current amplifiers because they take a low-current control signal and produce a higher-current signal. It uses this higher current signal to drive the motors. L293D has two H-bridge driver circuits built into it. Two DC motors can be operated simultaneously in its typical mode of operation, both in forward and in reverse direction. The motor operations of two motors at pins 2 & 7 and 10 & 15 can be controlled by input logic. Entry logic 00 or 11 will interrupt the respective engine.
Logic 01 and 10, respectively, will rotate it in clockwise and anticlockwise directions. Enable pins 1 and 9 (corresponding to the two engines) must be high for engines to commence service. The associated driver gets enabled when an enable input is large. As a consequence, the outputs become involved, and their inputs function in phase. Similarly, if they allow input is low, the driver will be disabled and its outputs will be off and high-impedance.

Raspbian Buster OS

Raspbian is the Foundation's official supported operating system. You can install it with NOOBS. Raspbian comes pre-installed with plenty of software for education, programming and general use. It has Python, Scratch, Sonic Pi, Java and more. The Raspbian with Desktop image contained in the ZIP archive is over 4GB in size, which means that these archives use features which are not supported by older unzip tools on some platforms. If you find that the download appears to be corrupt or the file is not unzipping correctly, please try using 7Zip (Windows) or The Un-archiver (Macintosh). Both are free of charge and have been tested to unzip the image correctly.

Putty

PuTTY is a free and open-source terminal emulator, serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. It can also connect to a serial port. The name "PuTTY" has no official meaning.

VNC Viewer

VNC® Viewer turns your phone into a remote desktop, giving you instant access to your Mac, Windows and Linux computers from anywhere in the world. You can view your computer's desktop remotely, and control its mouse and keyboard as though you were sitting down in front of it. **Use VNC** Server to look up the private (internal) IP address of the computer. Download **VNC Viewer** to the device you want to control from. Enter the private IP address in **VNC Viewer** to establish a direct connection. Enter the user name and password you typically **use** to log on to the **VNC** Server computer

• Python

Python is a broadly utilized abnormal state programming dialect for universally useful programming, made by Guido van Rossum and first discharged in 1991. A translated dialect, python has an outline theory which underlines code coherence (quite utilizing white space to delimit code squares as opposed to wavy props or catch phrases), and a sentence structure which enables developers to express ideas in less lines of code than conceivable in dialects, e.g. c++, java. The dialects gives builds planned to empower composing clear projects on both a little and expansive scale.

Adafruit IO

Adafruit Io is a IOT friendly webpage which enables users to create mini remotes with switches that can be used to operate the robotic arm via signals from motor driver using MQTT protocol**.**

IV. FUNCTIONAL ANALYSIS

In this project we are going to try to control the Robotic arm not only using the wired controls but with the help of Internet of Things which is the growing technology in recent times we successfully controlled the robotic arm using the IOT interface. This can be done via the 4 modules as listed below:
1) Raspberry pi Laptop System
2) Development of an account for Ada-fruit IO Remote
3) Formulation of operating python code software.
4) Robotic arm link with pi, servo motor, motor driver and checking.

A. Methodology

Linking Pi with Laptop

1. Format your new SD card using SD card formatter software and install Raspbian OS using eject flasher software and flash it.
2. Insert SD card in pi holder and power it using the universal cable and connect it to Wi-Fi router using Ethernet cable.
3. After downloading Putty and VNC viewer into your laptop, find out the assigned IP address to your pi via DHCP client list
4. Now after entering the IP address in putty CMD terminal will be opened where you have to insert the username and password of PI.
5. Now your laptop is connected to pi.
6. Now open VNC viewer and connect the new device to pi to view virtual pi desktop on your own laptop.

Development of a controller mini remote in Adafruit-IO and Account creation

1. here, we go to adafruit IO webpage and create an account for our self-using our very own email id and password.
2. Later, we create our own new dashboard based on our requirement and add on various buttons like on, off, move, pause in a drag and drop way.
3. Here, in my project I have added buttons like remote control, restart on and off for motor 1 and motor 2 respectively so as to control the robotic arm that has been created via adafruit io dashboard.

Formulation of Python code software

1. Post to the remote creation we develop a python code environment that coincides with the remote and parallel passes on low current signals to the motor driver which it converts to high current signals and execution takes place.

2. Here, we have used MQTT protocol which is the standard for internet of things messaging code. The MQTT is an OASIS basic Internet of Things (Iot) messaging protocol. It is designed as an extremely lightweight publish / subscribe messaging transport, suitable for connecting remote devices with a small footprint of code and a limited bandwidth of the network. Today, MQTT is used in a wide range of industries, including the automobile, construction, telecommunications, oil and gas, etc.

3. In the working python code we have used 3 definitions understandable by the client which are:

- Define connected- Which helps remote user to connect
- Define disconnect-Which helps remote user to disestablish the connection
- Define message-which enables the user to pass on a payload current signal via remote which then controls the motor driver accordingly so that the effect is seen in the robotic arm.

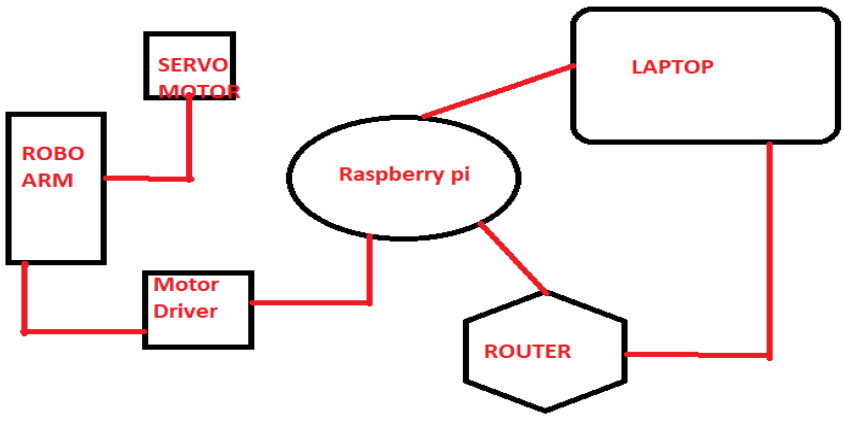
4. The advantages of using this would be-
I. Reliable message delivery
II. Bi-directional communications
III. Security enabled
IV. Support for unknown networks.

Robotic arm link and other connections

1. Here in this functional method we make sure all the connections are rightly established.
2. The connections should be as follows-
- Pi to Router
- Pi to laptop wireless
- Pi to motor driver
- Motor driver to Robotic arm
- Robotic arm to servo motor

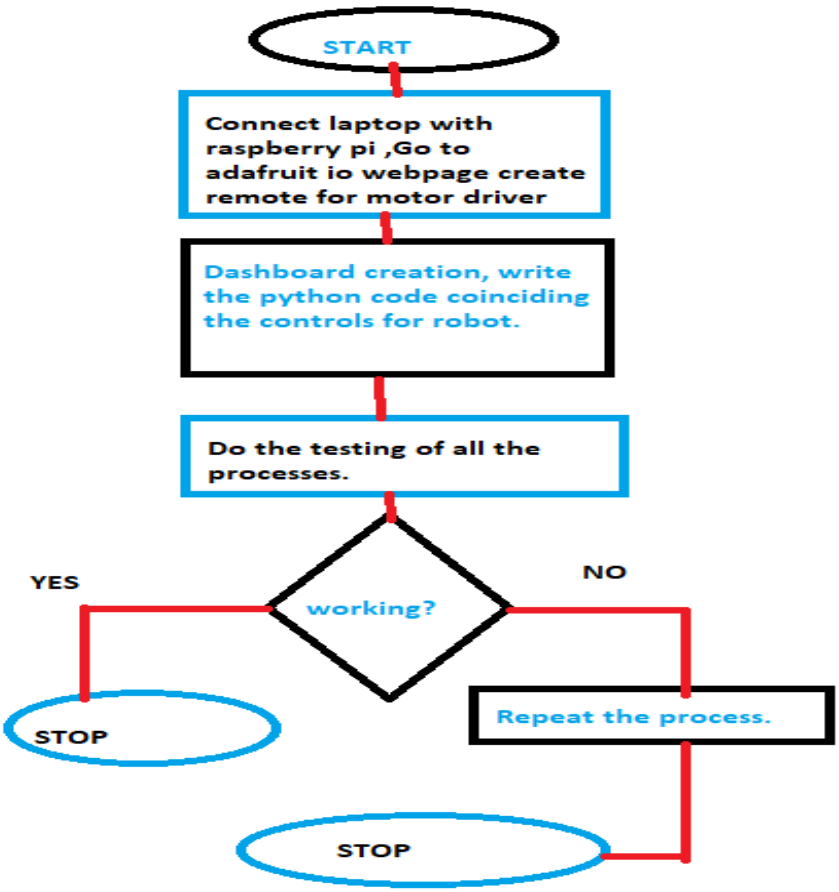
B. Experimentation

Block diagram of the workflow mechanism



BLOCK DIAGRAM OF THE WORKFLOW CONNECTIONS

C. Flowchart of methodology



FLOW CHART MECHANISM OF ROBOTIC ARM

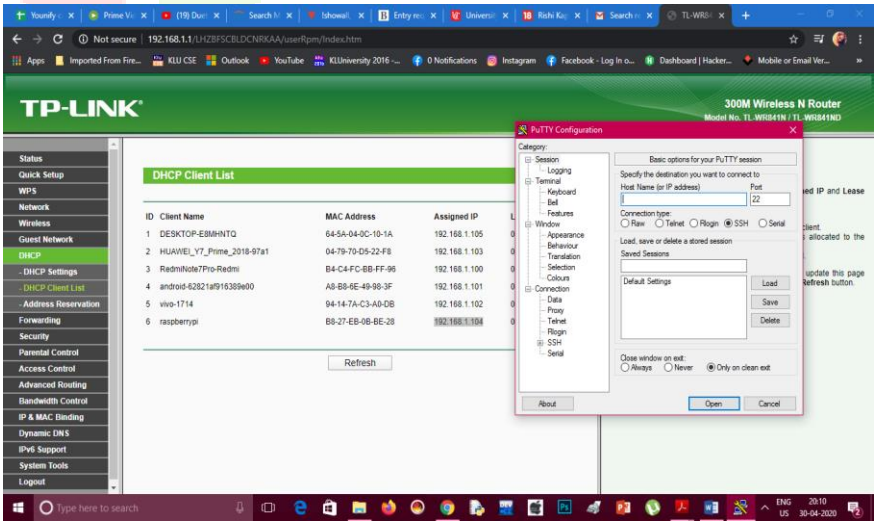
D. Working code:

```
# Import Adafruit IO MQTT client.

from Adafruit_IO import MQTTClient

import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BOARD)
GPIO.setup(3,GPIO.OUT)
GPIO.setup(5,GPIO.OUT)
GPIO.setup(7,GPIO.OUT)
GPIO.setup(11,GPIO.OUT)

# Set to your Adafruit IO key & username below.

ADAFRUIT_IO_KEY = '49cc45a9695e4bdb8ef8cfdb98dcff7d'
ADAFRUIT_IO_USERNAME = 'HEERA'
FEED_ID = 'abc'

def connected(client):
print('Connected to Adafruit IO! Listening for {0} changes...'.format(FEED_ID))
client.subscribe('abc')
def disconnected(client):
print('Disconnected from Adafruit IO!')
sys.exit(1)

def message(client, feed_id, payload):
print(payload)

#print(msg.payload)
```

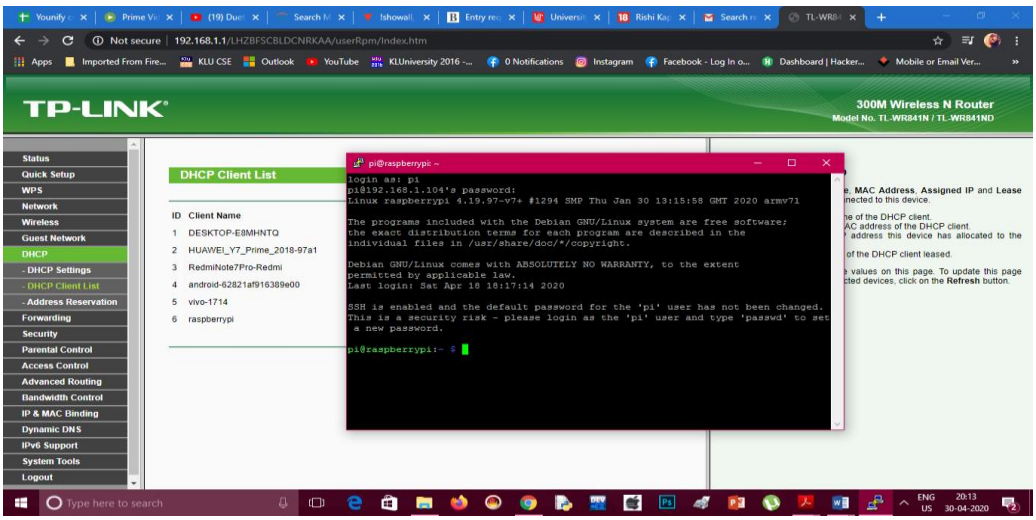
```
if payload=="5":
GPIO.output(3,1)
GPIO.output(5,0)
GPIO.output(7,0)
GPIO.output(11,0)
print("motor forward")

elif payload=="10":
GPIO.output(3,0)
GPIO.output(5,1)
GPIO.output(7,0)
GPIO.output(11,0)
print("motor backward")

elif payload=="13":
GPIO.output(3,0)
GPIO.output(5,0)
GPIO.output(7,0)
GPIO.output(11,1)
print("motor backward")

elif payload=="8":
GPIO.output(3,0)
GPIO.output(5,0)
GPIO.output(7,1)
GPIO.output(11,0)
print("motor backward")

client = MQTTClient(ADAFRUIT_IO_USERNAME, ADAFRUIT_IO_KEY)



client.on_connect = connected
client.on_disconnect = disconnected
client.on_message = message
client.connect()
client.loop_blocking()
```

E. Outputs

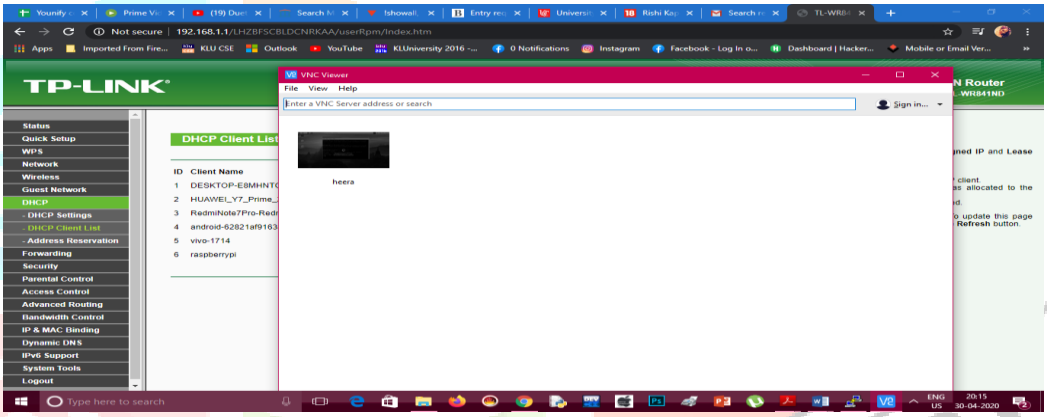
1. With putty



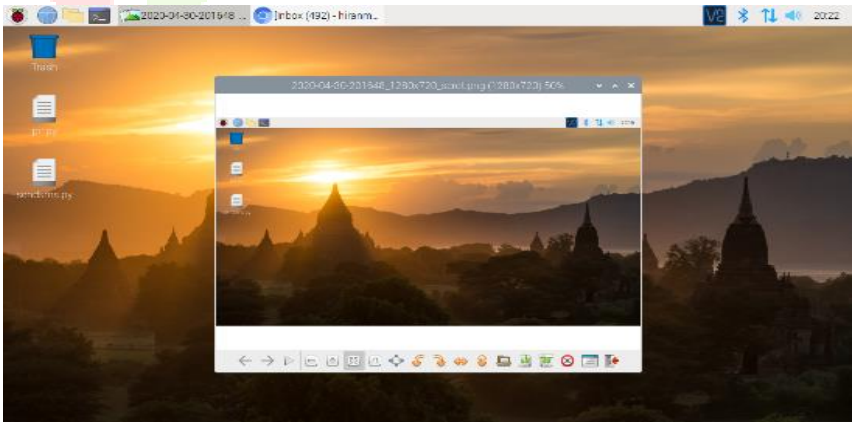
2. After inserting the right ip address



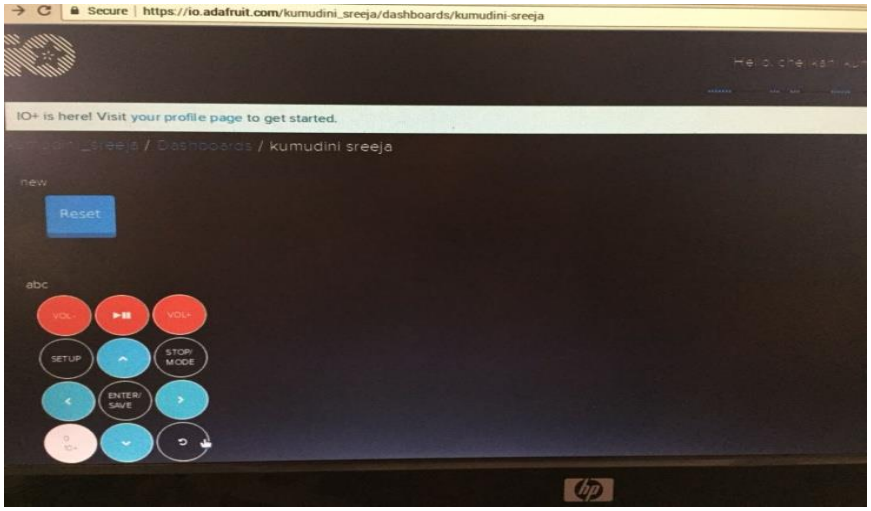
3. With VNC Viewer while creating a new virtual device named “HEERA”



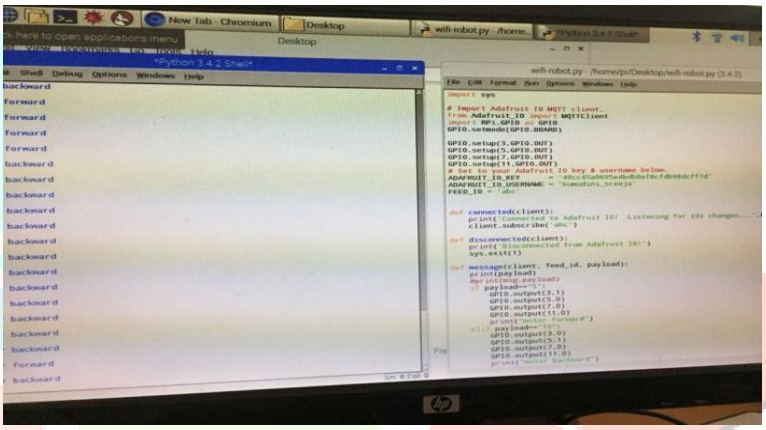
4. After creating the virtual device in laptop



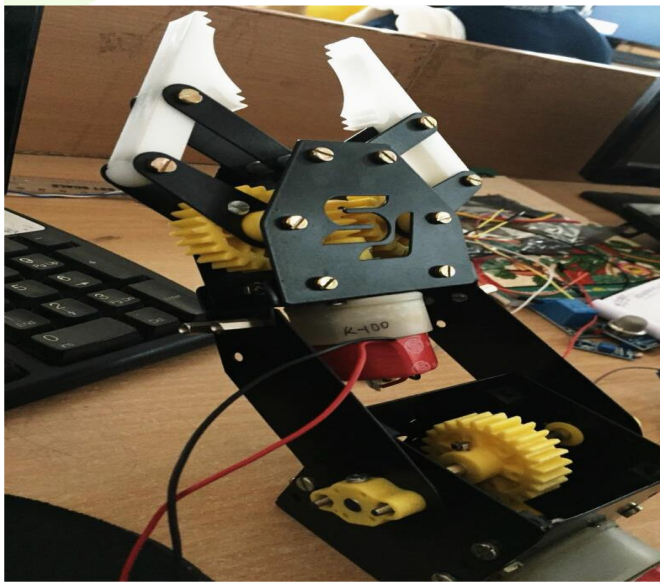
5. Adafruit account and remote creation



6. Python code environment



7. Robotic Arm Movement



V. FIGURES AND TABLES

Figure [1] - A Robotic Arm

Figure [2]: Raspberry Pie 3

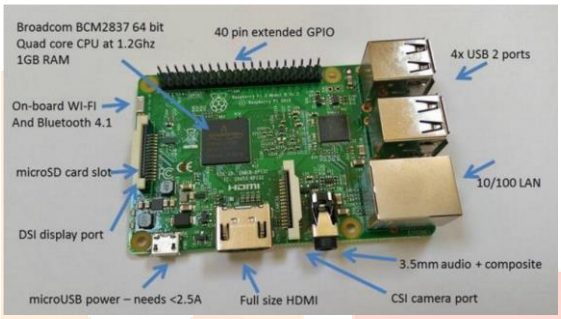


Figure [3]: Raspberry Pie 3 GPIO Pins

Pin#	NAME	Connection		Connection	NAME	Pin#
01	3.3V			5V (Powerboost)	5V	02
03	GPIO 2			5V (Cupcade)	5V	04
05	GPIO 3			GND (Powerboost)	Ground	06
07	GPIO 4	START			GPIO 14	08
09	Ground	GND (Cupcade)			GPIO 16	10
11	GPIO 17	UP		SELECT	GPIO 18	12
13	GPIO 27	DOWN		GND (Select/Start)	Ground	14
15	GPIO 22	LEFT		RIGHT	GPIO 23	16
17	3.3V			A	GPIO 24	18
19	GPIO 10	B		GND (ABXYR)	Ground	20
21	GPIO 09	X		Y	GPIO 25	22
23	GPIO 11	L Shoulder		R Shoulder	GPIO 08	24
25	Ground	GND (L)			GPIO 07	26
27	ID_SD				ID_SC	28
29	GPIO 05				Ground	30
31	GPIO 06				GPIO 12	32
33	GPIO 13				Ground	34
35	GPIO 19				GPIO 16	36
37	GPIO 26				GPIO 20	38
39	Ground				GPIO 21	40

Table [1]: Raspberry Pie Specification

CPU	QUAD CORE 64-BIT ARM CORTEX A53 Clocked at 1.2GHz
GPU	400MHZ VIDEO CORE IV MULTIMEDIA
MEMORY	1GB LPDDR2-900SDRAM (900MHz)
USB	4
VIDEO OUTPUTS	HDMI COMPOSITE VIDEO(PAL &NTSC)VIA 3.5mm JACK
NETWORKS	10/100MBPS ETHERNET &802.11n wireless LAN
PERIPHERALS	17 GPIO PLUS SPECIFICATION FUNCTION & HAT ID BUS
BLUETOOTH	4.1
POWER SOURCE	5V Via MICRO USB OR GPIO HEADER
SIZE	85.60mmX56.5mm
WEIGHT	45g

Figure [4]: Servo Motor

Figure [5]: Motor Driver Pin Diagram

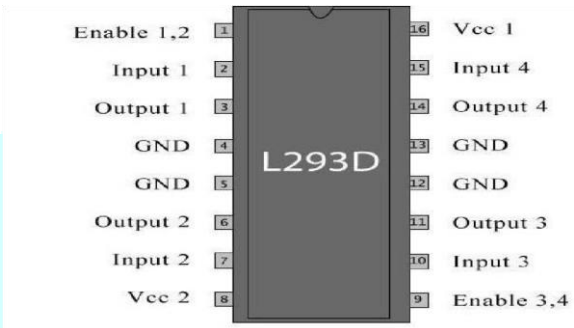


Table [2]: motor driver Specification

Pin No.	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	Vcc 2
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	Vcc

IV. RESULTS AND DISCUSSION

Thus, we have successfully established a system that makes robot to pick and place things accordingly in situations where in a man may not be able to access.

In this project we have well tried to control the Robotic arm not only by using the wired controls, but with the aid of the Internet of Things, which is the growing technology we have successfully operated the robotic arm using the Iot interface in recent times. This can be useful for various industrial applications where machines need control from remote locations. Not only does this project respond to the controls sent, it also tracks the movements and can perform the same tasks that repeatedly reduce human effort.

A lot of experiments were performed using Raspberry Pi to manipulate the robot arm. The robotic arm could have both automatically and manually worked which is necessary for industrial purposes. Experiments this has gained full precision to accomplish a mission. Below figure shows the Object recognition snapshots and local colour and manual web page identification. The robotic arm will pick the target one by one, and detect an object and position it at a given location.

VI. CONCLUSION & FUTURE SCOPE

Thus, we have efficiently developed a mini controller arm which picks and places things as desired. The paper discusses three degrees of freedom on robotic arm. The robotic arm had been constructed of readily available low-cost materials. The robotic arm model was developed, and the functionality was tested. Using the module restricts the robotic arm's remote access to a few meters. Future work may include using a ZigBee module to monitor the robotic arm from a remoter position. The robotic arm can be operated over the internet through Ethernet connectivity and a visual feedback camera.

Although there is much that can be said about Robotics and Iot, I feel there are still a lot of undiscovered surprises in store for us in this area. We see a lot of complex changes induced by technological progress around us, even without understanding that it is subject to using Iot without understanding it. I have always been a technology fan myself and while naysayers are afraid of its potential, I believe we need to push and explore more. When it comes to the future of Iot and Robotics, we first need to break down what both are in order to better grasp the potential developments in these spaces.

IOT: The Internet of Things or Iot is a collection of interrelated computing devices, mechanical and digital machines, objects, animals or people with unique identifiers (UIDs) and the ability to transmit data over a network without human-to - human or computer-to - computer interaction.

Robotics: Robotics is an interdisciplinary engineering and science branch that includes mechanical engineering, electronic engineering, computer science, and others.

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