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IoT BASED ROBOTIC ARM FOR HUMAN ASSISTANCE

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Abstract— Personal assistance robot is used to reduce human work in their day to day life. This paper describes the development and implementation of IOT- based human assistance robotic arm. It is mainly controlled by voice commands to pick and place the object in a particular place. Voice communication is done by Android application and Bluetooth module. Raspberry pi is used to control the motor drivers and also interfaced with LCD for displaying the commands. At the end effector,pi camera is placed to capture the object in front of the robotic arm. Image captured by the pi-camera is analysed in visual studio code in raspberry pi. YOLO v4 algorithm is used for the accurate, faster object detection in the real time. The identified object names are get extracted from the image using py-tessaract. Optical Character Recognition is used to extract the text from the image .Based on the input voice command the robotic arm will pick the particular object and compare the object name with the voice command. Then the robotic arm will perform their function based on programming.In this proposed work, building the low cost, user friendly efficient robotic arm is made from the cheap house hold materials. The performance of the proposed work is measured in terms of accuracy, DOF and latency.

Keywords— Robotic arm, Bluetooth module, object detection,YOLOv4, OCR, end effector.

I. I.INTRODUCTION

In this digital era, everything is digitalized and automation everywhere.Nowadays Robots become the complete substitute for humans and replace their works. 21st century is the booming age for robotics. Relationship between people and machine is the Human-robot interaction. Today, advanced robots are popping up that they can mimic like a human and think like them to make decisions.This paper proposes the IOT-based voice controlled robotic arm for helping physically disabled people and to assist elderly people.The robotic arm control is controlled by connecting to the android application through Bluetooth module connected to the Raspberry pi.The purpose of this project is to design a voice controlled robotic arm that can do some basic commands like move up, down, open, close and stop.Speech recognition is done at the input side. The gripper, also called as “end-effector” is used to grasp the object.By using pi-camera the image of the object is captured placed infront of the robotic arm.Then by

using YOLO v4 algorithm object is detected with a high accurate rate. The remainder of this paper is organized as follows. Section 2 discusses about research challenges. Section 3 describes about methodology involved in this work. Section 4 discusses about results obtained. Section 5 shows some concluding remarks and future scope of this work.

II.LITERATURE SURVEY

The literature works related to the usage and enhancement of robotic arm is discussed as follows. The paper intends to significantly enhance people's quality of life, particularly that of those who have physical and mobility limitations. The robotic system is based on the French Niryo-One robotic arm and has an HD (High Definition) USB (Universal Serial Bus) camera on the end-effector. They altered the YOLO algorithm to attain great accuracy by incorporating unique elements and extra computations for the kinematic model [1]. The robotic arm's ability to select and position an object in a random location is based on the Arduino, a few sensors, and a pi-camera. The inverse kinematics equation can be used to calculate the rotation angle of each servo motor using the distance value that the ultrasonic sensor provides. The Pi camera records the footage, which the Raspberry Pi then processes to find the centroid of the item. To move the robotic arm into the appropriate position, the Raspberry Pi communicates with the Arduino microcontroller[2].

The highlights of a robotic arm's performance based on the Internet of Things are discussed. A computer may keep control of the robot arm over the internet. This robot might be used to demonstrate how a robot could be utilised to carry out regular human duties around the house. The robotic arm's angle is controlled by an Arduino Uno, and it is connected to the internet by an Arduino Ethernet Shield. The accuracy test shows that the results of the real output of the motor driver compared to the input given to Arduino Uno through the internet are between 97 and 99 percent correct. The prototype of the robot showed that the process was effective. It is hoped that this friendly robot would bridge the gap between chores and robotics [3]. A self-feeding assistive robotic arm for patients with physical limitations of the extremities, such as stroke, spinal cord injury, and muscular dystrophy, has been developed in contemporary robotics research. A 7-DoF robotic arm was created such that it could feed in the same manner as a human arm, and it was controlled by a simulator. The robotic arm system can thus move more than 80% of food and water to their correct placements, according to experimental results. [4].The project is designed to operate robotic arm by using an Android application called AMR.By the smart analysis of the algorithm ,the system operates robotic arm depending on the data transmitted from the Android application device. This proposed system solves the problem by integrating robotic arm to a control unit that can be operated by Android smart-phone/tablet etc[5]. In this digital era, robotic control systems are being investigated and improved intensively, particularly in industrial manufacturing. They are investigated in a variety of methods, ranging from image processing to voice-activated applications. Robot communication systems must grow in three aspects of production: greater connection quality, safety, and cost.

In this paper work, a robotics control and monitoring protocols based on a developed 4.0 industry technology used in the Internet of Things (IoT).[6] Building the drone to assist in search and rescue operation this type of aerial robot is made for human detection it can be done

during the disaster zone using raspberry pi and pi-camera which is mounted on drone with the help of mask RCNN and YOLO.By VNC viewer the human detection is viewed on the laptop.This paper concludes with the feedback of using YOLO is faster then mask RCNN in the real time video[7]This proposed work uses the pi-camera for capturing the real time video.Surviellance drones are used to detect the humans in the country border.Computer vision is used for detection. Raspberry pi is integrated with gsm, flight controller,transmitter and receiver module[8]. This research project aims to build a rover for monitoring environmental conditions, as well as an existing detection system and data collection using closed-circuit television (CCTV), employees, and detecting animals. The system may be used to analyse damage and poisoning of regions based on sensor readings, as well as to monitor through the device's visual picture.

The rover uses the Internet of Things (IoT) concept and is capable of monitoring the state of the environment using sensors such as a sensing layer, thermometer, air quality sensor, ultrasonic sensor, and camera. A smartphone application will be used to drive the created rover, and sensor information and the camera picture will be analyzed through the app[9]. The current research aims to create a reduced system that can detect and warns the public about impending floods. The suggested floodwater detection and prevention system.Three parts make up the early warning system. The sensing unit uses a continuous monitoring system to keep track of environmental data.Sensors for ultrasonic, temperature, and humidity. The data gathered from the processing unit is processed and analysed by the processing unit.sensors. The alerting equipment then uses a siren and a Short Message Service to notify the involvement of local authorities.Notification by text message (SMS). To enable internet access, the system makes advantage of the worldwide system for mobile communication.permits cloud-based data collection, storage, and monitoring[10].

III. METHODOLOGY

The proposed work focuses on developing a voice controlled robotic arm for human assistance. The overall block diagram of the proposed work is shown in the Fig 1and the flow chart of the proposed work is depicted in Fig 2.

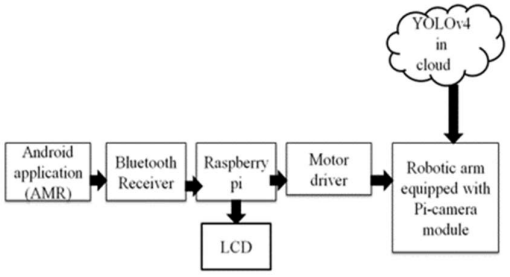

Fig 1: Block diagram of the proposed model

The block diagram explains the overall working of the suggested work. Android Application is used to pair the robotic arm with HC-05 bluetooth module. It is interfaced with raspberry pi. When the signal received from the microcontroller the motor driver start to run.Pi camera is mounted on the robotic arm detecting the object, then image is analysed by the You Only Look Once v4 algorithm.

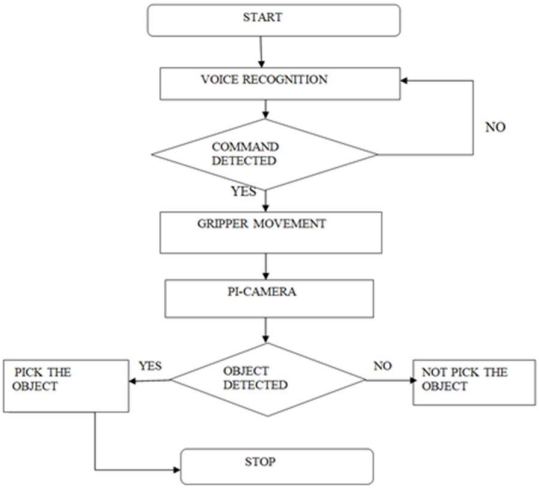

Fig 2: Flow diagram of the research work

This Flow chart explains the working flow of the research work.It starts with the voice command, when the command is detected it will proceed to the next step otherwise it will get into the loop again and again until it get a proper pronunciation of the voice command that programmed earlier.Gripper movement takes place based on recognized voice command.pi-Camera is attached with the robotic arm for the object detection. YOLO v4 employs to the accurate object detection. If the object detected,the arm will pick the object otherwise it won't pick the object.The system will stop when the mentioned work is done.

A.HARDWARE INVOLVED

RASPBERRY PI 3B

The Raspberry Pi 3 B is the Raspberry Pi's third generation. This is a powerful credit-card sized single system computer succeeds the rasberry Pi Model B+ and Raspberry Pi 3 B and may be used for a most of the applications.This type of board can replace the computer systems.

HC-05 BLUETOOTH MODULE

HC-05 wireless Bluetooth module is connected with smart phones Bluetooth at the input side of the proposed model.It has a 6 pin wireless Bluetooth module with button for arduino and raspberry pi is placed.The serial communication takes place between smart phone's Bluetooth and HC-05 bluetooth module.

L293D MOTOR DRIVER IC

A motor driver or motor driver IC by the name of L293D enables a DC motor to move in either direction. A pair of two DC motors can be controlled simultaneously in any direction by the 16-pin integrated circuit L293D. It means that a single L293D IC may operate two DC motors. In the integrated circuit for the motor driver, there is a dual H-bridge type (IC).

STEP DOWN TRANSFORMER

One sort of transformer that converts high voltage and low current from the primary side to low voltage and high current on the secondary side is called a step-down transformer. It has several uses, however it is primarily utilized in electrical systems like transmission lines.

PI-CAMERA

The Raspberry Pi is compatible with the tiny, lightweight Pi camera module. The Pi connects using the MIPI camera serial interface protocol. Applications for image processing,

machine learning, and surveillance frequently employ it. The sensor itself has a fixed focus lens and a 5 megapixel native resolution.

LIQUID CRYSTAL DISPLAY

LCDs are compatible with low-power electrical circuitry and can be operated for lengthy periods of time since they require less electricity. Here LCD screen is used to display the action of the robotic arm.

DC GEAR MOTOR

A DC A gear motor is one that is connected to a gearbox. RPM, which stands for revolutions per minute, is a unit of measurement for motor speed. By reducing speed and increasing torque, the gear assembly helps. By adopting the proper gearing, a gear motor's speed can be reduced to any desired level. The idea of gear reduction is to use gears to slow down the vehicle while boosting its torque.

7805 HEAT SINK

A circuit's voltage sources could change, causing variable voltage outputs. A voltage regulator integrated circuit maintains a steady output voltage. The 7805 Voltage Regulator, which belongs to the 78xx class of fixed linear voltage regulators designed to control such changes, is a well-known voltage regulator in an integrated circuit (IC).

B. SOFTWARE INVOLVED

VISUAL STUDIO CODE

An independent source code editor called Visual Studio Code is available for Windows, Mac OS, and Linux. It is mostly used by web developers and JAVA programmers, and it has several extensions to accommodate various programming languages. VS code is another name for Visual Studio Code. Users can open one or more folders, which can then be saved as workspaces for later usage, rather than having a system design. It can therefore be utilised as a language-neutral editor for any languages. It supports numerous programming languages, each of which has a unique set of features. Unwanted files and folders can be excluded from the project tree using the arguments. Many features of Visual Studio Code can only be accessed through the command palette and not through panels or the user interface. Visual Studio Code can be extended with extensions, which are accessible through a shared repository. This pertains to system language support as well as editor improvements.

AMR- ANDROID APPLICATION

It is an android application, needs internet and is mainly used for voice recognition purpose. AMR is a web-based voice control application that sends voice commands to a robot that is paired with a Bluetooth serial module using internal voice recognition on an Android mobile device. The programme may deliver the recognised voice as a string. If a voice command is recognized it will convert into string as *Move up#, * and # indicates the starting and ending bit.User have to install it before controlling the robotic arm from the Google play store.

OPTICAL CHARACTER RECOGNITION

Optical Character Recognition(OCR) it is a technology used to analyze the text in images. It is a commercial solution for extracting data from written or printed text in a scanned image or image file and turning the text into a computer form for data processing such as editing or searching. An Application called Python-tesseract uses Python to do optical character recognition (OCR). In other words, it will find and "read" text that is present in photos. Python-

tesseract is used to encase Google's Tesseract-OCR Engine. In this effort, the text was retrieved from the image captured by the pi-camera.

C. ALGORITHM USED

YOU ONLY LOOK ONCE (YOLO v4)

You Only Look Once uses the CNN to detect objects and eliminates background mistakes. Its unique features include speed detection and learning capabilities. The YOLO technique employs a neural network to enable real-time object recognition, and it is well-known for its accuracy and speed. This algorithm's implementation is done in Google Colab. For this implementation, the Darknet Framework was utilised. Because the algorithm would have to be run by the GPU, this will be chosen to get the greatest feasible FPS (Graphics Processing Unit). The COCO dataset was utilised for object recognition since it contains 80 different types of common things.

The x and y coordinates of the centres of the identified objects, as well as the certainty percentages for the class label it recognised, are generated by the method. Object recognition in YOLO v4 is quite accurate.This algorithm is known for its high accuracy,good learning ability and best speed in analyse.

COMPUTER VISION

OpenCV is a free and open-source library for computer vision issues. The quickest approach to install OpenCV to python is using pip, provided you have python 3 pre-installed in your PCs. You may do so by entering the command line below into your command prompt.

pip3 install opencv-python

Open the python IDE of your options and import OpenCV after you've installed the OpenCV package.

import cv2

IV.RESULTS AND DISCUSSION

For the limbs of the robotic arm is made up of aluminium rod. At the end ,gripper is attached for hold and release the object.The robotic arm is mount on the steel stand, here the electroni components can be mounted without distrubing the robotic arm movement.Smart phone is needed to connect with the robotic arm through bluetooth.AMR android application must be installed prior.Bluetooth module is present at the receiver side to connect with the robotic arm.After the signal receives from the microcontroller, the motor driver will starts to perform its function.The top view of the hardware set up of the prototype model is shown in the Fig 3.

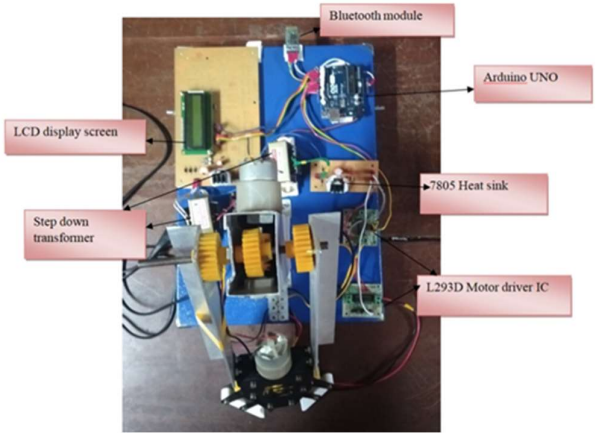

Fig 3: Top view of hardware setup

Based on the voice command the robotic arm will perform the function. It will take time to recognize the voice command of the user.In the below graph based on the voice command how much time it will take to response is in Fig 4.

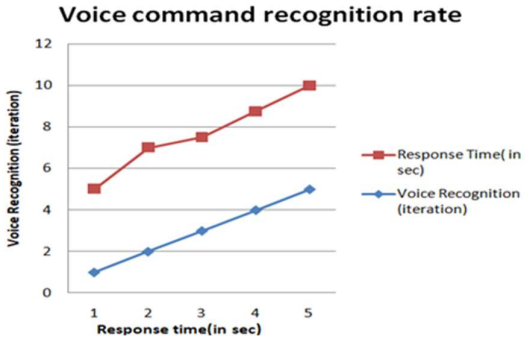

Fig 4:Voice Recognition Rate with iteration and reasponse time.

The commands used for controlling the robotic arm is shown in Table 4.1.For each commands the number of test conducted is 10 the percentage of the accuracy is measured.

Table 4.1 Voice command recognition (Speech to text conversion rate)

Commands given	No. of tests	No. of correct tests	Percentage of accuracy
Move up	10	9	90%
Down	10	10	100%
Open	10	10	100%
Close	10	10	100%
Stop	10	9	90%

Picture captured by the pi camera and it is analysed by the YOLO v4 algorithm and achieve 97.35% of accuracy in image detection.In the Fig 5 the object detection is done by YOLO v4 in visual studio code.The object identified is box and the keyboard with the image captured by the pi-camera.The execution of the each command is done based on the iteration the results are graphed in Fig 6.

Fig 5:Object detection by YOLO v4

Fig 6:Execution of the each command

Based on the iteration,how many times it will take to respond the command is measured with the repetation of five times.The object picking of the robotic arm is done and shown in Fig 7.

Fig 7:Object picking by the robotic arm

Only when the correct voice recognition the robotic arm will respond for its command that is programmed already.Microcontroller for controlling the motor drivers.Optical Character Recognition is used by the py tesseract to extract the text from the image captued from the pi-camera.Then the extracted text is compared with the input voice command.If it matches then the robotic arm will perform the pick action.The extracted text is done by OCR the results are shown in the Fig 8.

Fig 8: Text extraction from image

Comparision of the extracted text from the image is done by using python code.First the string1 is compared with the string2 then string 1 with string 3. The results are taken and shown in the Fig 9.

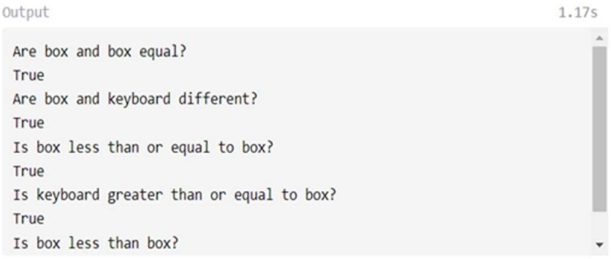

Fig 9: Comparision of the text

V.CONCLUSION

The goal of this study is to create a low-cost speech controlled robotic arm that can recognise and deliver things to the user. Our initiative seeks to improve the quality of life of those who have physical mobility disabilities.This work highlights the robotic arm is made from the aluminium rod it is much cost effective than the other robotic arm that has been purchased from the market.The mechanical part is stronger compare to other plastic robotic arms.This robotic arm is capable of lifting upto 1kg of load is one of the significant thing in this project work.Computer vision and voice control algorithms are used to power the robotic arm helper. It is a low cost, user friendly handmade robotic arm. This type of robotic arm uses low power Bluetooth technology.

Bluetooth connectivity between a smart phone and a microcontroller is possible. It may be utilised in a variety of sectors to pick up things that don't require human participation. It may be utilised to construct robots with military applications on a huge scale. It allows for greater application creation using the Android operating system. Bluetooth app called AMR is simple and free. With such a powerful smart phone connecting the Bluetooth module is done. Object detection is done by using YOLO v4 algorithm in open cv. We achieved the accuracy rate of 97.5 in detecting the object.2 DoF is implemented in this robotic arm. For the future work we decide to improve more degree of freedom in the robotic arm to move its arm to the greater extent. Latency can be improved further.

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