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DEVELOPMENT OF ROBOT TO ASSIST HOSPITALS DURING CORONAVIRUS COVID-19 PANDEMIC

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Abstract - *An indoor navigation hospital assist robot is a mobile robot that is designed along with a web-page to help doctors, nurses, and patients in the hospital during the COVID-19 isolation period. The robot is used to detect and locate medicines kept in different racks by scanning the QR code. The robot is used to carry food and medicines without creating direct contact between humans and thereby maintaining social distancing. The robot will collect oropharyngeal swab for testing from patients, so medical workers don't have to directly collect the swab. Wi-Fi based navigation and obstacle avoidance mechanism will make the motion flawless. The robot can be controlled by the user by giving specific voice commands and through the webpage. The voice command is received by a microphone and processed by the voice module. After recognizing the voice command by the robot, a command message is sent to the robot's microcontroller by the voice module. The microcontroller analyzes the message and takes necessary actions. The robot shows indoor maps of hospitals, including the labs and various scanning facilities in the various floors using voice recognition. It also shows doctors' availability. It can also detect the face of medical workers by face detection mechanism. The sanitizer bottle is attached to the robot for disinfecting hands.*

***Key Words*: Robot, indoor-navigation, voice control, face recognition, corona, covid-19, pandemic.**

1. INTRODUCTION

Indoor navigation is one of the elemental purposes for real-time use of a mobile robot. There are a plethora of researches and many of them are implemented on the topic of autonomous indoor navigation for practical use. The algorithms are not easily accessible to users for practical purposes and users face restrictions in adapting the algorithm for navigation implementation. There are many algorithms and methods for obstacle avoidance, but it is not easy to integrate the algorithm into navigation software for practical implementation. Using an online cloud server the voice commands are processed in real-time. The speech signal commands transformed to text form are communicated to the robot. The users are provided with audible directions by the system to the desired destination. Also, a camera s used to detect persons. Camera capture the picture continuously, if any person matches the already given database then his name will b say by robot and can hear using a speaker. This project is one of the successful implementations of the indoor navigation which is practically feasible in the respect that it combines voice and webpage controlling, identification of the location of medicines on the rack, and obstacle avoidance, and path tracking in a coherent manner.

2. LITERATURE REVIEW

Obstacle Avoidance Robot [1]
Obstacle avoidance robot vehicle which identifies and avoid the restrictions in its path using ultrasonic sensors. AT mega 8 micro-controller is used to control the desired operation. An ultra-sonic sensor sends a command to the microcontroller when it senses the obstacle in its proximity. The robot is redirected to alternate directions by the microcontroller. The microcontroller does this by actuating the motors which are interfaced with it through a motor driver, depending upon the input signal.

Speech-To-Text Conversion System Using Hidden Markov Model [3]
Directing and controlling systems and machines with speech is an important discovery that improves human life and increases the comfort of the users. The robot is fully controlled by the voice input received through its microphone, which is analyzed and processed in the computer and sent to the robot and the robot will act accordingly. The important medium for communication is through speech and by the development of communication technologies in the last era, the speech system starts to be the pivotal point for interfacing many systems. The speech system is more adaptable and easier to communicate than different complex interfaces.

Indoor Navigation using Wi-Fi signals [6]
There are various methods and advantages for the navigation system by using already installed infrastructure such as Wi-Fi Access Point. An indoor navigation system was created using both inertial sensors and Wi-Fi signal strength information. The modular approach is used for the whole system architecture, both hardware and software which make it easy for test and benchmark of various algorithms and data fusion techniques. To validate the system basic algorithms are performed using simulated data through a software-in-the-loop setup.

Real Time Face Detection and Tracking Using OpenCV [8]

By tracking and analyzing different head positions and gestures, eyes, the face can be detected using Haar Classifier through Raspberry Pi BCM2835 CPU processor which is the integration of SoC with GPU based Architecture. The libraries used for face detection are SimpleCV and OpenCV.By using a computer the results are computed with the help of libraries along with the hardware were attained through 30 fps for higher accuracy and speediness for face detection.

3. BLOCK DIAGRAM

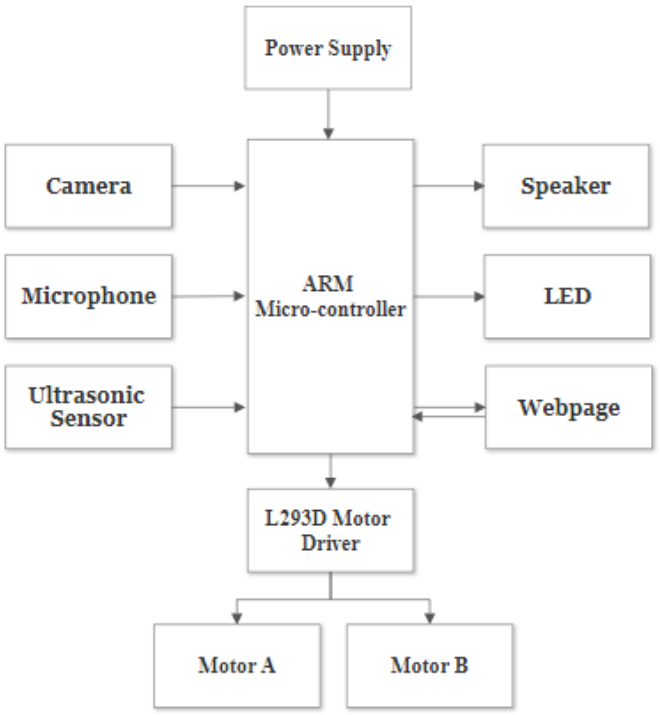

Fig-1: Block diagram

3.1 HARDWARE USED

Raspberry Pi 2

Raspberry Pi 3b+ is originally created for educational purposes with the size of a credit card. It is a 1.4GHz 64-bit quad-core Broadcom ARM cortex A53- architecture processor which is having 4 USB 2.0 ports and extended 40 pin GPIO header with low energy onboard Wi-Fi, Bluetooth, and USB ports. It has improved power management to support a more powerful external USB port.

Fig-2: Raspberry Pi 3b+

Ultrasonic sensor

The ultrasonic which is having a dimension of about 45*20*15mm consists of ultrasonic transmitters, receiver, and a control circuit. It has a ranging accuracy up to 3mm and provides a 2cm-400cm non- contact measurement function with a working frequency of 40Hz.

Fig-3: Ultrasonic sensor

Web camera

Webcams consist of a lens, an image sensor, support electronics, and contain a microphone for sound. Different types of lenses are available, and most common among that in the consumer-grade webcams, which is a plastic lens that can be moved in and out to focus the camera.

Fig-4: Webcam

Motor driver L293D

It is a typical motor driver that permits the DC motor to drive on different directions.L293D is a 16-pin IC that receives signals from the microprocessor and transmits the relative signal to the motors.

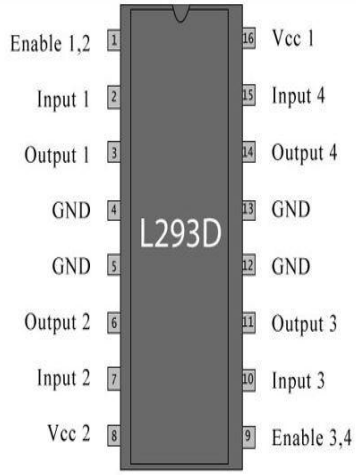

Fig-5: L293D Motor driver

DC motor

It transforms direct current electrical energy into mechanical energy. The speed of the DC motor can be controlled over a wide range, using variable supply. Speed can also be altered by changing the strength of the current in its field windings.

Fig-6: DC motor

LED

The light-emitting diode is a semiconductor diode which is available in different colors, size along with special applications such as Ultraviolet and Infrared. It includes a chip of semiconductor material doped with impurities.

Fig-7: LED

3.2 SOFTWARE USED

Python

Python is an object-oriented programming language. It has dynamic semantics which are combined with dynamic typing and dynamic binding. It is a high-level language, very simple, easy to understand and learn syntax, user friendly, and has a low cost for program maintenance. Python supports code reuse and modularity in which a bug will never cause a segmentation fault thereby increase productivity.

OpenCV

Open-source computer vision is known as OpenCV. It was originally developed by Intel is a library of programming methods which aimed mainly at real-time computer vision. OpenCV is basically written in C++ but there are bindings in python, java, and MatLab.

4. ROBOT OPERATIONS

Voice control

The speech conversion technology is used by the voice-operated robot to identify, analyze, and interpret the voice commands. In the future society, this smart voice-controlled robot will play an important part. A Voice recognition system created as a user interface to control and direct the system. The first step is to give voice commands through a microphone. And the commands are processed by the system software by analyzing the signals sent to the Bluetooth modem which is connected wirelessly to the Raspberry Pi board. 2 DC motors are used to control the robot. Through IC-L293D these DC motors are actuated by the Raspberry Pi and the robot moves accordingly.

Automatic speech recognition or speech to text recognition method is used to identify the spoken word into the text. It combines extremely complex linguistic, mathematics, and computing method for speech recognition [3]. Language is the only thing that differentiates people far above than any other creature. The little sound packets called phones which are the ideal bits of sound are generated when a word is spoken which corresponds to the letter or group of letters in the spoken word. All words are built from the sound block called phonemes. For instance, when the word stop is said it creates the phones s, t, a, a, p. Actual bits analyzed are always with the phonemes. Speech recognition by the basic principle of using its components is a good way but the use of language in the account is a better way so the language model is used for recognition.

Obstacle avoidance

Obstacle avoidance is the initial and important requirement of an autonomous mobile robot. It is designed to navigate the robot in an unknown environment by avoiding clashes. Ultrasonic sensors are employed to measure and calculate the distance between the source and target with the help of ultrasonic waves. Ultrasonic waves are selected because of their relative accuracy across short distances and will never cause disturbances as they are inaudible to the human ear.

Sonar has been used to measure distance with high accuracy and solid readings HC-SR04 is widely used for non-contact distance measurement for distances from 2cm to 400cm. Basically it includes an ultrasonic transmitter, receiver, and control circuit. The transmitter transmits short bursts that get reflected by the target and are picked up by the receiver. The time difference between the transmission and reception of ultrasonic signals is calculated by using the equation,

$$\text{Speed} = \text{Distance} / \text{Time} \quad (1)$$

where speed is the speed of the sound. Time taken by pulse is to and fro travel of ultrasonic signals, while we need only half of this. Therefore, Time is taken as Time/2. The speed of sound at sea level = 343 m/s or 34300 cm/s [1]. Thus,

$$\text{Distance} = 17150 * \text{Time (unit cm)} \quad (2)$$

Web-page control

Raspberry Pi is having 4 USB slots to use for external accessories and HDMI slot for connecting display module or TV. In order to connect raspberry pi to a laptop with LAN cable Ethernet cable can be used [5]. We create a localhost address with Internet protocol version 4 (IPV4) after connecting with pi in the network and sharing center. Then click on IPV4, then properties, and provide a static IP address. This address is localhost for LAN cable connected to the raspberry pi. Now using the communication tool known as putty communication can be established with raspberry pi and laptop. After this raspberry pi can be connected through putty with username and password. For the application of webpage controlled robot raspberry pi acts as the webserver. Through various scripting languages, the webserver can be developed.

Face detection

Face detection is an application classified under computer vision technology in which algorithms are developed and trained to properly locate faces in images. These can be taken from a webcam or from photographs. Camera software should identify and detect the features of the face for detection. It uses classifiers, which are algorithms that have been trained to detect faces using a large number of images in order to get more accuracy. OpenCV uses two types of classifiers, Local Binary Pattern and Haar Cascades.

A Haar Cascade is based on “Haar Wavelets” which is defined as a sequence of rescaled “square-shaped” functions that together form a wavelet family or basis.

A green rectangle will be generated around the face after detecting the face. HAAR Wavelet algorithm is employed to analyze pixels in the image. Machine learning technique is used to get a high degree of accuracy from "training the data", which uses "integral image" techniques to measure the features detected. Adaboost learning algorithm has been used by HAAR Cascades that selects a small number of important features from a large set to a high good result. A function is trained from a lot of positive and negative images in machine learning. This process in the algorithm is feature extraction. In order to train the data, an XML file is used. The XML file is:

haarcascade_frontalface_default.xml

A rectangle with coordinates (x, y, w, h) around the detected face in the image by the detectMultiscale module from OpenCV.

Medicine detection from rack

The robot can be kept in the pharmacy. The robot scans the QR code of medicines in the prescription of the patient. The robot then identifies the medicine and indicates the position of medicine in the rack. The robot then goes and collects the medicines and navigates back to the patient

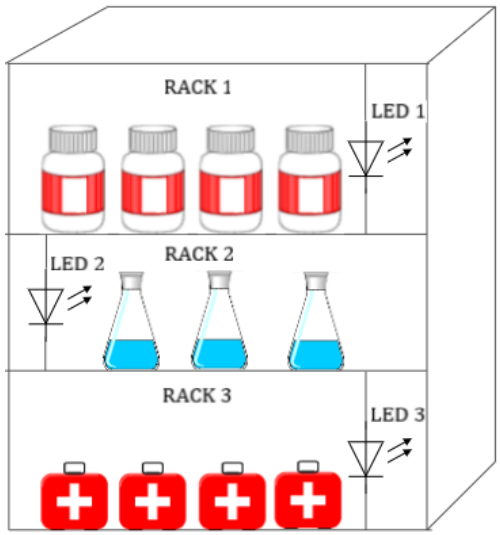

Fig-8: LED rack system to indicate medicine

5. RESULT

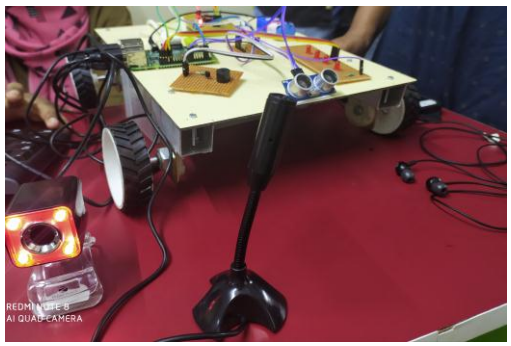

Fig-9: Front view of the robot

6. ADVANTAGES

- Cost-effective- comparing to the existing system on an average requires 4-5 lakh
- User friendly- touch screen display with web-page to guide people.
- Quick operation
- Highly secured

7. CONCLUSIONS AND FUTURE SCOPE

We designed and implemented an autonomous indoor navigation robot that can be used in hospitals, for visually impaired persons, and different other applications. Obstacles are detected and the alternate paths will be taken by the help of ultrasonic sensors. This robot can identify and detect the face of individuals by comparing it with the database and by using the speech system, the name of the particular person will be provided. The web-page is designed and implemented to control and operate the robot. Medicines kept at different racks will be identified by the led blinking when the respective codes of the medicines are given on the web-page. A bottle sanitizer is attached to the robot so that patients can disinfect their hands. At present, work is a prototype working model. The next phase in the future is to make a more powerful robot and to increase the size of the robot for better and efficient usage.

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