HOME ROBOT

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Abstract - *The home robotics is an evolution of the existing home automation. This project presents an approach to home robot using Raspberry Pi .This project is specially designed for patients suffering from serious diseases like paralysis which will helpful to family of that patient, the robot only work through the authorized persons instructions . This design is a small portable monitoring system for home & office. This includes the different process like voice reorganization, face detection, object localization, pick and place. All this is controlled by Raspberry Pi processor. The pairs of webcams are used & are able to implement a basic frontal obstacle avoidance system. With the help of the stereoscopic system, we inferred the position of the object that serve as reference to the bot. The final system is capable of identifying & following target object in a distance of over 10 Ft.*

The model B Raspberry Pi is a 3.5 W, computer with 1.2 GHz ARM V8 processor & multiple i/o interfaces. We use OpenCV libraries to process images & POCKETSPHINX for speech recognition.

Key Words: Home Robot, Raspberry Pi, OpenCV, Stereo Vision, Pocketsphinx, Degrees of freedom

1.INTRODUCTION

Robotics plays very vital role in various fields of our society such as personal security, business, industries, etc. Starting from small houses to huge scale industries, now home robot is essential and plays very vital role to fulfill our day to day aspects in many ways. Now a day keeping care taker for elder people or servant due to different reasons due to these reasons domestic robots are useful. Domestic robots are of two types 1. Indoor Domestic Robots; 2. Outdoor Domestic Robots. The home robots are come under Indoor domestic robots. This machine is mobile machine, which could pick up the object from one place and deliver at particular place, without complaining & getting tired. The number of human interactions for the control of basic human function can be replaced by using home robot which can be considered as an act of using electronic system\devices and its programming. What actions the system is to execute can be controlled by using processing component of the system which is the heart of the system. In this proposed system, the Raspberry pi as a really powerful microcontroller and in the mean time it will act as a normal use computer. Hence this system will work in standalone mode without the necessity of the PC. Pair of webcams is used and are able to implement a basic frontal obstacle avoidance system. The two images captured between two cameras called disparity. Disparity means difference. Disparity map is measurement of difference between two images.

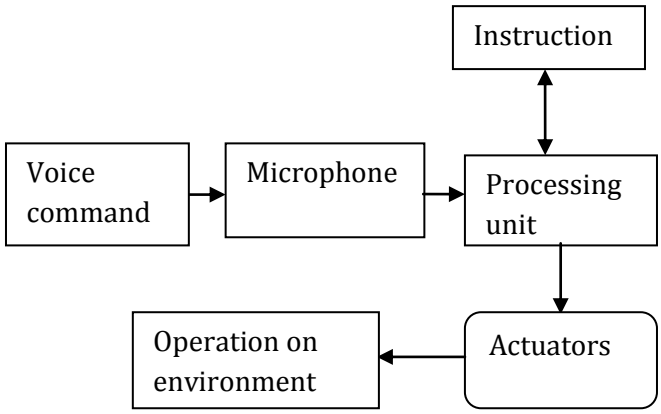

Fig1: Major components of Robotics system

Compter vision is one of the most demanding areas in a robotic field. To move materials, parts, tools or specialiezed device through variable programmed motion for performance of variety of tasks robot act as a programmed motion for performance of variety of tasks. Robot act as a programmable multifunction manipulator.. This proposed system is entirely voice controlled system and for this POCKETSPHINX software is used. Pocketsphinx is a part of the CMU Sphinx Open Source Toolkit For Speech Recognition.

I. 1.1 LITERATURE SURVEY :

- In the 18th century scientists made one doll type machine which was stationary and used to help to pick up the object from one and deliver at particular place. As this machine was stationary it could not deliver the objects from far distances so there was need for mobile machine, which could pick up the object from one place and deliver at particular place. The robot in the project will overcomes all the problems.
- There are lots of home robots available in the market which are designed and manufactured by different companies, they are very costly. This is one of the robot which is manufactured at low manufacturing cost.
- ASIAN JOURNAL OF SCIENTIFIC RESEARCH, 2015 this paper published the Hand Gesture based control of robotic hand using Raspberry Pi processor.

- International journal of science, engineering and technology research (IJSETR) April 2015, the paper published the design of Raspberry Pi vehicle with stereovision

1.2 Proposed system:

The proposed system in home robot using OpenCV and Raspberry Pi. To design and implement the portable monitoring devices for home and office is the main objective of the system. When instructions are given, the robot initializes the camera and checks for the authentification of the person. Once the person is authorized the instructions will be accepted by the processer were processers will give signal to the stereo camera to detect the object in surrounding. After localization of the object the processer will give the signal to pick up the object from its source location. Once the object is picked up the instructions will be given to deliver it at its destination location. For this the program is written in python environment in software implementation.

2. Mechanical Assembly

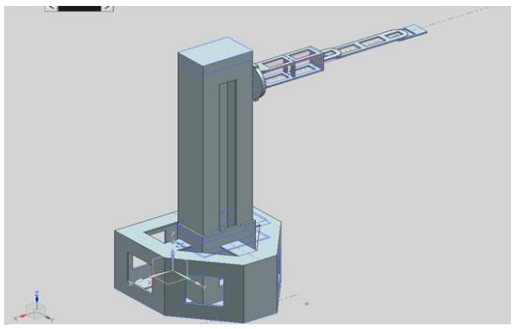

Fig 2: Mechanical assembly structure

Fig 2 shows the frame structure of the Robot. This is fully made up of Aluminum. Aluminum is light in weight and having high tensile strength which is sufficient for Robot. It has size of 35cm*35cm*80cm with weight of 22kg with max speed 3 ft\sec.

Drive Motor Selection:

- Inclined angle = 10 degrees
- Drive wheels = d= 4.37 in; r = 2.18in
- Acceleration a = 1.72 m\s^2

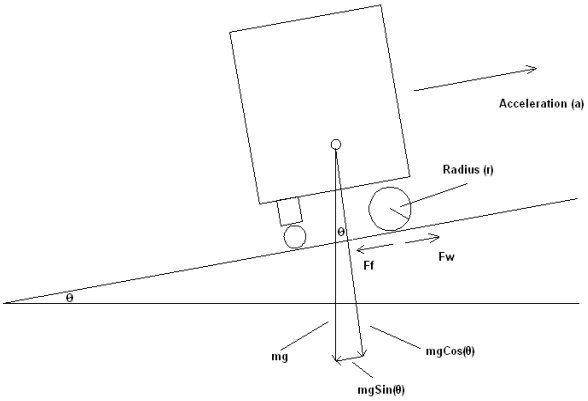

Fig 3: Inclined angle of bot

Torque=22kg(1.72m\s^2)+(9.81m\s^2*sin(10)*0.0553

T = 4.162 N-m

Convert it into kg-cm, we get **16.75 kg-cm**

We use two drive motors which having the torque 35 kg per motor and having speed of 100 RPM, and two omniwheels are used for proper balancing the bot. The size of that wheels is 4 inches.

Robotic Arm: To pick up and place the object we design a one robotic arm with two finger gripper. This arm made up of aluminum and cardboard. As shown in a Fig4 the link 1 is of aluminum and all these links are connected through actuators i.e. servo motors. This is operated through the processor Raspberry Pi. Here, link 1 is of 21 cm and 120 gm, link 2 is 22 cm which is made of the glass fiber and of 70 gm and link 3 of 24 cm with weight 80 gm. These arm carry the object of weight 120 gm efficiently. The robotic arm having the five degrees of freedom to pick and place operation

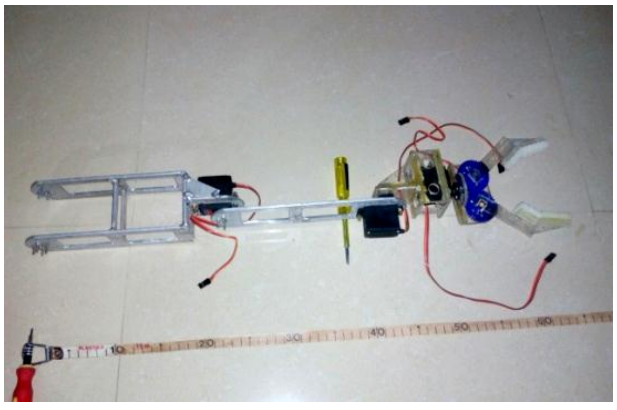

Fig4 : Robotic Arm

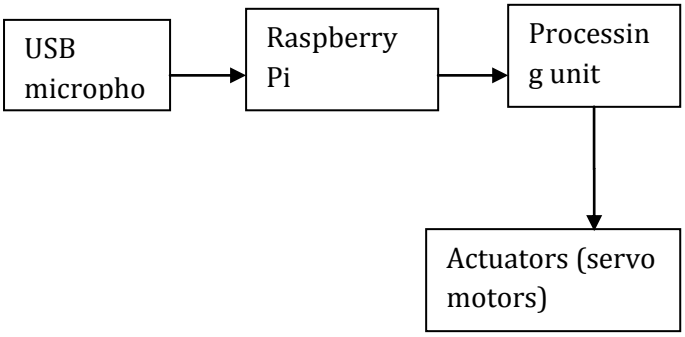

Fig5: Block Diagram of the robotic arm

II. Working process:

Thir are two steps which can be used to implement the proposed work there are – 1. Hardware Implementation

2.Software Implementation

Block Diagram:

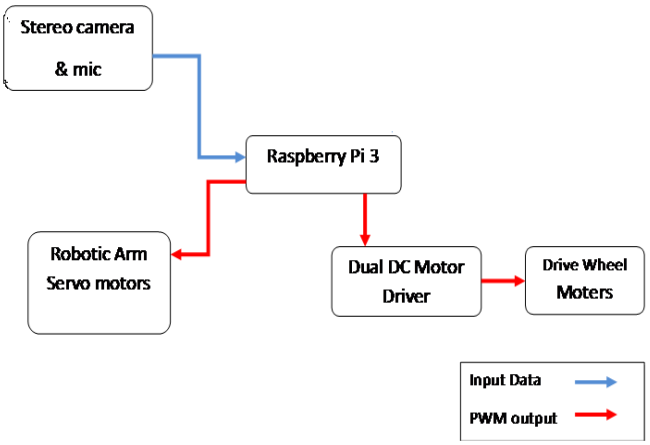

Fig 6: Block Diagram

1. Hardware Implementation

The system consists of Raspberry Pi, Dual DC motor driver 20A, Logitech 310 Webcam, Power supply.

A. Raspberry Pi 3 Model B

The Raspberry Pi 3 Model B is used in our robot. Raspberry Pi is a series of credit card-sized single-board computer with Linux or other small operating systems. It was developed by Raspberry Pi foundation in UK. It consists of an 64-bit Quad Core ARM v8 processor, which runs at 1.2 GHz clock speed, 1GB LPDDR2 RAM shared with GPU, a Video Core IV 3D Graphics Core, 4 USB ports: HDMI, 3.5mm analogue audio-video jack, 4*USB2.0, Ethernet, Camera Serial Interface(CSI), Display Serial Interface (DSI). It also has 40-pins header, Populated General Purpose Input\output (GPIO). It requires power of 5v , 2.5 Amp.. The Raspberry Pi needs an external Secure digital (SD) card to store its operating system and also all the user data

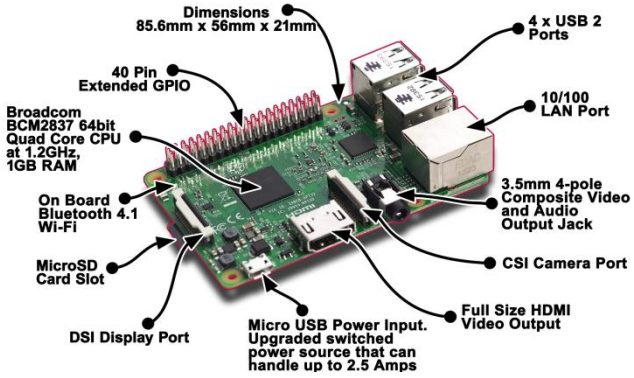

Fig 7: Raspberry Pi 3 Model B

The Raspberry Pi and the subject of home robot is a remarkable one. The raspberry pi will help us to automate a home at a relatively low cost. The remarkable affordable cost is the most numerous thing why we are go for the raspberry pi. Hence, Raspberry pi has many advantages such as it can be act as normal use computer with keyboard, mouse and monitor connected so that it can be used as really powerful microcontroller.

B. Dual DC Motor Driver 20A :

It is ideal for application where two motors are required for up to 20 Amperes of current during startup and during normal operations. It comes with a TTL/CMOS based interface that can connect directly to the IOs of an MCU and also includes protection circuitry to avoid any electrical fluctuations the normal operation of an MCU.

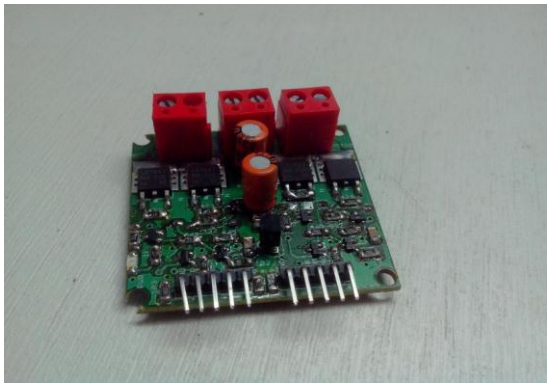

Fig 8: Dual DC Motor Driver 20A

A. LogitechC310 Webcam:

For stereo vision we use two Logitech webcam. It has a HD video capture capacity up to 1280*720 Pixels and photos up to 5 megapixels. It requires windows vista, Windows 7(32 bit or 64 bit) or windows 8, 1 GHz, 512 MB RAM or more, 200 MB hard drive space, USB 1.1 port (2.0 recommended).

Fig9: Logitech 310 webcam

C. Power Supply:

The power source used for the system is a 12 volt 15 Amp DC acid battery, but our processor Raspberry Pi needs only 5V, 2.5 Amp power to work properly, Similarly servo motors needs 6V and more than 6V supply. So we can design a DC-DC regulator circuit to fulfill the requirements. For this reason we use an LM 350 regulator.Fig.10 shows the pin diagram of Ic 350.The LM 350 is a series of adjustable 3-termnal positive voltage regulator which capable to produce fixed 3A over a 1.2V to 33V output range.

Formula to find V_{out} :

$$V_{out} = V_{ref} (1 + R_2 \setminus R_1) + I_{adj} R_2$$

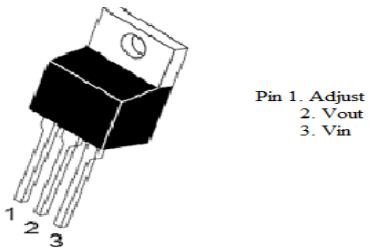

Fig.10: LM 350 regulator IC

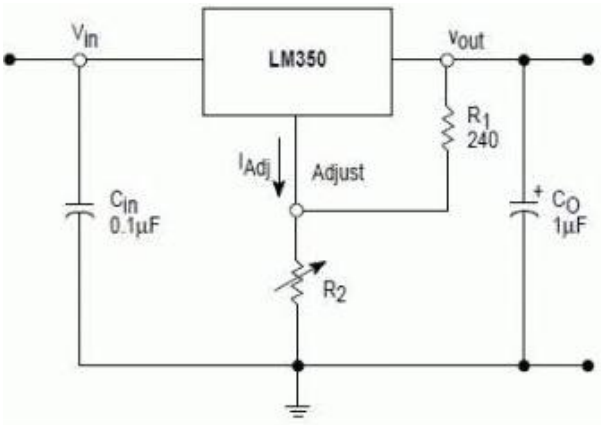

Fig11: Varible regulator circuit of LM 310

2. Software Implementation

Software implementation of this work uses Raspberry Pi and Python programming language. The total programming is done in Python. The program includes capturing image, saving the image, to move object, parts, tools.

A. OpenCV Libraries:

Computer vision is one of the most demanding areas in the robotic field. It has a library of programming functions mainly aimed to the real computer vision. Computer vision is a scientific field which attempts to provide a sight to the machine and it has a multi-platform availability. It supports a wide variety of programming language like C++, python and java. The two advantages are, our code is as fast as original C\C++ code, and it is very easy to code in Python.

OpenCV provides a set of modules that can execute roughly the functionalities listed below:

- Core: This module includes core data structure, data types and memory managements.
- Imgproc: This module is an image processing module. Image filtering, structure and shape analysis.
- Video: Video analysis module that includes motion analysis, background subtraction, and object tracking algorithms.
- Objdetect: Object detection using cascade and histogram of gradient classifier. Object module that uses to recognize face, eyes, etc.

RESULT AND DISCUSSION

Implementation details and results related to the smart home robot are discussed here.

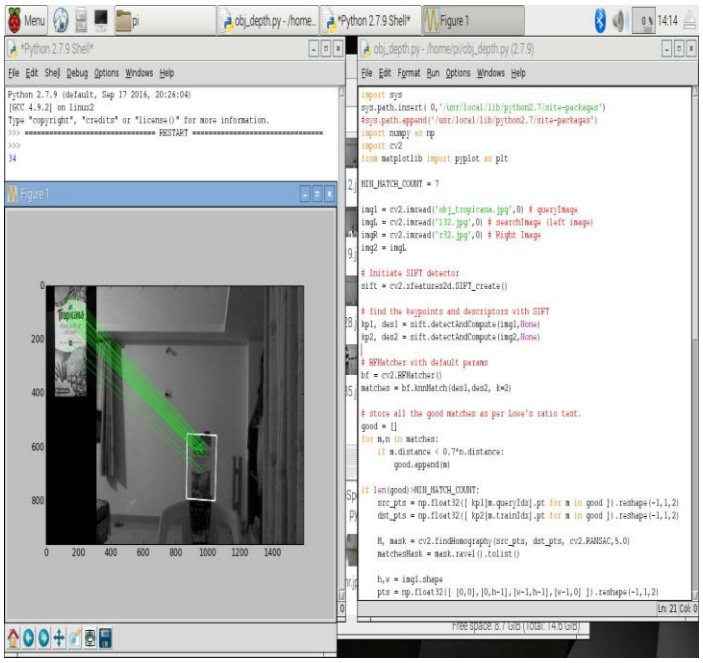

Fig.12: Object Depth Estimation

Object depth estimation:

Here the distance between the current position of the robot and the object is calculated so that robot can approach it. According to that the signal is given to the motors.

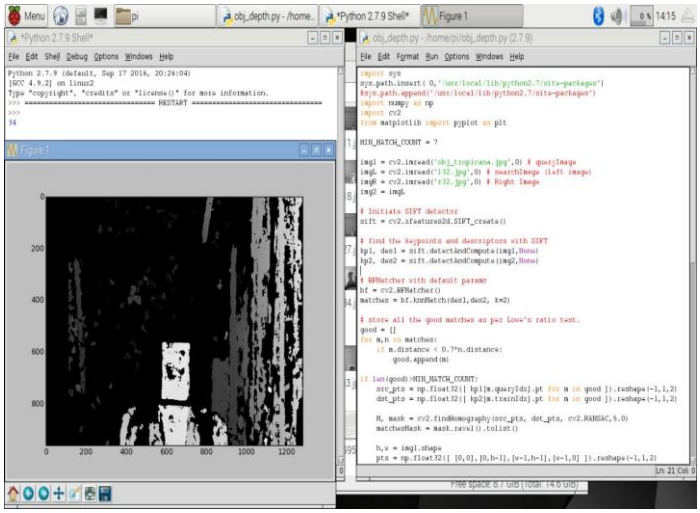

Fig.13: Object Detection code

Object detection code:

This is done with the help of gray code detection technique. From the stereo camera the object closer to the camera is indicated in the white color whereas the distance goes on increasing the shade changes from gray to black.

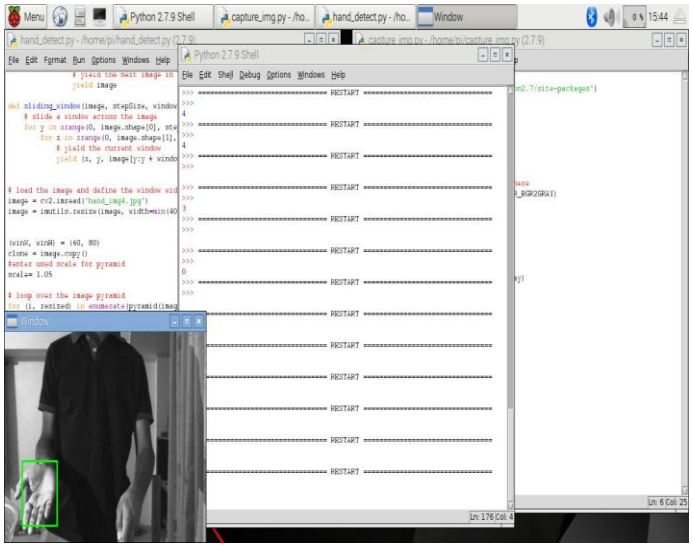

Fig.14: Right Hand Detection

Hand Detection:

Python code is used to detect the hand of the person so that it can deliver the object in hand either in left or right. For this the instruction to br given by user is " give (object name) into my hand.

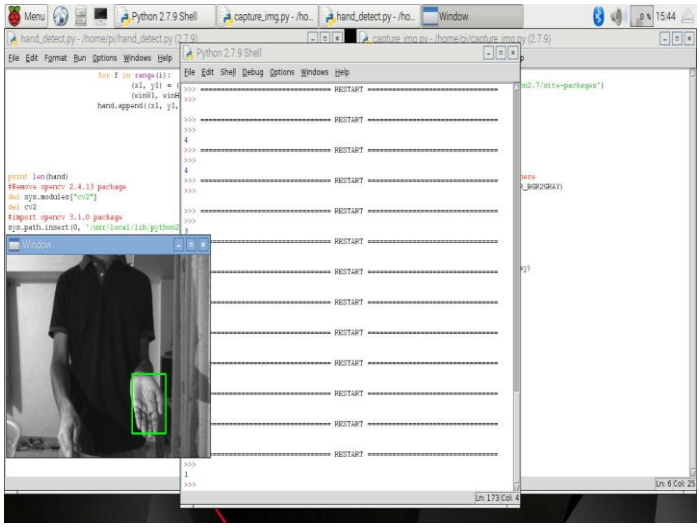

Fig.15: Left Hand Detection

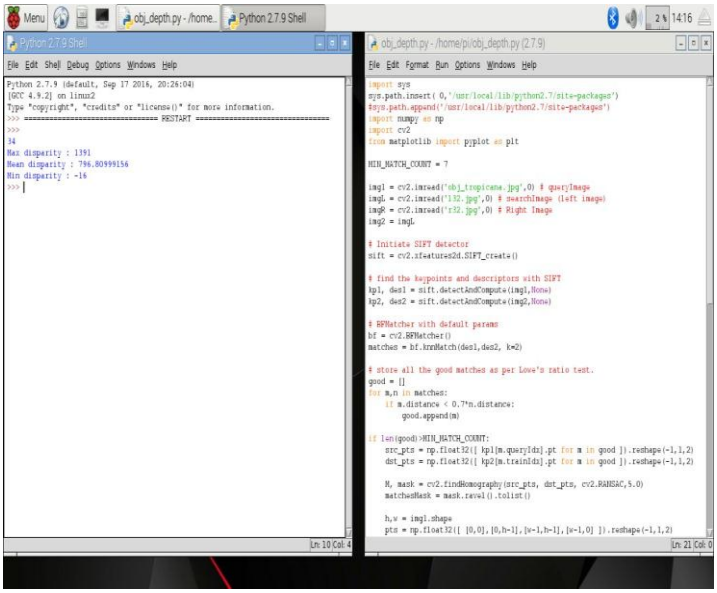

Fig.16: Object depth code in python

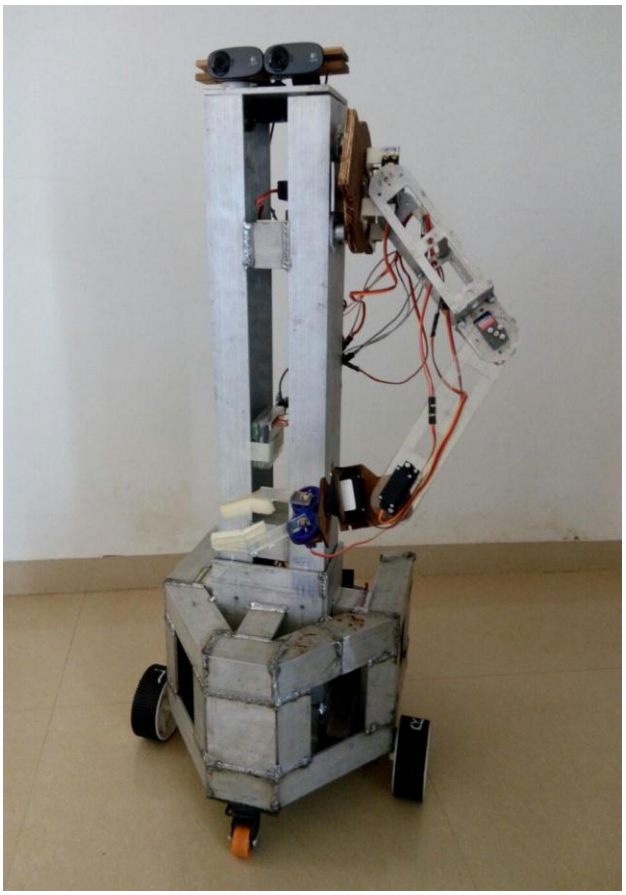

Fig.17: Home robot

Figure 17 shows the final prototype of our project.

3. CONCLUSIONS

In this project we have designed and implemented home robot using raspberry pi. The whole system works in standalone mode without necessity of computer. It has small size and it is portable, it can be placed in any room and detect the voice successfully. It has future that it can have two arms which can be mind-controlled.

ACKNOWLEDGEMENT

I extended my sincere thanks to professor Mahantesh P. Mattada. Department of ENTC and also my earnest thanks to Mrs. Chougule Sangeeta Rajendra. Head Of Department of ENTC for their support to carry out this project work successfully.

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