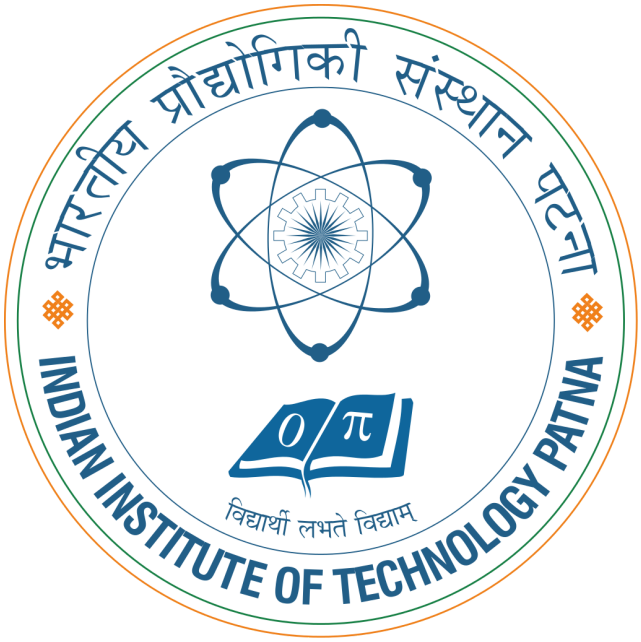

Indian Institute of Technology Patna

CS 299 - Innovation Lab

Final Evaluation Report

Autonomous Helper Bot

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INDEX

Autonomous Helper Bot

1. Abstract

The aim of this project is to build a working robot that detects an object desired by the user, picks it up, tracks the user and brings it to the user. This robot acts as a helper and fetches objects for the user, which makes work easier for the user, as less human effort has to be made to fetch objects. This problem is important as aims at saving time and effort of the user, which can be utilized for other chores where more human input is required. Making of this robot also gives rise to challenges regarding the movement of the robot, object detection, autonomous picking of the object using an arm(building an arm being a different challenge altogether!) and tracking the user; and the inspiration to solve these challenges makes this problem and the proposed solution interesting.

2. Aim:

Create a robot that autonomously fetches a desired object for the user from a distance.

3. Objectives

To create a robot which:

- Detects desired object at a far off location.
- Autonomously navigates and reaches the desired object.
- Picks up the object using its arm mechanism after reaching sufficiently close to it.
- Tracks the user and navigates to deliver the object to the user.

4. Current Status:

The concept of a robotic domestic help has been lingering around for quite a while. A variety of helper robots are already developed or are under development which can clean the floors and windows, or iron shirts, or mow lawns. But a helper for fetching objects has not been developed commercially, to the best of our knowledge. Research is going on actively in this field in major research institutes of the world. Georgia Tech is developing a technology called El-E to assist users with limited mobility with daily chores. Research is ongoing at Brown University too, which is funded by DARPA and NASA.

Our project aims at creating a prototype for a robot for fetching objects autonomously, which can be developed to extreme extents later, in the near future. As this type of development is relatively new in the field of robotics and Computer Science much more advancements and technology integration is expected in the future.

5. Novelty of the Project:

Integration of the following features together in a single body robot is the novelty in this project to the best of our knowledge:

- Autonomous navigation - The robot detects the object at a distance and navigates itself to the object avoiding any collisions.
- Autonomous picking - The robot uses its arm to sense the object and pick it up.
- User tracking - The robot tracks the location of the user and brings the object to the user.

6. Timeline:

Week 0 - Week 4
9th Jan - 30th Jan

- Initial planning of the project involving :
  - Use-cases
  - Structure
  - Hardware and materials required
- Exploring available image processing libraries to leverage for the project.
- User tracking logic

Week 5- Midterm Evaluation
31st Jan - 20th Feb

- Acquiring the components required for the project.
- Final prefabrication design of the body of the robot.
- Fabricating the robot's base with plywood and aluminium.
- Completing the circuitry and hooking up the motors making the robot mobile. http://bit.ly/2ERN7EL
- Initialising the Raspberry Pi with Raspbian OS.

- Making the motors controllable with signals from the Raspberry Pi using L293D Motor Driver IC and custom external power-source.
- Testing Image processing using SimpleCV and OpenCV libraries to detect dummy objects.

Midterm Evaluation - Week 8
21st Feb - 13th March

- Programming the User Tracking Algorithms into the RasPi
- Handling Navigation and localisation for the movement of the bot.

Week 9 - Week 11
14th March - 27th March

- Fabricating the arm after fetching required servos.
- Independent arm movement programming and testing.
- Attaching the arm with the rest of the bot.

Week 12 - Week 14
28th March - 10th April

- Object - Arm calibration.
- Alternative storing mechanism.
- Multiple Object fetching
- Handling more complexity in Object type and navigation.

Week 15 - Final Evaluation

- Final testing of the bot.
- Final report and presentation preparation.

7. Detailed Developments:

The work on this project has always been in progress according to the timeline specified. All the steps of the job have been fulfilled as per the deadlines and we proceeded in accordance with the plan. The detailed progress report of the project, is as follows:

Taking off, from where we left in the mid-term evaluation, we proceeded with the plan and integrated everything after working on every aspect as an individual module, after working on the entire pseudocode for the same.

- Object Detection Using Image Processing - We designed the sample objects pertaining to a specific colour(green here). The program written detects the colour and hence the object according to the boundaries for the colour specified. The program is run through a Raspberry Pi, the object being analysed by the Pi camera module.

- Designing of the Arm - The structure of the arm was designed with wood and aluminium. It consists of one single joint connected via a strong SERVO motor to rotate it via a specific angle. The claw is connected to the arm by a micro-SERVO motor to lift the object.

- Sensing of the Object And Operation Of The Arm - The Pi camera senses the object and Pi commands the Arduino to move the robot towards the object. The ultrasonic sensor makes it stop at a specific distance and then the arm reacts. It moves accordingly to grab the object and lifts itself.

- Exploring User Tracking - A mechanism similar to object detection is used in user tracking. User has a portable base station of a specific colour(yellow here). After lifting the object the robot detects this base and moves towards it.

- Raspberry Pi-Arduino Mega Interfacing - As Arduino Mega board was used for movement of the robot and controlling the SERVO motors for motion of the arm, and Raspberry Pi was used for the Image Processing, it was necessary to make them work together. Hence the Arduino was interfaced to work according to the commands given by the Pi.

- Integrating Everything Together - Finally after working on separate modules as specified above, all the modules were integrated together the code sequenced according to the pseudocode as the functioning of the robot is tested rigorously.

8. How It Finally Works:

The robot functions as planned. The entire functioning of the robot in the according steps is as follows:

1) The Arduino makes the robot rotate till it detects the object.

2) Once the object is detected by the Pi camera, it gives commands to the Arduino to move the robot forward to the object.

3) Once at a specific distance from the object detected by the ultrasonic sensor, it stops.

4) Then the Pi commands the Arduino to lower the arm and grip the object. Once the object is held the arm is lifted.

5) Then the Arduino makes the robot rotate till it detects the base.

6) Once the base is detected by the Pi camera, it gives commands to the Arduino to move the robot forward to the base.