Machinilog 2016 Team Description Paper

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Abstract. This document briefly describes the RoboCup@Home team Machinilog of Bahria University Islamabad, Pakistan for RoboCup@Home. We have developed our own indigenously designed robot to execute different tasks such as manipulation, navigation, speech recognition, face detection, object detection etc. Furthermore this paper also describes our Robot's hardware and software architecture and different approaches used.

Keywords: RoboCup, RoboCup@Home, Service robots, COB, Machininlog, AI

1 Introduction

In the field of Robotics and Machine Intelligence, Service Robots are drawing more and more attention of researchers. The common goal of all these efforts is to enhance the research and solve challenging problems. Research in the field of Machine Intelligence is moving and growing at a fast pace, but still some problems are still needed to be solved and there is always room for advancements. Service Robots pose a real challenge due to the multi-facted nature of the problem. Firstly, the robot should perceive information from its environment. Second aspect is autonomy, the robot should be able to think and act wisely in different scenarios under different constraints. The third and most important aspect is Human Robot Interaction (HRI). In recent years, RoboCup has become one of the best avenue for researchers and enthusiasts to exhibit and share their expertise and skillsets. RoboCup@Home [1] provides researchers with an excellent platform that focuses on all the above aspects of Domestic and Service Robots.

The team Machinilog at Bahria University Islamabad was established at the end of 2015. The motivation behind it was to develop an agent with advanced AI capabilities like task planning, human robot interaction and knowledge procurement in the area of service robots and RoboCup@Home was identified as a central theme around which the above agent would be developed.

In this paper we discussed our latest progress for our robot named Robo-Hat. Section 1 shows hardware construction and modules used. Software architecture including manipulation, navigation, people detection and object avoidance are briefly discussed in section 2.

2 Hardware Design

This section briefly discusses hardware components used for Robo-Hat. Our robot perceives information from environment using its sensors. After data analysis, the robot takes decisions and interacts with the environment to perform the desired tasks, such as object detection, tracking, obstacle avoidance and gesture recognition etc. Depth information along with images is an integral part of the data acquired for recognition purposes; we have used Microsoft Kinect and a wireless camera for visual input to the robot. In Robo-Hat layered design architecture [2] is considered for the design and structure of the robot.

Fig - 1 – Basic Structure of the Robot.

We considered the first layer to be the bottom or the base layer of Robo-Hat. This was designed indigenously using an aluminum sheet. Batteries, motor drivers and ultra-sonic sensors are mounted on the first layer.

Second layer is the upper body and arms of the robot. The robot's arms are used for manipulation of objects in the environment. We are using a 5 DoF robotic arm for Robo-Hat. Robo-Hat's arm can lift around 500 gram weight. Third layer of the robot is its head. Microsoft Kinect and camera are mounted here.

Obstacle avoidance and distance measurement from objects is basic information required by a robot to maneuver in a cluttered environment. Instead of using laser range finders we have used depth images from Kinect for obstacle avoidance and distance measurement. The output from Kinect is also used for Simultaneous localization and mapping.

Controlling and managing the speed of a Robot is a critical requirement in Robot motion and maneuvering. DC geared Motors are used for robot motion. 2 dry cell batteries are responsible for providing power the robot. Inter communication between Robo-Hat and Processing is achieved by Arduino.

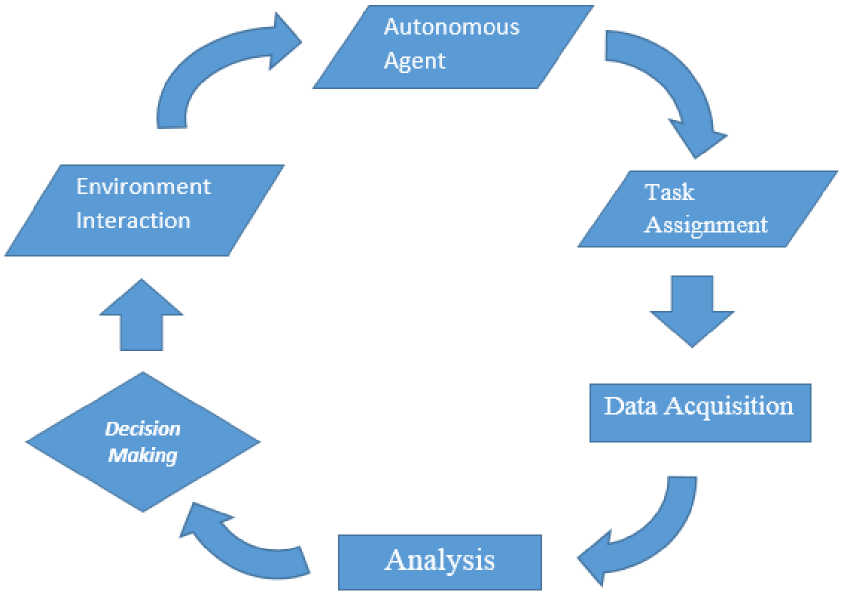

Fig - 2 – System Level Diagram

3 Software Architecture

We have used Robot Operating System [3] for our robot's software architecture. This is the most common and widely used technique of the RoboCup@Home teams. A typical system-level diagram of a robot is shown in figure-2.

3.1 Face Recognition

Face Recognition is an important aspect in Human Robot Interaction, as it allows the Robot to identify humans in a similar way as humans identify each other using facial features. In our robot, detection and recognition is done by processing the data coming from the depth sensor. We use cob_people_detection, a ROS package, for facial recognition. The concerned faces are first trained by taking the images of the subjects, and then these learned models are loaded in the cob_people_detection package for facial recognition.

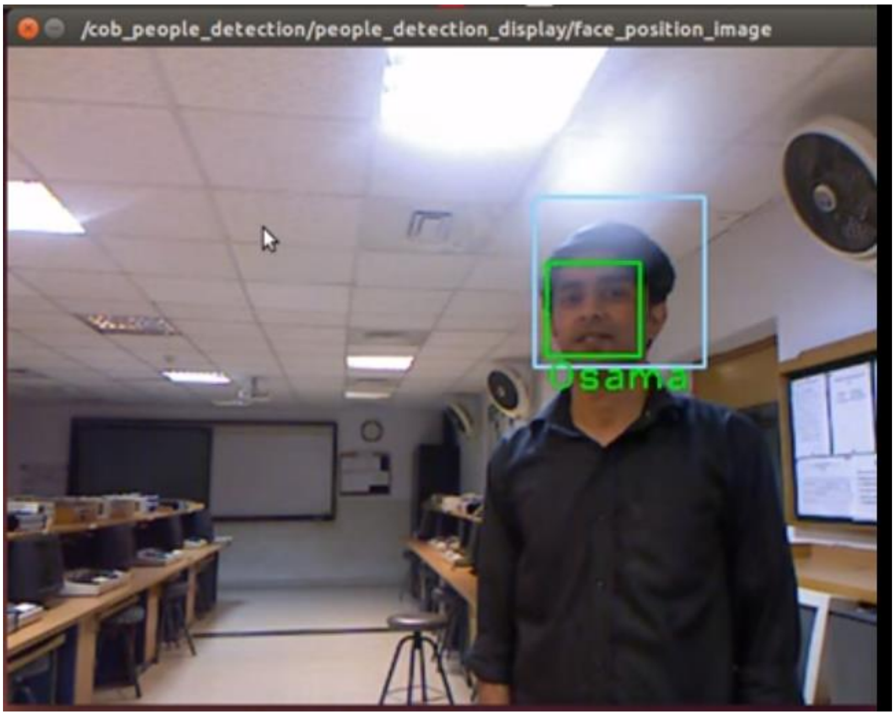

Fig - 3 – Example Face Recognition

3.4 Manipulation

Object manipulation is an important aspect in RoboCup@Home which is used in tasks like lost’n’found or fetch’n’carry etc. For manipulation of the environment, the robot uses its arm and gripper. The input of this module is coordinates of the place where the object is placed. Robo-Hat has a 5 DoF arm for which we used MoveIt [4] for manipulation purposes.

In future, we intend to work on Machine Learning based approaches for manipulation. Specifically, we intend our research direction to be geared towards Deep learning applied on vision data for manipulation of objects.

3.3 Navigation

Service robots should be able to navigate in both dynamic and static environments especially through narrow and cluttered paths. Localization is a fundamental need of an autonomous robot. For localization, an autonomous robot needs map of its surrounding, which is not known a-priori. For building a map of a robot laser readings are necessary. We have used Kinect’s RGB+D data that was converted to laser scans [5]. For mapping of an unknown cluttered environment we implemented gmapping. For maneuvering an environment autonomously we used ROS navigation stack. For Simultaneous Localization and Mapping (SLAM), ROS navigation stack is used. Obstacle avoidance is achieved by global costmap and global planner and navigation of the robot is achieved by local costamp and local planner in the navigation stack. The output of gmapping is shown in Figure–4.

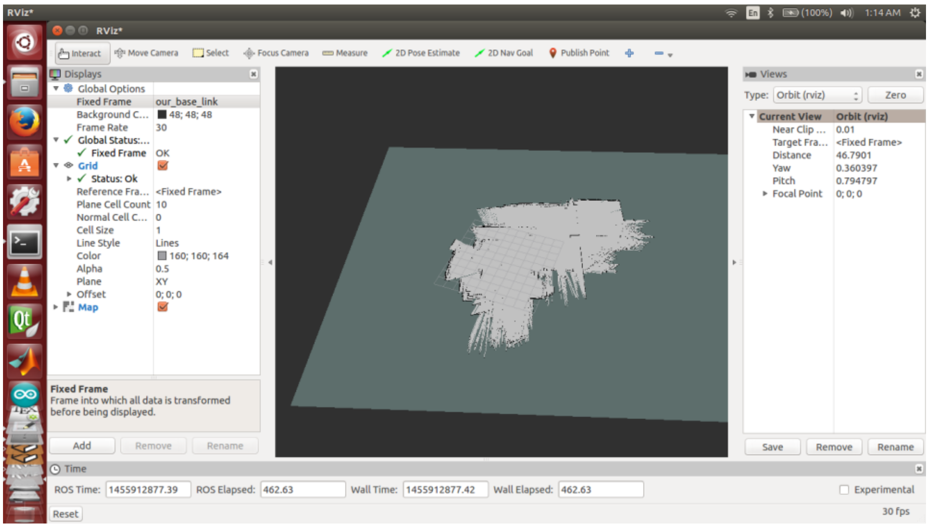

Fig – 4. Gmapping implemented in ROS

3.5 Human Robot Interaction

HRI is an important aspect of RoboCup@Home where both vocal and visual commands are given to the robots. We used Pocket Sphinx by Carnegie Mellon University [6] for speech recognition. Festival [7] is used for speech synthesis so that the robot could talk back to the person for an interactive human Robot experience.

3.6 Object Detection

In our system, Object Detection is achieved using find_object_2d package in ROS, in which FAST/BRIEF feature detectors have been used by our system to detect and recognize objects. We later intend to use iai_kinect2 package for detecting images in 3D, as well as to find their coordinates in the 3D space. An example of the Object Detection can be seen in Fig – 5.

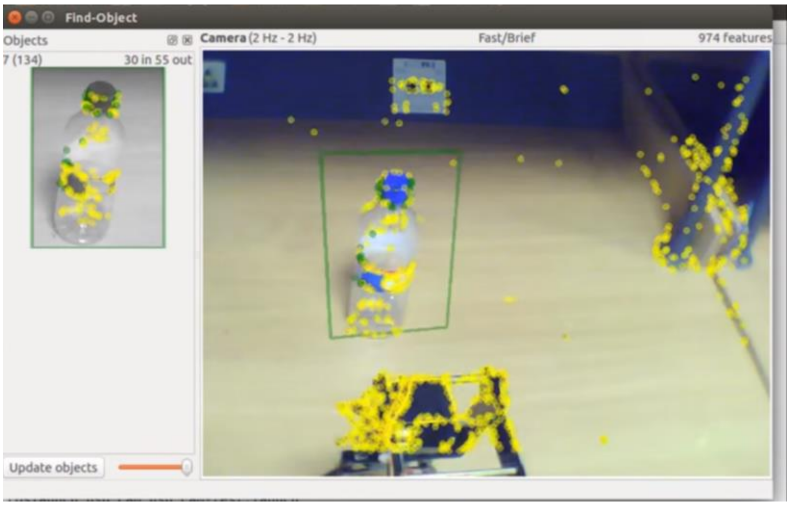

Fig - 5 – Object Detection and Recognition

4 Conclusion

The paper briefly discusses the current state of the robot named Robo-Hat by team Machinilog. The robot heavily uses ROS as its basic platform to communicate with and integrate all its hardware and software components. The simple architecture of the robot allows us to focus on the basic steps involved in the development of a service robot which could be employed in a home environment.

References

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Table 1. Core Hardware Specifications of ROB-HAT

Name	ROB-HAT
Base	Fully autonomous two wheel drive
Motors	Power Window
Controller	Arduino Uno
Depth Sensor	Kinect for XBox 360
Camera	Stereo Camera
Manipulator	6 DoF Indigenously designed arm
Batteries	3x 12 volts 3.3 Ah Dry Cell Batteries
External Sensor	Emergency Stop Button
Computer	DELL XPS Core i7 16Gb Ram

Table 2. Software specifications of ROB-HAT

Operating System	Ubuntu 14.04 LTS
Middleware	ROS Indigo
Face detection and recognition	Care-o-Bot Package
People Tracking	Care-o-Bot Package
Navigation	ROS Navigation Stack
Localization	AMCL
Arm manipulation	MOVEIT
Speech Recognition	CMU Pocket Sphinx
Speech Synthesis	Festival