Team EME

Proposal: RoboCup@Home Standard Platform

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1- Introduction

The field of domestic robotics is still in its infancy although considerable work is being done in this field. The aim of our project Intelligent Driving system (IDRIS) is to develop assistive robot technology for personal domestic applications and make a working prototype. Focus of this project lies on the following domains: Human-Robot- Interaction and Cooperation, Navigation and Mapping in dynamic environments, Computer Vision and Object Recognition under natural light conditions, Object Manipulation, Adaptive Behaviors, Behavior Integration, Ambient Intelligence, Standardization and System Integration.

2 - Project Objectives

- Navigation and Mapping in dynamic environments
- Voice Recognition & Synthesis
- Sound Source Localization
- Face Recognition
- Object Detection & Manipulation

3 - Method Implementation

The intelligent driving system is implemented on a turtle bot using ROS (robot operating system). The project has been divided into different modules, namely

- SLAM (Simultaneous Localization and Mapping)
- Person Recognition
- Voice based modules
- Object detection
- Manipulation

1. SLAM (Simultaneous Localization and Mapping)

The localization and mapping of a dynamic environment will be accomplished by implementing a visual-SLAM algorithm with images obtained from Intel RealSense camera connected to the robot. Once the map has been obtained a path planning algorithm will be used to help the robot reach the desired location.

Algorithm

Simultaneous Localization and Mapping is a diverse field and a lot of work has been done on it from years. There are various algorithms that had been developed to accomplish this task. Comparison table of different algorithms is provided below

TABLE

Algorithms	Year	Open Source	Input	Drawbacks	Assumptions
RGB D-SLAM	2012	yes	RGB Image/ Depth Image	Error in depth calculations	
OpenRat-SLAM	2013	yes	RGB Image/ odometry	Inaccurate, time consuming	weight links matrix has Gaussian distribution
LSD-SLAM	2014	yes	RGB Image	Tracking loss + no fall-back strategy for tracking loss	Noises and inverse depth is Gaussian
ORB-SLAM	2015	yes	RGB Image/ Depth Image	Not scale aware, have to manually set trajectory	Robot movement b/w two consecutive frames is relatively small
DSO-SLAM	2016	not yet	-	-	-

According to pros and cons of each algorithm the most suitable for our requirement is ORB-SLAM. ORB-SLAM is a versatile and accurate Monocular SLAM solution able to compute in real-time the camera trajectory and a sparse 3D reconstruction of the scene in a wide variety of environments, ranging from small hand-held sequences to a car driven around several city blocks. It is able to close large loops and perform global relocation in real-time and from wide baselines. It includes an automatic and robust initialization from planar and non-planar scenes. A novel survival of the fittest key frame selection allows to maintain a compact map, while improving the tracking robustness as key frames are inserted very fast during exploration. It's an efficient technique and the main advantage is the backup plan. It has bag of words that are used to identify the location if robot loses its trajectory. It takes monochrome/color image as input and produces a sparse 3d, key-frame poses and co-visibility graph.

2. Person and Object Recognition

Intel RealSense F200 cameras are going to be installed on the hardware for person, as well as the object recognition. Two cameras will be attached to the Robot to capture a wider picture. The cameras are chosen because they are capable of giving a depth and disparity imaging. They work on VGA depth resolution and RGB imaging.

The Algorithms under consideration are as follows

However, PCA with eigenfeatures (the latest development on the principal component analysis) is going to be used owing to the system's efficiency and accuracy.

Methods	Recognition Time (sec.)	Recognition Rate (%)
PCA(Principal Component Analysis)	24.13	98.99
KPCA(Kernel PCA)	20.33	94.99
LDA (Linear Discriminant Analysis)	33.80	97.99
LEM(Line edge map)	5.07	96.00

3. Voice based modules

To interact with the people around, in a dynamic environment voice based modules will be integrated with other modules.

Voice based modules comprise of:

- Voice recognition
- Voice localization
- Voice synthesis

To carry out voice based tasks or tasks which require human robot interaction, three microphones will be integrated with the hardware, 120 degrees apart and a kinect sensor. HARK, open source robot software for voice modules i.e. voice localization, automatic recognition and voice synthesis will be used.

Using HARK will enable the robot to understand what the user says. After understanding it will be able to respond (reply and perform actions) accordingly and the robot will be able to distinguish different voices or voices coming from different positions. Hark will provide real time processing.

5-Manipulation

The end effector on Manipulator is of type impactive. It is a 5DOF. Two servo motors are used. One in vertical Y axis, to rotate around and one in horizontal axis. The idea is to keep a gripper with styro foam insulation to give a better grip as well as to avoid and electric shocks.

4 - External Components

Following is the list of components that will be used for project:

- Intel RealSense F200 Front Camera
- Laptop
- Speakers
- Microphones and Kinect sensor
- Gyro meter

- Accelerometer
- Blue tooth module
- Robotic manipulator

5 - Research Interest

Focus of our research is multi functioning human assistive robot that can perform task of daily routine like detection manipulation of object, interaction with humans, security purposes. The basic goal is to make an efficient and intelligent robot that can take correct decisions according to situations.

6 - System's Re-usability

Since we are focusing on developing multi functioning human assistive robot that can survive in dynamic environment so the robot's modules integration setup will be flexible enough to bear any future changes, addition of new modules and will allow the robot to perform any particular or fixed action under given conditions.

7 - Real world Applications

This Intelligent driving machine can facilitate human beings do laborious tasks painstaking activities and in carrying out repetitive and time-consuming tasks efficiently both at domestic and industrial scale. This project aims at designing a prototype to demonstrate the usefulness of autonomous robotic applications. Examples of situations where this type of robot will be beneficial to the society include:

- Personal robot assistant
- Guide robot for the blind
- Robot care for elderly people
- Robot Receptionist
- Security systems