KameRider @Home 2015 Team Description

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Abstract. This document is the team description paper of the team KameRider for the participation of RoboCup @Home league in RoboCup 2015, Hefei, China. Team KameRider is a collaborative effort that aims to develop an open robot platform for service robotics. This paper describes the motivation of this effort, the hardware and software of the robot developments, and the scientific contribution and social impacts of our work via the proposal of RoboCup @Home SPL (Standard Platform League).

1 Introduction

Team KameRider is a collaborative effort that aims to develop an open robot platform for service robotics. Started from 2013, the very limited development resources and manpower team condition had urged a strong motivation to develop a more affordable yet functional solution to take part in RoboCup @Home league and service robot development.

The current team objectives are as follows:

A. Utilize open source solutions for both hardware and software developments for low cost and large community support to develop an open robot platform.
B. Open source the developed robot platform with support wiki, source codes on GitHub and 3D printing parts to ensure easy reproducibility, to build up a community-driven development effort.
C. Participate in RoboCup @Home to benchmark the robot performance.
D. Support the proposal of RoboCup @Home SPL (Standard Platform League).

2 Background and Motivation

2.1 The challenges of RoboCup @Home

Starting from 2006, RoboCup @Home [1] has been the largest international annual competition for autonomous service robots as part of the RoboCup initiative. The challenge consists of a set of benchmark tests to evaluate the robots' abilities and performance in a realistic non-standardized home environment setting [2]. It has greatly fostered artificial intelligence development in various domains including human-robot interaction, navigation and mapping in dynamic environments, computer vision, object recognition and manipulation, and many more developments on robot intelligence.

However, it is observed that the development curve of the RoboCup @Home teams have a very steep start. The amount of technical knowledge and resources (both manpower and cost) required to start a new team has made the event exclusive to only established research organizations. For instance, in domestic RoboCup Japan Open challenge, the participating teams in RoboCup @Home were less than 10 teams and similar teams ever since the past few years. There were actually several new team requests but the development gap was too huge for them to even complete the robots.

For this reason, our team had initiated the development of an open source robot platform for RoboCup @Home in 2013. The goal of the project is to develop a basic robot platform to facilitate startup team for the participation in RoboCup @Home. It is developed based on open source solutions for both hardware and software developments for low cost and large community support to facilitate startup of the novice teams. The first working prototype (Fig. 1) had participated in RoboCup Japan Open 2014 and had the honor to receive the *Japanese Society for Artificial Intelligence (JSAI) Award*. Along with the development, we are honored to obtain support from RoboCup Japan Committee and RoboCup Federation, and bonded collaborations with Universiti Teknologi Malaysia (Malaysia), Nankai University (China) and Tamagawa University (Japan).

Fig. 1. The first working prototype of the open robot platform for RoboCup @Home

3 Robot Developments

3.1 Open robot platform development

The open robot platform has a current basic robot hardware configuration (Fig. 2) for fundamental robot platform and add-on modular component systems for customized applications. For example in Fig. 3, a manipulator system (with top vision) and an extended top vision system are added to the hardware configurations during RoboCup Japan Open 2015 for the applications in *Restaurant* task and *Follow Me* task.

3.2 TutleBot as the basic robot hardware platform

TurtleBot[1] is a low cost (basic kit is approximately USD 900), personal robot kit with close integration to popular open source software, ROS[2] (Robot Operating System) [3]. The open source robot kit is adapted as the basic mobile platform for this development. The height of the mobile platform is adjusted (currently working on an elevated upper platform with linear motor), a secondary vision system and a robotic arm are added for the manipulation tasks, and 3D printed parts for component systems. An interactive interface with speech and facial expressions is in development for human-robot interaction. A general laptop PC (currently working on a single board computer system) with speakers and microphone is served as the main robot controller. Fig. 2 illustrates a basic robot hardware configuration for this development, and Fig. 3 shows add-on modular component systems, e.g. a manipulator system (with top vision) and an extended top vision system are added to the hardware configurations during RoboCup Japan Open 2015.

3.3 ROS as the robot software framework

ROS (Robot Operating System) is an open source robot software framework with a large community to provide huge collection of robotic tools and libraries. With ROS as the fundamental software framework, this work will adapt and assemble ROS packages and stacks to realize the navigation, manipulation, vision and speech functions of the robot in order to perform the tasks in RoboCup @Home.

Navigation. With the Kobuki[3] and MS Kinect sensor as the mobile base hardware configuration, the TurtleBot navigation package[4] is used for robot navigation with map building using gmapping and localization with amcl, while running the navigation stack in ROS. With the prebuild map and predefined waypoint locations, we can then instruct the robot to travel to a specific goal location with path planning using actionlib[5].

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[1] http://www.turtlebot.com/
[2] http://www.ros.org/
[3] http://kobuki.yujinrobot.com/home-en/
[4] http://wiki.ros.org/turtlebot_navigation/
[5] http://wiki.ros.org/navigation/Tutorials/SendingSimpleGoals

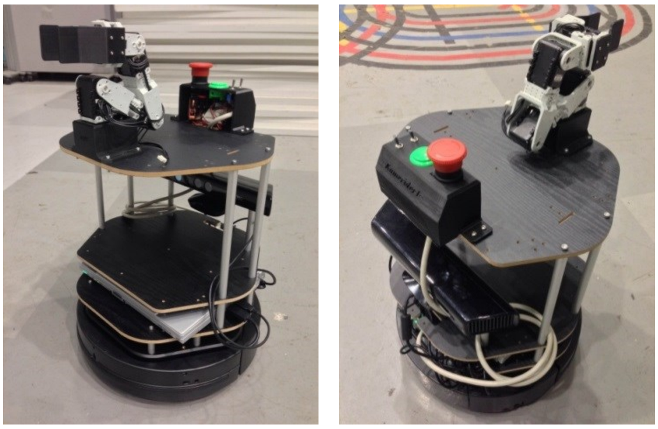

Fig. 2. The current basic robot hardware configuration

Fig. 3. Two hardware configurations during RoboCup Japan Open 2015

Manipulation. We are using TurtleBot Arm[6] for object manipulation (Fig. 3). It consists of 5 Dynamixel AX-12A servo motors, controlled by an ArbotiX-M controller board. While effort to integrate with MoveIt! is still in progress, we have integrated the arm control with simple object detection (color detection[7]) to grasp objects.

Elevated Platform. An elevated platform (Fig. 4) is under development for flexible height manipulation. The current design is target to enable object manipulation at the height ranges from 0.3m to 1.8m.

Vision. A second vision system (Fig. 5) is built on top of robot with MS Kinect for people/object detection and recognition. The people tracking package is used to track people in the *Follow Me* task.

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[6] http://wiki.ros.org/turtlebot_arm
[7] http://wiki.ros.org/cmvision

Speech. For human voice interaction, we use CMU Pocket Sphinx speech recognizer[8] as our robot speech recognizer. It uses gstreamer to automatically split the incoming audio into utterances to be recognized, and offers services to start and stop recognition. The recognizer requires a language model and dictionary file, which can be automatically built from a corpus of sentences. For text-to-speech (TTS), we are using the CMU Festival system together with the ROS sound_play package.

Apart from human voice interaction, we have also tested sound source localization using HARK[9] for possible people search when the person is outside of the robot visual perception area.

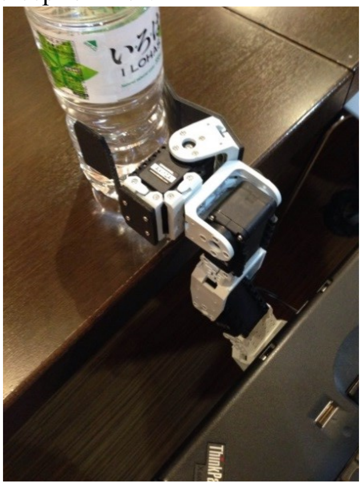

Fig. 3. Robot arm for object manipulation

Fig. 4. Elevated platform for flexible height manipulation

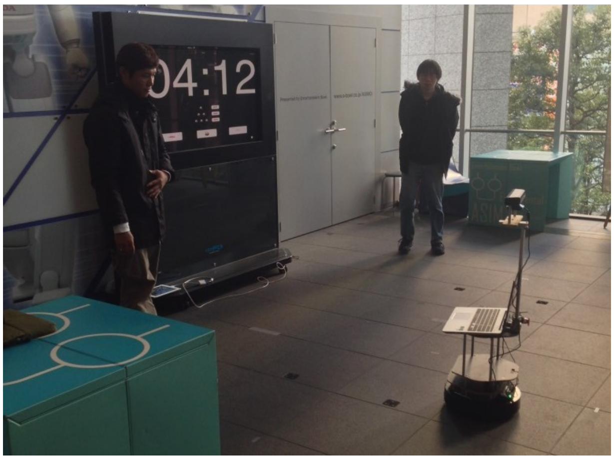

Fig. 5. Vision system on top of the robot

[8] http://wiki.ros.org/pocketsphinx

[9] http://www.hark.jp/wiki.cgi?page=HARK-ROS-TURTLEBOT

Iconic robot facial expression system. An iconic robot facial expression system as shown in Fig. 1 is under development. The iconic design is simple (low computing power requirement) yet expressive to create the character of the robot with more human-like expressions.

4 Scientific Contribution and Social Impacts

4.1 Open robot platform for service robotics

This work aims to utilize open source solutions for both hardware and software developments for low cost and large community support to develop an open robot platform for service robot research and development. The developed robot platform is open sourced with support wiki, source codes on GitHub and 3D printing parts to ensure easy reproducibility, to build up a community-driven development effort for service robots.

- Support Wiki: http://openbotics.org/kamerider/
- Source codes (GitHub): https://github.com/kamerider/
- Demo Videos (YouTube): https://www.youtube.com/user/kameriderteam

4.2 The Proposal of RoboCup @Home SPL (Standard Platform League)

Align with the development of the open robot platform, a new league proposal of RoboCup @Home SPL (Standard Platform League) has been initiated by the RoboCup Japan Committee in early 2014. The goal of the proposal is to simplify the hardware challenges of RoboCup @Home with a standardized robot platform. Also, due to the technical complexity of RoboCup @Home, minimum game rules will be adjusted (more lenient) for RoboCup @Home SPL to reduce the complexity of the robot platform in order to be more affordable for new teams. Along with this initiative, a series of related workshops (Fig. 6), and preliminary challenges (i.e. Intelligent Home Robotics Challenge 2014 (Fig. 7) and RoboCup Japan Open 2015 (Fig. 8)) are currently taking place in Japan.

4.3 RoboCup@Home SPL demo challenge during RoboCup Japan Open 2015

A demo challenge of RoboCup@Home SPL was organized in RoboCup Japan Open 2015 on May 2015 at Fukui, Japan. A local organizing committee was setup within the RoboCup@Home Japan Committee for the organization of the competition. An entry level standard robot platform based on TurtleBot with arm was decided with four tasks from RoboCup@Home rulebook of 2014, i.e. *Basic Functionalities*, *Follow Me*, *Restaurant*, and *Open Challenge* were selected for the SPL challenge. A dedicated website, http://www.robocupathomespl.org/ and a mailing list, robocupathomespl@googlegroups.com were started for information dissemination of the competition rules and standard platform specifications, and public announcements of related events. Six teams had participated in the challenge with encouraging performance.

Fig. 6. Workshop hosted by Family & Robotics

Fig. 7. Intelligent Home Robotics Challenge.
Team KameRider is proud to be the winner of Mobile Robot Category 3rd Place and Overall 3rd Place in the Intelligent Home Robotics Challenge with the open robot platform.

5 Team Members

Team KameRider is a collaborative effort with the current collaboration members as follows:

- Team Leader: Jeffrey Too Chuan Tan (The University of Tokyo, Japan)
- Supervisors: Che Fai Yeong, Mohd Ridzuan bin Ahmad, Cheng Siong Lim (Universiti Teknologi Malaysia, Malaysia), Hanfu Wang, Feng Duan (Nankai University, China), Hiroyuki Okada (Tamagawa University, Japan)
- Students: Nicole Lei May Tham, Yip Loon Seow, Muhammad Najib Abdullah, Wei Kang Tey, Kian Sheng Lim, Mohamad Hafizuddin bin Majek, Muhammad Faiz bin Muhammad Rozi (Universiti Teknologi Malaysia, Malaysia), Peipei Song, Wenyu Li, Fengting Li, Chengguang Xu, Zhendong Luo, Zihao An (Nankai University, China)

Fig. 8. RoboCup@Home SPL demo challenge during RoboCup Japan Open 2015. Team KameRider is proud to be the 1st place winner of the demo challenge with the open robot platform.

References

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