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 for service robot research and development.
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 challenges to benchmark the robot performance.
D. Support the proposal of RoboCup @Home SPL (Standard Platform League).

2 Background and Motivation

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).

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 and preliminary challenge are currently taking place in Japan.

The technical challenge of this work is the reduction of complexity and standardization of robot system requirements, while not compromise too much of the technical challenges intended in RoboCup @Home. However, the impact of this work is believed to significantly promote the participation of RoboCup @Home league to foster service robot development.

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

3 Robot Developments

3.1 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 serves as an ideal mobile platform for this development. The height of the **mobile platform** will be adjusted (currently working on an elevated upper platform with linear motor), a secondary **vision system** and a **robotic arm** will be added for the manipulation tasks, and 3D printed (emergency) **switch box**. An **interactive interface** will also be built with speech and facial expressions for human-robot interaction. A general laptop PC with speakers and microphone is served as the main robot controller. Fig. 2 illustrates a basic robot hardware configuration for this development.

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[1] http://www.turtlebot.com/
[2] http://www.ros.org/

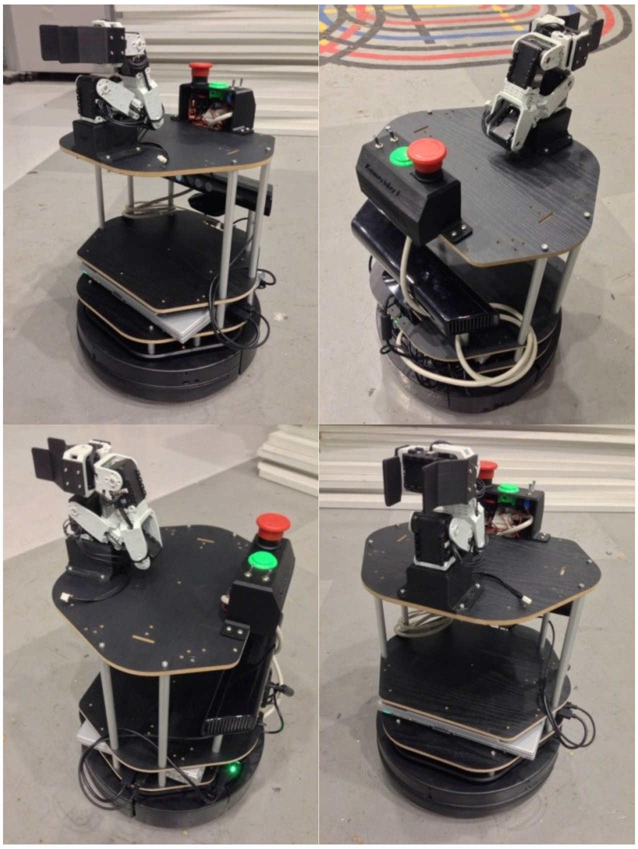

Fig. 2. Basic robot hardware configuration

3.2 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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[3] http://kobuki.yujinrobot.com/home-en/
[4] http://wiki.ros.org/turtlebot_navigation/
[5] http://wiki.ros.org/navigation/Tutorials/SendingSimpleGoals

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.

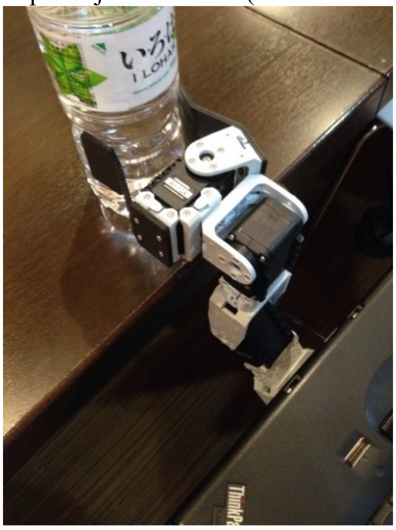

Fig. 3. Robot arm for object manipulation

Vision. A second vision system (Fig. 4) 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.

Fig. 4. Vision system on top of the robot

[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.

4 Scientific Contribution and Social Impacts

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

RoboCup @Home SPL (Standard Platform League). This work will support the proposal of RoboCup @Home SPL by providing an open robot platform that is relatively affordable, easier development startup, open source and community driven. The technical challenge of RoboCup @Home SPL is the reduction of complexity and standardization of robot system requirements, while not compromise too much of the technical challenges intended in RoboCup @Home. This proposal is aimed and believed to significantly promote the participation of RoboCup @Home league to foster service robot development.

The first demo challenge of RoboCup @Home SPL is planned to be held in RoboCup Japan Open 2015 on this coming May. To facilitate the participation of the demo challenge, a series of related workshops (Fig. 5) and preliminary contest, *Intelligent Home Robotics Challenge* are currently hosted by RoboCup @Home Japan Committee, Intelligent Home Robotics (iHR)[10] RSJ and Family & Robotics[11] organization:

- 2014.08.31 Workshop: Introduction to ROS and TurtleBot2
- 2014.09.04 Workshop: RoboCup @Home Challenge with TurtleBot2

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

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

[10] http://intelligenthomerobotics.org/

[11] http://www.familyrobotics.org/

- 2014.09.28 Workshop: “Grab a bottle” with TurtleBot2
- 2014.11.16 Workshop: “Follow me” with TuetleBot2
- 2014.12.06 Intelligent Home Robotics Challenge (Fig. 6)

Fig. 5. Workshop hosted by Family & Robotics

Fig. 6. 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: Mohd Ridzuan bin Ahmad, Cheng Siong Lim (Universiti Teknologi Malaysia, Malaysia), Feng Duan (Nankai University, China), Hiroyuki Okada (Tamagawa University, Japan)
- Students: Wei Kang Tey, Kian Sheng Lim, Mohamad Hafizuddin bin Majek, Muhammad Faiz bin Muhammad Rozi (Universiti Teknologi Malaysia, Malaysia)

References

[1] Thomas Wisspeintner, Tijn van der Zant, Luca Iocchi and Stefan Schiffer, "RoboCup@Home: Scientific Competition and Benchmarking for Domestic Service Robots", *Interaction Studies*, Vol.10, No.3 (2009), pp.392-426.

[2] Tijn van der Zant and Luca Iocchi, "Robocup@Home: Adaptive Benchmarking of Robot Bodies and Minds", *Social Robotics*, (2011), pp.214-225.

[3] Quigley, Morgan, Ken Conley, Brian Gerkey, Josh Faust, Tully Foote, Jeremy Leibs, Rob Wheeler, and Andrew Y. Ng. "ROS: an open-source Robot Operating System." In *ICRA workshop on open source software,* vol. 3, no. 3.2, 2009.