Abstract. This paper provides a brief description of a home service robot named Jarvis. The robot is developed by Dong Yang team from Prince of Songkla University, Thailand. The technical knowledge of the robot about background, mechanical design, sensors, display, control system and programing are revealed.

1 Introduction

Team Dong Yang was founded in June 2011 to build a service robot and participate in the Thailand Robot@Home competition. Originally, there were eight undergraduate students and three advisors working on a home service robot as a senior project in the requirement for the Bachelor of Engineering in Mechatronics Engineering of Prince of Songkla University. In meantime, the team has been participated the Thailand Robot@Home competition 2011-2012 and received awards of the first runner up and the best human-robot interface. Consequently, the team has been selected by Thai Robotics Society to enter the RoboCup@Home 2012 competition in Mexico.

In order to enter the RoboCup@Home competition, this paper is developed. The principle of making this robot is based on system integration of exist technologies. The technical descriptions of the robot are written in following topics: structural and mechanical design, input sensors and output display, control system and programing.

2 Structural and Mechanical Design

Main structure of the robot consists of three components: body, base and arm. The structure is made of aluminum beams and plates as shown in Figure 1. The body of the robot is a square-cross-section pole where the arm, display, Kinect sensor and controllers can be attached on.
Underneath the body is the wheel base which contains the battery and driving system. The driving system of the robot is the 4-omnidirectional-wheels system as depicted in Figure 2. This enables the robot to move and rotate in various directions depending on the rotation of the wheels as described in Table 1. It is capable of travel in narrow space and can be wireless controlled.
Table 1. Robot movement in different directions by the driving system.

<table>
<thead>
<tr>
<th>Robot movement</th>
<th>Wheel rotation</th>
<th>Vector of each wheel</th>
<th>Direction of robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward (North)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backward (South)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding left (West)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding right (East)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding to northeast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding to southeast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding to northwest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sliding to southwest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotating (Clockwise)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotating (Counter clockwise)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The robot arm has 4 degree-of-freedom (DOF). Those are one vertical linear movement, two horizontal rotation movements and one DOF of the robot gripper. Accordingly, there are 4 servo motors for controlling the robot arm as shown in Figure 3. The motors are integrated into the arm structure to control the shoulder, elbow, wrist, and gripper. An ultrasonic sensor is attached inside the robot hand to measure the object’s distance. A web camera located on the robot hand is used to classify objects by taking the image.

![Fig. 3. The arm robot in grasping action](image)

### 3 Input Sensors and Output Display

#### 3.1 Input Sensors

**Robot arm sensors:** An ultrasonic sensor is placed inside the gripper in order to measure the object’s distance. In addition, a web camera on the robot hand is used for distinguishing type of objects. The locations of the sensor are shown in Figure 4.

![Fig. 4. Ultrasonic sensor and web camera on the robot hand](image)

The picture of the object in front of the camera is taken and processed by comparing with the data base image to classify type of object. Example of the screen display during the object classification of the pickup task is shown in Figure 5.
Navigation, image and voice sensor: The Microsoft Xbox KINECT sensor (Figure 6) [1] and C# programing is implemented for navigation, face recognition and speech recognition. Inside the Kinect sensor, there are four microphones for voice receiving, a color camera for face recognition and color image detection, a monochrome CMOS camera and an infrared projector for depth measurement in the navigation task.

By implementation with the developed software written C#, the Kinect sensor is a useful tool for a home service robot to complete the assignment tasks. The screen display in the face and speech recognition task with the image and voice taken by the Kinect sensor is shown in Figure 7.
Example of the screen display in the follow human task based on the data from the Kinect sensor is illustrated in Figure 8.

3.2 Output Display

The robot voice output device is an ordinarily portable USB speaker (Fig 9) connected with the computer. This enables the robot to speak with human. In addition to the computer screen, the image display can be done via an iPad tablet (Fig 9).
4 Control System and Programing

Using the Kinect sensor as a main sensor for taking image and receiving voice from the environment, the main processing and control unit is a laptop computer to process the input data and send the control signals to microcontrollers for driving the wheel base and robot arm. For examples, the computer signals the related microcontrollers to response in action, such as driving the robot wheels to follow the human, or moving the robot arm by human voice order to grasp the object.

The software is programmed based on Visual Studio C# and EMGU OpenCV library. The control diagram of the robot is illustrated in Figure 10.

![Diagram of the main control system](image)

Fig. 10. Diagram of the main control system

Arduino microcontroller [2] that controls the driving system and robot arm are shown in Figure 11.

![Arduino microcontroller](image)

Fig. 11. Arduino microcontroller

Each of the wheels is driven by a DC motor. The speed of the motor is controlled by Pulse Width Modulation (PWM). The direction of rotation is controlled by the H-Bridge circuit. The H-Bridge circuit makes use of MOSFET transistors to control flow of the current through the motor as depicted in Figure 12. There are two digital control signals to control the rotation of a motor via four MOSFET transistors.
5 Summary

This home service robot is a developing project for competing in RoboCup@Home League. It has already shown that existed technologies can be implemented to serve as a human service robot, within one year of building and development. The further research of this robot aims for friendly feeling of the human-robot interface, not only by the look but by the robot response.

Acknowledgements

The authors would like to thank staffs and students at the Mechanical Engineering Department, Engineering Faculty, Prince of Songkla University, Thai Robotics Society (TRS), Siam Cement Group (SCG) and many others for their support, without them the team could not this far.

References


List of Components

Microsoft Kinect sensors, Omni-directional wheels, Severmotors, DC motors, Web camera, Ultrasonic sensor, Arduino microcontrollers, USB portable speaker, iPad tablet, Visual Studio C#, EMGU OpenCV.
Team Information

Team: Dong Yang
University: Prince of Songkla University
Country: Thailand
Team website: http://www.me.psu.ac.th/robocup

Team members:
Assoc. Prof. Dr. Pruiittikorn Smithmaitrie Major Advisor (Faculty)
Ms. Chalita Hiransoog Advisor (Faculty)
Mr. Nitipan Vittayaphadung Advisor (Faculty)
Mr. Kittikun Chongcharoen Team leader (Student)
Mr. Thosaporn Kongsucharit Member (Student)
Mr. Pirunkorn Thanauswapolkul Member (Student)
Mr. Phichaiporn Bomlai Member (Student)
Mr. Thunyatat Angsupisit Team Supporter (Student)
Mr. Kittipong Chartwut Team Supporter (Student)
Mr. Ekasit Kanjanakaew Team Supporter (Student)
Mr. Pornpon Sawangpipop Team Supporter (Student)