RoboCup@Home League 2013

<BART LAB AssistBot (THAILAND)>

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Abstract. 'BART LAB AssistBot Team', the robotics team from Thailand, has been continuously researching and developing service and assistive robot, and has been joining the Robot@Home Competition in regional level since 2011. In 2011, the team attended Thailand Robot@Home Championship 2011 and is awarded 'the Best Creativity Award.' BART LAB AssistBot team has firstly experienced in international competition in @home robot league in RoboCup Japan Open 2012, Osaka. From the experience in RoboCup Japan Open, BART LAB AssistBot team developed the new robot as second iteration (AssistBot II), which is developed to reduce some limitations from the first one. Then, the team attended to Thailand Robot Championship 2012 in Robot@Home League, and received 'the Best Technique Award.' The team consists of eighteen members, and one robot (AssistBot II). It is highly mobility robot with a driving system consisting of four individual driving wheels, four motors to drive wheel and four motors to control a direction. Furthermore, this robot is developed by applying a localization system, navigation system and obstacles avoidance with a combination of information from a laser rangefinder and camera. Moreover, there are two manipulators which are equipped at left and right side of the robot body. Each manipulator consists of 6 degree of freedom, and is attached to robot that is similar to a human body. The ultimate goal of BART LAB AssistBot Research and Development team is to produce robust service and assistive robots with high relation for human application.

1. Mechanical System

1.1 Driving System

The robot is designed to operate in a house, so a small radius to turn is required. An independent driving system is used in the robot. There are all 8 motors in the independent driving system. Four motors are designed for wheels, and another four ones are used to change the direction of wheels. The independent driving system is able to control a turning radius. Closed loop control is applied to control the direction and the speed of the wheels. All of the motors are attached with optical encoder for close-loop control feedback.

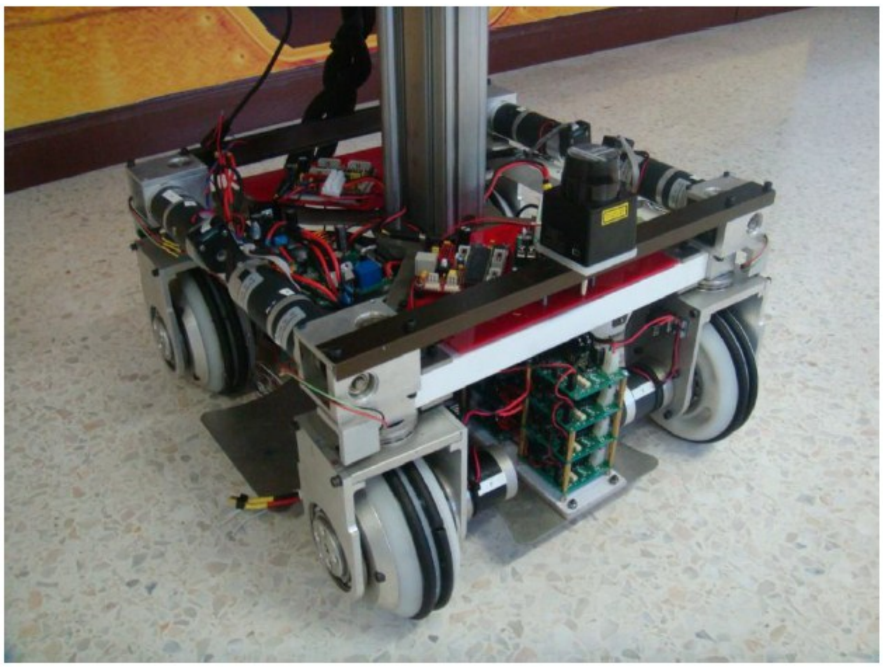

Figure 1: The base of the robot

1.2 Another Mechanical System

Manipulator

There are two manipulators which are equipped at left and right side of the robot body. Each manipulator consists of six degrees of freedom, and is attached to robot that is similar to a human body. Figure 2 shows the manipulator of the robot.

- Two degrees of freedom on the top are designed to mimic the motion of human shoulder

- Two degrees of freedom are designed to mimic the motion of human elbow
- One degree of freedom is designed to mimic the motion of human wrist
- One degree of freedom is designed to mimic the motion of human hand for grabbing an object

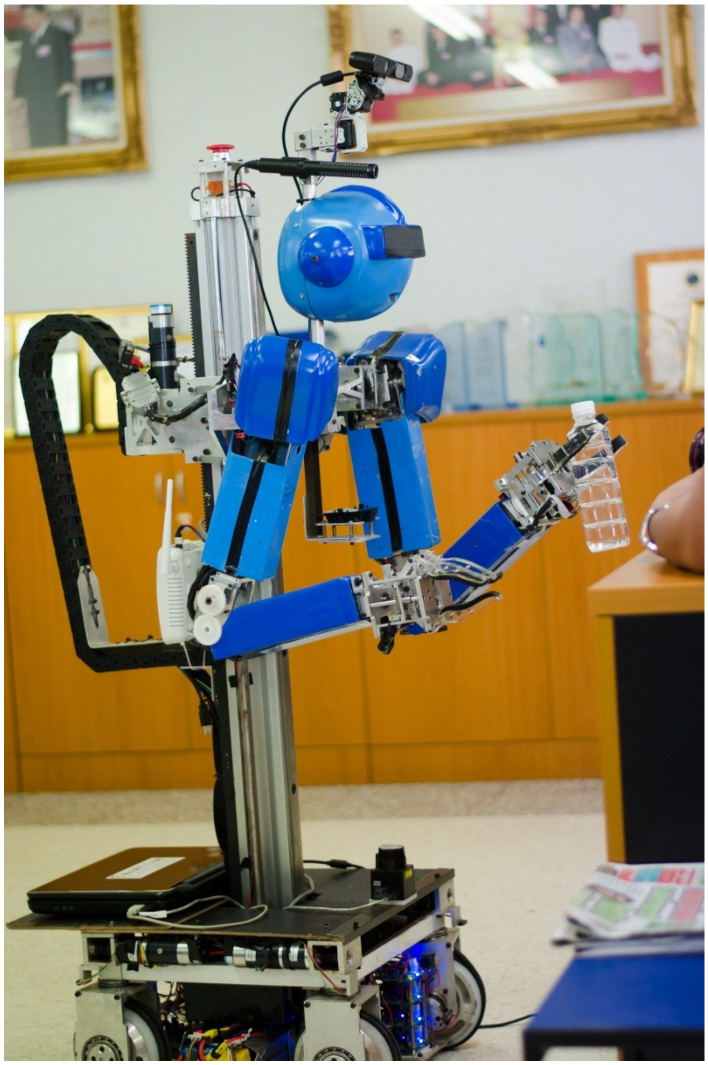

Figure 2: The manipulator of the robot

2. Software Description

The software architecture of the robot is based on ROS (Robot Operating System), which combines several nodes to perform the specific task. Figure 3 shows the overview diagram of important node. We use ROS packages to connect with common devices. For example, the 2D range finder is interfaced with laser_drivers package (hokyo_node), the RGB-D camera is implemented with OpenNI package and the camera is implemented with uvc_camera package.

We develop ROS node to preform specific task based on several open source library such as OpenCV and OpenNI for image processing. In order to interface for controlling the robot movement, we develop our own ROS packages and messages to interface with hardware microcontroller for controlling the manipulators and wheels.

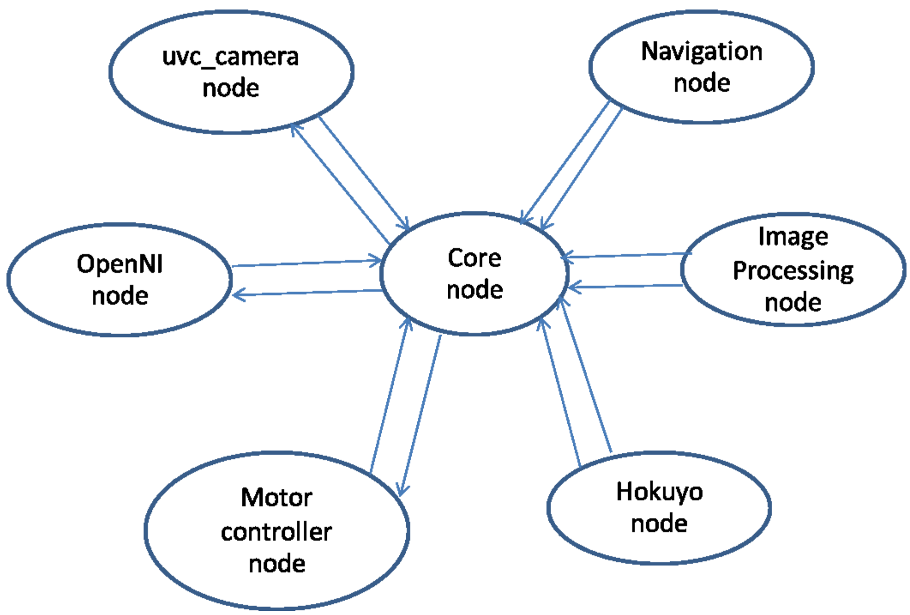

Figure 3: The overview of control diagram

Therefore, the integrated software of robot consists of several ROS nodes for interfacing, calculation and controlling. For example, the manipulation task program is developed by combining the image information from uvc_camera node and the depth information from OpenNI node to our processing node then sends the command through the motor controlling node to perform the task. The follow me task of the robot is based on fuzzy logic control and kinect OpenNI library for human detection. The main idea of this system is to follow the human and avoid the obstacles as the same time. The fuzzy logic controls have two separate subsystems. The first subsystem is using human position related to the robot head as the input to control the degree of robot's neck. With this subsystem, robot will move the head in the horizontal plane to follow the human position. The second subsystem is using robot's neck position together with range data from laser range finder that attached at the robot based. The first priority of the second subsystem is to follow the human by control the angle of wheels to make the robot heading parallel to the human heading. If there are obstacle between the robot and human, the robot will avoid the obstacle and try to compensate the heading back while the robot head is still follow the human position.

3. Scientific

Manipulator:

The manipulators are designed to mimic the human motion. To grab an object, 2 cameras are used for object recognition and object localization. The inverse kinematic is used for approaching the object.

Independent drive

The independent drive system is controlled by using microcontroller. One wheel consists of two degree of freedom, one for driving the wheel and another for changing the direction of the wheel.

Independent drive control system

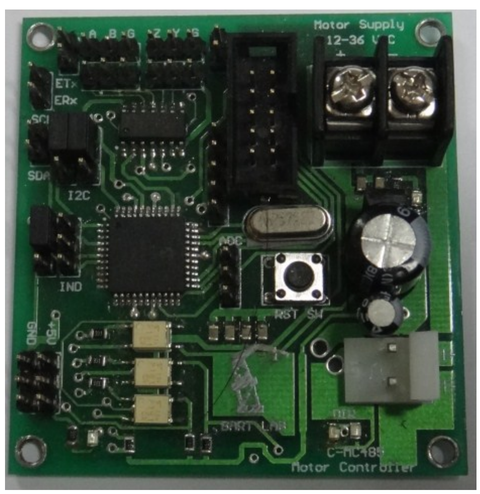

Figure 4: Motor controller Rev.03

For a low-level control, the robot microcontroller is dsPIC30F4011 to control each motor 8 for base platform drive 12 for manipulator and 1 for body up-down. A motor controller can drive motor current up to 9 amps continues and 30 amps peak and we use 2 power supply to feed for motor controller 1.motor supply 2.logic supply for isolation between logic supply and motor supply for communication is used RS-485 bus communication to communicate with master. A motor controller be in slave mode and computer be in master mode to control slave via 2 wire twist-pair cable and master connect to the media converter to convert signal USB to RS-485 for suitable with motor controller and connect with 20 motor controller and it can connect with incremental encoder and hall effect sensor directly for control angle for 4 wheels use incremental encoder and hall effect to measurement and control the angle for each wheel and send an angle to master for monitoring wheel of robot. Furthermore, incremental encoder is applied to main motor for a robot speed measurement in both of forward and backward movement.

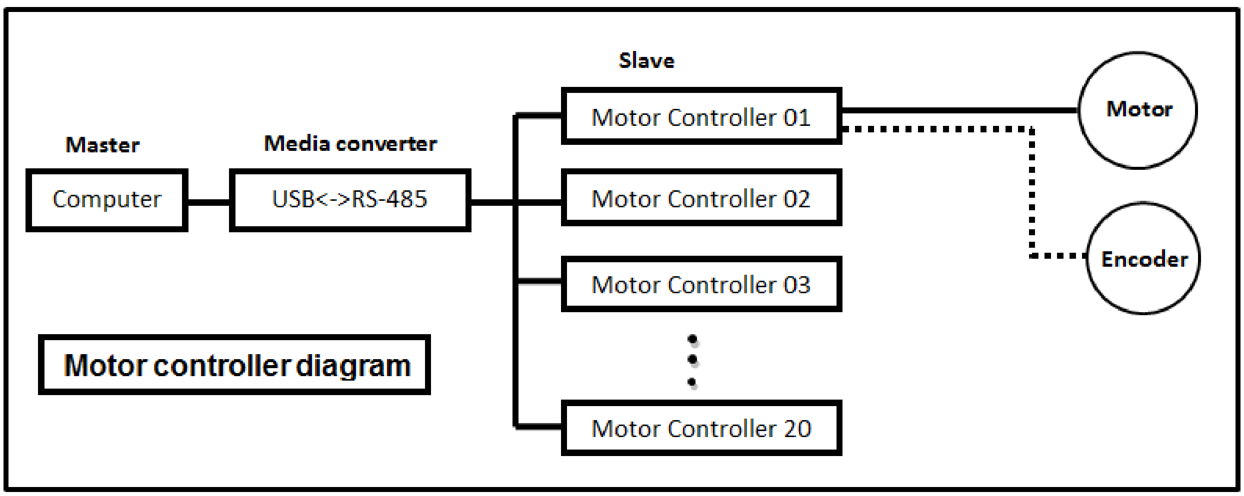

Figure 5: Motor control diagram

4. Research Interests and Application

@home robot is a research project for medical application. The project is interesting in logistics and service in hospital. For logistics, the robot is applied to carry drugs and medical supply to reduce a workload in routine work. For the service approach, robot uses in a hospital to communicate and navigate a patient to the right department. In addition, robot can keep basic information of patient such as blood pressure measurement, temperature checking, and database of patient.

Basic work of a robot in a hospital

1. Robot can communicate to human by using speech.
2. Robot can navigate itself in hospital area by map base generation.
3. Obstacle avoidance is important in the hospital area.
4. Robot can localize itself.

   These basic works can apply to use in the @home robot.

The advantages of using robot in logistics

1. Robot can carry more load than a human.
2. Robot does not need to take a rest. It can run continuously.
3. Robot can work on weekend.
4. Robot does not avoid its duty.

The advantages of a robot in hospital service

1. Robot need not take a break and can service a patient incessantly.
2. Robot can operate work repeatedly.

Applications

1. The robot uses in the hospital Service.
2. The robot uses in the hospital logistics.