Human-Robot Interaction for Remote Application

MS. Hendriyawan Achmad
Universitas Teknologi Yogyakarta, Jalan Ringroad Utara, Jombor, Sleman 55285, INDONESIA

Gigih Priyandoko
Faculty of Mechanical Engineering
gigih@ump.edu.my

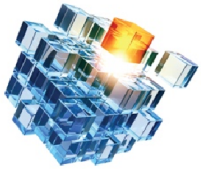
Mohd Razali Daud, Hamzah Achmad,
Faculty of Electrical & Electronics Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, MALAYSIA
mrazali@ump.edu.my, hamzah@ump.edu.my

Highlights: The development of Human-Robot interaction needs an advanced knowledge when the robot performs complex tasks. Traditionally, the interaction between human and robot tends to be operated with a peer to peer mode which relies on dedicated and customized network protocol. Our innovation emphasizes the use of robot operating system (ROS) which runs the distributed network concept and provides the solution to prevent re-invention the wheel in the robotic software development to interact with a human in the dynamic configuration. This innovation is highly recommended in the large scale robot development, i.e., industrial applications or military missions.

Keywords: *Human, Robot, Interaction, Operating System, Network.*

Introduction

The technology of robotics has grown rapidly and applied to many fields, such as industry, education, health, household, entertainment, and the military. Moreover, a mobile robot navigation technology is now increasingly sophisticated, with the technology of 2D/3D mapping (Zlot & Bosse, 2014). In some cases, the robots share the same resources and work in remote collaboration with the humans to accomplish the task. Human-Robot interaction in far distance has many advantages in the daily life, but it needs an advanced knowledge when the robot performs complex tasks. Previously, the remote interaction between human and robot tends to operate on a peer to peer mode which relies on dedicated and customized network protocol. This traditional method needs highly efforts to re-develop the software when the robot environments or configurations are changing dynamically. Our innovation emphasizes the use of robot operating system (ROS) as the core of human-robot interaction. ROS runs the distributed network concept which comes up with the solution to prevent re-invention the wheel in the robotic software development due to the environment or configuration changing. The distributed capability of ROS enables the system to reconfigure dynamically during the operation with multiple nodes, instead of a peer to peer model. Thus, the robots and humans can collaborate to perform complex tasks on the same network simultaneously. Every node connected to the network can publish and subscribe the messages as required to accomplish the collaboration task between humans and robots. This innovation is highly recommended in the large scale robot development, i.e., industrial application and military operation.



Description

The interaction between human and robot is an advanced technology developed by the researcher for last decade to enhance the people's live in many fields. The biggest problem is the development of the software itself. Sometimes, the robot operated for critical mission comes up with complex configuration both hardware and software, and this is a big challenge. The researcher must design the software of the robot to deal with high-end sensors and actuators which provide the information and control accurately. Previously, many scientists in the world have been working on the development of robotic software but fragmented into individual groups and their methods sometimes not well organized globally and repeated by others instead of improvement, known as re-invention the wheel and catastrophic in the technology development to grow rapidly. The market demands led the perspective of the robotics development into well organized globally by set the software framework as the core of the development. Nowadays, researchers are trying to create a software framework for robotics in the form of open source, and possibly open for another researchers contribution in term of improvement instead of re-invention. ROS (robot operating system) is the most widely used framework for robotics software development so far. In 2015 alone, more than $150 million in venture capital (VC) funding was invested in businesses that utilize ROS(Brian Gerkey, 2015). High demand on ROS mostly come from an industrial segment that wants to increase the production capability using large scale robotics technology but easy in the software development.

Our innovation tries to emphasize the method how the human and robot are doing interaction by using ROS framework to accomplish the mapping task. The

mapping is an important step when a mobile robot wants to explore the unknown environment (Chen & Yinhang, 2008)(Wolf & Sukhatme, 2008)(Rusu, 2010). The robot utilizes several sensors such as LIDAR (Light Detection and Ranging), Kinect Camera, and IMU (Inertial Measurement Unit). Inspection robots enable operators to plan outages more precisely and efficient and thereby reduce downtime. The inspection increases the availability of facilities and makes them more profitable, as well as boosting the safety of people and the environment. Eliminate individual entry in confined spaces and perform the inspection from a safe & remote location. It can save the life of workers and allows the operator to access areas that could not be found by anyone before, get more coverage, inspect behind baffles & obstacles. An inspection mission is a complex task which requires tens or hundreds of software function.

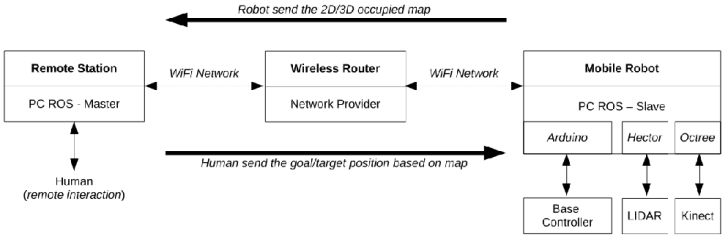


FIGURE 1. Proposed concept of Human-Robot interaction using ROS for remote mapping mission

ROS framework comes up with the modular design which divides the robot software operation into modules. Each module communicates by using the topic which contains the particular message. The use of modules make the dynamic re-configuration on the robot software are easy to do. ROS is a meta-operating system which runs under Linux OS. As an open source, researchers around the globe have been collecting ROS

stacks and packages in ROS repository so that researcher can use it for their project easily. However, contribution to the ROS repository is widely open for ROS user as well by modification or invention. High demand on ROS stacks from researchers increased the number of ROS stack production year to year exponentially. Moreover, ROS provides better methods which can be chosen based on our desires and purposes. It is also the product of trade-offs and prioritization made during its design cycle (Quigley et al., 2009).

The innovation of ROS leverages the legacy method of robotics system development by the community in the world for last decade. ROS provides standard operating system services such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management. Running sets of ROS-based processes are represented in a graph architecture where processing takes place in nodes that may receive, post and multiplex sensor, control, state, planning, actuator and other messages. We applied the ROS environment in our innovation to handle the resources from hardware layer to application layer which decrease the development time significantly for indoor mapping mission by the robot.

The advantage of this work for the community is a human-operated remote 3D mapping solution which provides the technology to describe an unknown environment in the particular area for the military or industrial plant in the form of deep 3D map regard to reconnaissance, safety, or inspection mission.
Currently, we are implementing the innovation to the wheeled mobile vehicle, which has a high market demand for industrial and educational purposes.

However, the innovation is not limited to the ground vehicle only, the aerial and underwater robot are possible objects for future development as required by the market. The commercial value of the innovation is the product of robot which has robust and modular development system to deals with multiple resources and deep missions as customer need, i.e., industrial and military.

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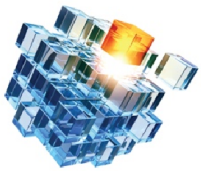

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