Reliability of ROS Networked Mobile Robots

Petri Tapani Oksa, Tampere University of Technology, Tampere, Finland

Tarmo Lipping, Tampere University of Technology, Tampere, Finland

ABSTRACT

When working remotely with mobile robotics, a reliable wireless communication network becomes essential, especially in large operating regions. As most teleoperated robots rely on standard Wi-Fi communication, network behavior has a crucial effect on autonomous robot control. The main goal of this research is to measure and diagnose the system reliability, roaming issues, and bottlenecks of such data transmission. To study these significant factors, two measurement scenarios were conducted. Measurements consist of two Wi-Fi access points (AP) and a TurtleBot II robot used in two different system set-up configurations. In the first configuration, two APs are connected in bridge mode (LAN connection) and in the second configuration the APs are connected in WDS bridge (Wireless Data Distribution) mode. This article presents the results of Robot Operating System (ROS) IEEE 802.11 network measurements in roaming mode, in wireless bridge mode, and in an extended coverage area employed in WDS mode. Results of data transmission measurements, configurations, and evaluation of the entire system are also presented. All the measurements utilize the Open Cloud Robotic Platform (OpenCRP)[1] an open-source cloud robotics ecosystem based on service-oriented PaaS architecture using the Ubuntu Linux operating system.

KEYWORDS

Mobile Robot, Open Source, Packet Loss, Remote Control, Roaming, ROS, Wi-Fi Traffic, Wireless Network

1. INTRODUCTION

Future robotic systems will be situated in highly networked environments where they communicate with industrial control systems, cloud services, or other systems at remote locations (Dieber et al., 2017; Sanfeliu et al., 2008; Kamei et al., 2017; Hajjaj et al., 2018). Wireless communication is one the major concerns regarding networked robotics, mainly in connection with networked service robots (Barriquello et al., 2018). Maintaining network connectivity is crucial for multi-robot and human-robot teams (Fabresse et al., 2017). If robots lose their network connection, they cannot receive commands or share sensor data with teammates. Zhivkov et al. (2017) state that most research in the multi-robot systems and human-robot interaction communities assumes 100% network connectivity but this is unrealistic for real-world domains.

With different operating conditions, interference, obstacles, and the type of building materials used, it is difficult to predict the path loss components that are crucial for network design (Rath et al., 2017; Wang et al., 2014; Awad et al., 2018) in an indoor environment. Limited coverage range,

complex missions, and dynamic obstacles are examples of issues faced by remotely controlled mobile robots. To remotely operate these robots, wireless communication is the basic need thus making a reliable network configuration complicated in many cases. Network communication methods between user and robot must handle latency, packet loss, variability, and loss of signal, for example (Tardiolo et al., 2013 & Handayani et al., 2017). In addition, a long network disconnection stops ROS topic streams and topic subscribers must be restarted. To overcome this drawback, certain AP parameters, provided by the vendor, can help to ease the communication line configurations.

Several mobile robots can be used with ROS (Ma et al., 2018; Grewal et al., 2018). One of the most popular robots is the TurtleBot II, a developmental kit for researchers, hobbyists, and software developers (Biro, 2018). A wheeled TurtleBot II is integrated with several simple and low-cost state-of-the-art hardware devices such as Microsoft's Kinect Xbox 360 sensor, Yujin Robot's Kobuki, and iRobot's Create. It is a moving platform intended for indoor environments with 3D perception capabilities by means of Kinect and Asus Xtion Pro Live (Martinez & Fernández, 2013). TurtleBot II is an evolution of the TurtleBot platform, the cheapest robot on the market with ROS architecture. TurtleBot II (Kobuki base) is a new version of the TurtleBot platform and has more features than its predecessor: odometric measurement precision, open protocol, higher speed and mobility, larger diameter wheels, and the capacity to overcome obstacles up to 12 mm (Kobuki Turtlebot II, n.d.).

Healthcare and hospice operations include processes that can be assisted by mobile robots. The service architecture model developed at Tampere University of Technology, Pori unit, consists of a novel mobile cloud robotic platform in the support of patient work. The ecosystem, OpenCRP, holds an open-source cloud-computing platform, software frameworks, UI, and a physical multi-robot environment for the automation or assisting of preprogrammed work processes. Figure 1 shows an overview of the ecosystem.

OpenCRP is an open-source cloud robotics ecosystem based on service-oriented PaaS architecture using the Ubuntu Linux operating system. Its multi-robot API allows any ROS robot to share its collected data via the cloud. The ecosystem's cloud environment is implemented through an Apache Hadoop software framework and configured as an HDFS cluster (Hadoop Distribution File System). The HDFS cluster operates as data storage for large data sets and could be managed from remote computers with terminal commands. In this paper, ROS IEEE 802.11 data transmission network measurements using a TurtleBot II mobile robot are presented. The rest of the paper is organized as

Figure 1. OpenCRP system overview
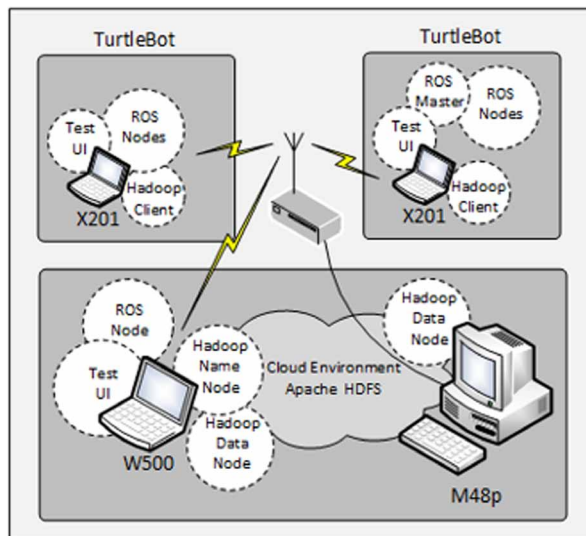
13 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/reliability-of-ros-networked-mobile-robots/228981

Related Content

A Survey of Open Source Statistical Software (OSSS) and Their Data Processing Functionalities
Gao Niu, Richard S. Segall, Zichen Zhaoand Zhijian Wu (2021). *International Journal of Open Source Software and Processes (pp. 1-20).*
www.irma-international.org/article/a-survey-of-open-source-statistical-software-osss-and-their-data-processing-functionalities/274513

A Novel Approach to Optimize the Performance of Hadoop Frameworks for Sentiment Analysis
Guru Prasad, Amith K. Jain, Prithviraj Jainand Nagesh H. R. (2019). *International Journal of Open Source Software and Processes (pp. 44-59).*
www.irma-international.org/article/a-novel-approach-to-optimize-the-performance-of-hadoop-frameworks-for-sentiment-analysis/242947

A New Framework for Reusing Business Processes Via Mashup: BP_Mashup
Zenak Fethiaand Zaoui Lynda (2017). *International Journal of Open Source Software and Processes (pp. 52-70).*
www.irma-international.org/article/a-new-framework-for-reusing-business-processes-via-mashup/203648

Software Defect Prediction Using Genetic Programming and Neural Networks
Mohammed Akourand Wasen Yahya Melhem (2017). *International Journal of Open Source Software and Processes (pp. 32-51).*
www.irma-international.org/article/software-defect-prediction-using-genetic-programming-and-neural-networks/203647

What Audacity!: Decreasing Student Anxiety while Increasing Instructional Time
Peter B. Swanson, Patricia N. Earlyand Quintina Baumann (2011). *Free and Open Source Software for E-Learning: Issues, Successes and Challenges (pp. 168-186).*
www.irma-international.org/chapter/audacity-decreasing-student-anxiety-while/46314