Fachhochschule Dortmund

University of Applied Sciences and Arts

(Master Embedded Systems for Mechatronics)

The Robot Operating System 2 (ROS 2) Evaluation

Research’s Thesis

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# Abstract

Since ROS 1 (Robot Operating System) has been initially created in 2007 by Willow Garage, it has become one of the most common open-source robotics communities. Along with many advantages, it has also some disadvantages like not providing real-time control and robot security, ROS 2 has been created to leverage what is great about ROS 1 and providing what is not. Here we evaluate real-time control of ROS 2 and compare it to ROS 1. I set up an experiment in PX4-Autopilot (open-source autopilot system for autonomous aircraft), which sends goal points over a topic along with a heavy task sending and receiving HD images in both ROS 1 and ROS 2. Then we observe the throughput, delay in both of them. The results show that ROS2 always has significantly better outcomes from the real-time control perspective.

# Declaration

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Ich versichere, dass ich meine Arbeit – bei einer Gruppenarbeit meinen entsprechend

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I hereby confirm that I have written the Master Thesis at hand independently – in case of group work: my respectively designated part of the work -, that I have not used any sources or materials other than those stated and that I have highlighted any citations properly.

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# 1. Introduction

## 1.1. Motivation

With the purpose of creating a development environment for PR2 robot, Willow Garage has started developing ROS. It is aimed to provide the software tools that users can take to undergo research and production development of PR2. However, there is not only PR2 in the world, so the team of ROS had decided to support other robots as well and then made a great effort to create software interfaces that allow software as much as possible to be used elsewhere.

ROS has been successfully fulfilled requirements to provide the software tools for PR2 in the use case of a single robot, with no real-time requirements, excellent network connectivity, and applications in mostly academia [1]. Nonetheless, when adapting to a variety of robots like wheeled robots, legged humanoids, industrial arms, outdoor ground vehicles, aerial vehicles, ROS has shown some disadvantages with other new use cases.

Furthermore, a huge number of robots used ROS in the industry alongside the academic research which is the initial focus. ROS-based products like commercial cleaning robots, manufacturing robots, agricultural robots are coming to the market [1]. ROS has also been used by government agencies.

With the new use cases of the broader ROS community including teams of multiple robots, small embedded platforms, real-time systems, non-ideal networks, production environments [1], ROS 2 has been created to serve these new requirements while also maintaining what is best in ROS 1.

From the first alpha release of ROS 2 was in 2015 to the latest version of ROS 2 Foxy Fitzroy, ROS 2 has gained popularity and ROS developers has started to discover ROS 2. As a result, ROS 2 evaluation should be carried out to obtain a full understanding of all the great features of ROS 2 that ROS 1 does not have.

## 1.2. Problem statement

Originally, ROS 1 does not support real-time which is the key feature of many robotics systems.

## 1.3. Structure

# 2. Background

## 2.1. ROS 1 basics (advantages and disadvantages)

## 2.2. ROS 2 basics

## 2.3. ROS 1 and ROS 2 comparison

## 2.4. Evaluation tools

# 3. Experiment implementation

## 3.1. ROS 1 example

## 3.2. ROS 2 example

# 4. Results discussion

# 5. Conclusion

# Bibliography

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| [1] | B. Gerkey, "Why ROS 2?," Open Source Robotics Foundation, Inc., n.d.. [Online]. Available: https://design.ros2.org/articles/why\_ros2.html. [Accessed 23 March 2021]. |