Graphical User Interface Design for a UAV Teleoperation

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Abstract

The number of drones being used around the world grows at a high speed. New drones' manufacturers are emerging and new drone designs are being developed. Most drones are controlled by remote control, while UAV joysticks and communication protocols are different. However, the Robotic Operating System (ROS) unifies the control process for drones. In this article, we present a universal graphical interface for controlling drones using ROS. The program is written in C++ and Qt Framework. It enables to control UAVs, receive and visualize the data from drones. Due to the use of ROS topics, this program can be applied to any drone integrated with ROS.

Keywords: Unmanned Aerial Vehicle, UAV, GUI, Teleoperation, Control.

1. Introduction

Unmanned aerial vehicles (UAVs) are used in a large number of applications. Drones are utilized in the entertainment industry to create 3D shapes and luminous objects[1]. They are also taking part in more serious military and dual-use missions. They find their use in in the tasks of terrain survey, mapping of the environment[2], static and dynamic objects detection in the environment[3].

Fig. 1. Graphical user interface design from Zul and Husry[6].

Drones are also employed for specific indoor applications. For example, UAVS are able to read RFID tags as a part of the autonomous inventory of warehouses and operate together with ground robots[4].

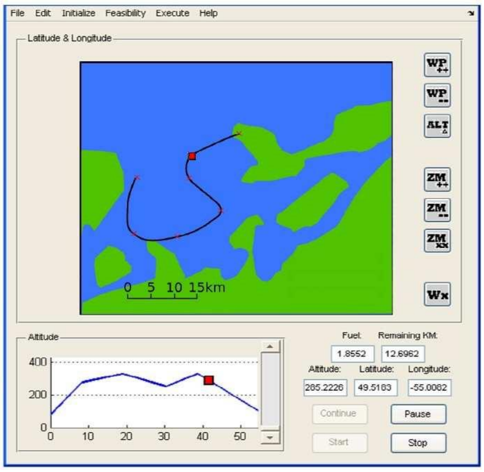

Fig. 2. Graphical user interface design from Perry and Taylor[7].

UAVs are able to operate alone or act in a group. A group of drones can have a robotic leader or not. The user can control robots one by one or the whole group, like a swarm[5].

Traditionally, drones are controlled using joysticks. A group of drones is controlled using specially developed programs. However, there is a unified framework for controlling robots – Robot operating system (ROS). In this paper, we present a new design for controlling drones using ROS.

2. Existing GUIs for Drones

Drones are usually controlled by an operator using a joystick or special software. Currently, several different interfaces exist for controlling drones. In some of them, one UAV is controlled, while in other cases there is a user that controls a group or swarm of drones. In this work, we surveyed the existing GUIs to find the most necessary widgets for UAV control.

Fig. 3. Graphical user interface design presented in the paper[8].

The GUI from Zul and Husry[6] contains altitude, position, and compass widgets (Fig. 1). In addition, the GUI contains data on the fuel level and the current battery charge. However, the graphical interface does not provide video stream from the cameras.

Another GUI for unmanned air vehicle mission planning and execution was presented by Sean R. Perry and James H. Taylor[7]. It allows tracking the drone over long distances and provides route planning (Fig. 2). The graph of change in height is displayed in the GUI. However, the interface does not provide real-time control of drones and does not track the status and speed.

Yet another GUI was presented in 2020 year in the Iraqi journal of computers, communications, control and systems engineering[8]. It uses a map from images from space, displays the speed and altitude of the drone. But there is no way to control the drone and there is no way to enter exact values in the GUI.

More options for controlling the drone were presented in the article "Natural user interfaces for multimodal human-drone interaction"[9]. According to the article, GUI is an auxiliary tool that allows one to perform high-level operations (takeoff / landing / flight in place). The interface enables to track the position of the drone relative to the coordinate axes. This GUI is programmatically associated with Aerostack*. The GUI cannot be used on every drone.

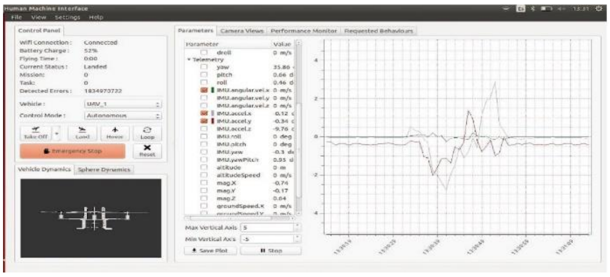

Fig. 4. Graphical user interface design presented in the paper[9].

3. Drones in ROS

The ROS framework has multiple drones that can be modeled and programmed. A lot of researchers use the hector_quadrotor UAV model to test drone control algorithms[10]. However, there are other drone simulation packages based on the PIXHawk and Mavlink controllers[4]. The new GUI should be able to control all drones that contain the ROS framework.

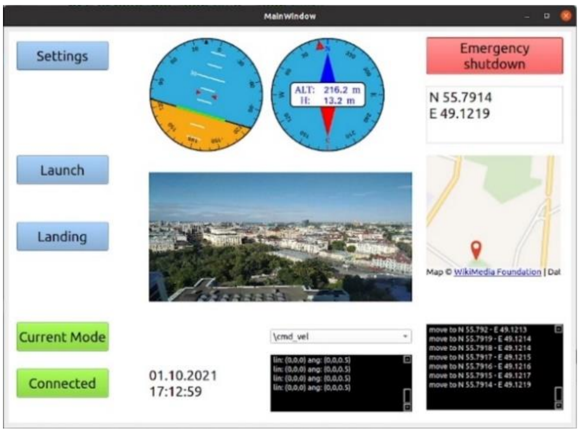

Fig. 5. New graphical user interface design.

4. Graphical User Interface Design

The graphical interface is written in C++ \ Qt Framework. It is designed to control a UAV using ROS. It includes the following widgets (Fig. 5):

- button “Settings”;
- button “Launch”;
- button “Landing”;
- button “Emergency shutdown”;
- info form “Current Mode”;
- info form “Status of connect”;
- info form “Date and time”;
- info form “Coordinates”;
- aerial widget (compass, height, roll, pitch indicators);
- image viewer (for video stream);
- map widget;
- combobox “topic select”;
- topic logs;
- other logs.

The map widget is created with QML, it renews UAV’s position in real-time. The coordinates of the UAV are displayed in a designated graphical interface’s form. Users are able to change the scale of the map using a mouse wheel.

The aerial widget includes several data. It shows compass, altitude, height, roll, pitch angles data. The source code of the widget can be found by link†.

Users can select a ROS-topic in the combobox. Messages that are published in this ROS-topic will be displayed in the “topic logs” form as text.

Clicking the “Settings” button opens the window with UAV connection parameters. The drone control buttons are also configured in the "Settings" form.

The developed GUI is able to control all drones that are a part of the ROS framework.

Acknowledgements

This paper has been supported by the Kazan Federal University Strategic Academic Leadership Program ("PRIORITY-2030").

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Authors Introduction

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Currently he works as an Assistant Professor at Kazan Federal University. He obtained his Ph.D. at Kazan Federal University in 2020. He teaches the following master's courses: «Robotic Operating System», «Industrial robotics» and others. Author of an online course and methodological guide on the Robotic Operating System (ROS). His main interests are path planning, robot operating system, and autonomous mobile robots.

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