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Design of Ground Control Station GUI using AppDesigner

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***Abstract*—The main objective of the paper is to introduce a software-based ground control station designed using AppDesigner toolbox of MATLAB which can be developed without having to be a professional developer and using only one environment for development. The proposed system also assures the existence of data handling and visualization in real time as an alternative to the traditional solutions. This system is a low-cost and provides high quality solution in controlling the vehicle during the mission.**

Keywords—ground control systems, software-based technology, graphical user interfaces, matlab, visualization, real-time systems.

I. INTRODUCTION

According to Kyle (2018), the number of launch operations per year has been increasing in recent years because of unique missions and cost-effective launch methods [1]. Each mission requires a unique operation process. However, the common system among these operations is control stations.

Control stations has a significant-role for the whole launching process thanks to the ability to show the conditions of vehicle in real time. The whole process is managed and tracked using these stations and it is the only one system that responsible for the link between the operator and the vehicle, so the stability of the system has to be thought against to the unplanned scenarios, unfortunately providing a redundant system always doubles the cost [2].

The researches and projects have been done until today generally are mission unique designs and based on different technologies for graphical interface design, development algorithms and processing data. This separated development technique is a tough method and requires more process and time.

Thanks to the 2019 version of MATLAB, we get an integrated environment called AppDesigner for a modern GUI development and programming as an alternative for the traditional GUIDE toolbox [3]. This designer provides us a time effective drag and drop feature and a compiler for creating standalone desktop applications without having to be a professional developer.

II. DESIGN AND IMPLEMENTATION

A. Objective

AppDesigner based Ground Control Station provides a software-based alternative against the traditional methods. The objective is to overcome some of the disadvantages of the separated development progress where many professional developers are needed during the period. The current system uses AppDesigner for programming, processing and the design of the graphical interface.

B. Proposed System

The main idea of the system is to develop a control station for the vehicles being managed remotely. The whole system works in two phases, one is at vehicle side and another one is at station side and the main technologies behind the system are sampling and telemetry.

The following procedure describes how the system works; initially the ground control software and the vehicle system are being paired to set a data link up, then the link is verified by sending data to and receiving data from the vehicle. After everything is ready to launch/begin, ground control software is being gotten the mode of collecting data by the operator, so the software gets the data and draws real-time graphs besides storing them. If a guidance is needed for the vehicle, the ground station can send commands to guide it. As seen in the example scenario, a control software for ground stations that operates like traditional solutions can be developed thanks to AppDesigner, without being a professional developer or using different technologies for each sub development process.

C. Methodology

This section briefs the implementation details involved while modeling the system for both the ground control software and vehicle sides.

The system of vehicle side was developed using an Arduino development board, LM35 temperature sensor, buzzer, LED and RFM9X transceiver module. The algorithm developed in C/C++ language samples the data from the sensors and transmitted it to the ground side at the same time

it listens to the commands from the ground side as an interrupt [5].

The ground control software consists of hardware and software sides. The hardware integrated in this side consists of an Arduino board and RFM9X transceiver module and it is used as an interface between AppDesigner and the vehicle side. AppDesigner and Ardunio board communicate with each other by UART protocol [4].

After the data is being sampled and transmitted to the ground side, AppDesigner gets the data and parses it to update the real-time graphs on the interface.

D. Future Scope

The system has been implemented before in a model satellite project using old-generation MATLAB toolbox called GUIDE however, the old generation GUI had not modern look and a compiler for a standalone desktop application to be run independently of MATLAB.

Thanks to this new generation GUI tool, the ground software side can be enhanced to get the control conditions easier using modern components. Also using the standalone desktop application has advantages on the system performance and system resources. This model demo shows and proves that the system can handle all requirements.

III. TESTING

Software testing methodologies including white box test, dynamic test and GUI test [6]; besides that, unit test, integration test, system and performance level test have been completed step by step.

White box and dynamic tests were implemented for MCUs and AppDesigner algorithms. As a unit test, functions and communication interfaces were verified. After component tests had done on hardware, integration tests were done. After the system level tests, we found some errors during the environmental test related to radio frequency communication, so we kept the transceiver modules close to each other to prevent the noise from affecting the data signal.

IV. CONCLUSION

Ground control station is one of the most important things a launch operation needs to track and manage the progress in real time. However, to make the development process easier and to decrease the dependencies of different technologies, we suggested using a MATLAB toolbox called AppDesigner. It provides the developer an integrated environment for GUI and coding. As shown above, ground control stations can be developed using AppDesigner without being a professional developer.

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