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Real-Time Software for Test and Performance Evaluation of Sensor over RS-422 Interface

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Abstract: In this paper, it is discussed that Real-Time Software Application helps in testing and performance evaluating the Sensor over RS-422 Interface. The Real-Time Software application which is developed according to the user requirement helps in easy to use and makes the testing process fast. Various software programming languages are available for developing the application. In this work, the use of python programming language for developing the application is discussed. Also, the advantage of developing real-time software for testing the device is discussed.

***Index Terms* – Interface, Real-Time Software, Test, Application Development, Serial Communication. .**

I. INTRODUCTION

Application Softwares are generally used to perform a specific task. Application Software is developed by software programmers. Nowadays different programming languages are available to develop an application. In this work Python programming language is used because it provides many libraries for developing an application and it is easy to write programs in Python. If an application software dealing with real-time data from the environment, then those types of applications are called Real-Time Software applications.

A sensor is an electronic device that is used to measure the physical properties from the surrounding environment or otherwise respond to change in the environment. In this work, the testing and performance evaluation of the Sensor or device is done with the help of real-time software application is explained. The communication between the Sensor and the System is done with the help of the RS-422 Interface device.

Testing is one of the important stages of every electronic device to make sure that the device or Sensor works properly. The real-time software application makes this testing process easy and fast. With the help of application software, we can see the performance of the Sensor in the developed application.

II. LITERATURE SURVEY

Serial Communication is the method of sending data one bit at a time, whereas in Parallel Communication several bits are sent at a time. Communication Standards are a set of rules to be followed by all participants to communicate with one another. In many of the devices, we use RS-232 as the common standard. In the avionics industry, almost all the devices are built on the RS-422 standards because of the benefits offered by them.

RS-232 stands for Recommended Standard – 232. The Electronic Industries Association (EIA) introduced RS-232 as a Recommended Standard in the year 1960. RS-232 supports both synchronous and asynchronous transmissions. RS-232 [1][2] is commonly used in telecommunication, computers, and industrial communication devices. RS-232 supports point to point communication between the devices. RS-232 has a low data transmission rate, short cable length support, and a large voltage swing. RS-422 was introduced to enable a higher data transmission rate over serial data lines than was possible with RS-232. The RS-422 [4][5] can provide data speed of 10Mbps up to 50 feet distance. With the reduced data speed RS-422 can transmit up to 4000 feet at the rate of 100 kbps.

The key feature of RS-422 is that it uses the Balanced / Differential Transmission Technique. RS-422 uses Differential Transmitters and Receivers. In a Balanced data transmission system the voltage produced by the drivers across a pair of signal lines. These lines produce output signals. When one is low, the other is high and vice versa. RS-422 balanced data transmission also requires a ground (GND) connection, even though the GND connection is not used by the receiver to determine the logic state of the data. Table I shows the comparison between RS232 and RS422 Standard.

Table 1: Comparison of RS-232 and RS-422 Standard.

PARAMETER	RS-232	RS-422
Communication Mode	Full duplex	Full duplex / Half-duplex
Cabling	Single-ended	Differential
Signaling Mode	Un-Balanced	Balanced
Maximum Distance	15 meters at 9600 bps	1200 meters at 9600 bps
Number of Transmitters and Receivers	1 transmitter and 1 receiver	1 transmitter and 10 receivers
Topology	Point-to-point	Point-to-point
Contact Pins in use	TxD, RxD, RTS, CTS, DTR, DSR, DCD, GND*	TxA, TxB, RxA, RxB, GND

Advantages of RS-422 over RS-232 are as follows:

- Long Distance Transmission
- Noise Resistant
- Support up to 10Mbps data transfer rate
- Multi-drop.

In this work, the RS-422 Serial Communication Standard is used to communicate between the Sensor and the Real-Time Software Application. The Sensor used in this work supports the Serial Communication. RS-422 supports user defined messages structure to communicate between the two serial devices.

III. ARCHITECTURE

The Architecture Design of the proposed system is shown in Fig 1.

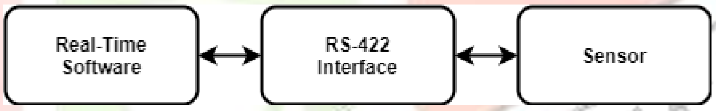

Fig 1: Architecture Design

3.1 Real-Time Software

Real-Time Software refers to programs that perform tasks right at the moment they are said to be executed without any error. In the proposed system, real-time software is developed to test and performance evaluation of Sensor over RS-422 Interface. The developed software can send commands to the Sensor, displays the response (data) from the Sensor in GUI and it can plot the graph based on the data received from the Sensor. The developed Real-Time software application can log the sensor data for post data analysis. Python programming language is used to develop the real-time software application.

3.2 RS-422 Interface

RS-422 acts as an intermediate for Communication between Sensors and developed real-time software. It supports a serial type of Communication. RS-422 supports a high data transmission rate of up to 10Mbps.

3.3 Sensor

The Sensor collects the data from the environment and responds accordingly. The Sensor starts sending the data when it receives ON-command from the user and stops sending the data when it receives OFF-command. The generated data is displayed on the application to test and performance evaluation of the Sensor. The Sensor supports a serial type of communication.

NOTE-Necessary hardware connections and software installations should be done to perform the task.

IV. SYSTEM MODEL

In this project, the whole system can be viewed as three blocks which are Sensor 1, Sensor 2, and the Software. The performance evaluation of the Sensor-1 is done by comparing with the Sensor-2. This is done by simultaneously collecting data from both the systems during the Outdoor Testing. At the same time software, logs the data in real-time from both Sensor-1 and Sensor-2 systems for the post-Data Analysis. Fig 2 shows the system model.

Communication between the software and Sensor is done in command and response mode. The software sends the ON-command to the Sensor on-clicking the ON button from the GUI. On receiving the ON-command the Sensor will send a response that can be seen on the GUI. The software is used to display important information on the GUI and plot the graph based on the data received from Sensor-1 and Sensor-2. The On-click function code is written in Python Language.

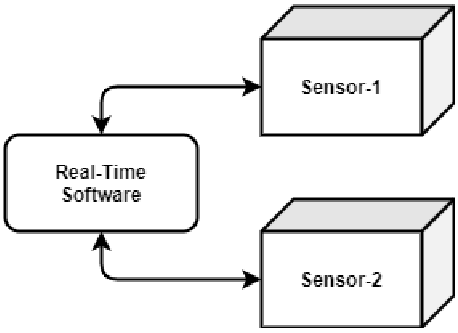

Fig 2: System Model

V. WORKFLOW

The whole software is written in a modular format in which each module is written in a different file. Each file has unique functionality. This helps the developer to understand the program clearly and updates can be made easily. Fig 3 shows the workflow of the program.

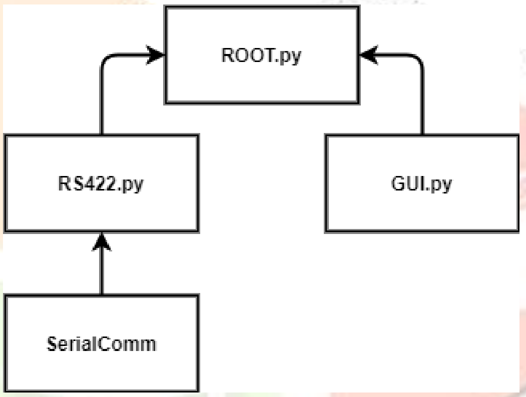

Fig 3: Workflow of program

The **ROOT.py** is the main file that imports all the required modules (GUI, RS422) for this project. First, it creates an instance of GUI.py which is responsible for creating GUI.

The **GUI.py** file contains code related to the GUI. The GUI is developed using python library **PyQt5**. The GUI is developed according to the user requirement. Widgets like Labels, Line Edits, Tabs, Radio Buttons, List Widgets, etc. are used in developing the GUI. The Layouts are used to align different widgets (like Buttons, Labels, Line Edits, etc.) in the GUI. The GUI can also plot graphs based on the received data from the Sensor. The graph plotting helps in Data Visualization.

The **RS422.py** file contains the code related to the On-Click button's actions, code for Communication between the Backend and GUI. The program for this project is written in such a way that each button has a specific function. On-Clicking that button the respective command will be sent to Sensor. The Sensor in return sends response data which is in raw format; it is converted to useful information and displayed on the screen. The threading concept is used to process multiple events at the same time.

The **SerialComm** file contains the code related to the Serial Port Programming, which is written using the Python C Extension concept. The command and response structures are defined in this file. This file is converted to Python Extension Module (.pyd) file so that it can be imported by other python files.

NOTE: Nowadays most of the systems have USB ports. So, a USB-to-Serial converter [3] having RS-422 standard is used to communicate between System and Sensor. While testing, the Sensor continuously sends the data. So, GUI also updates simultaneously, at the same time data is logged. The log data is used for post data analysis of the Sensor/device.

VI. REQUIREMENTS

6.1 Software Requirements

- **Python:** Python 3.5 or above version is mandatory. Python is a high level, interpreted programming language. It is a dynamically typed and object-oriented language. Python is created by "Guido Van Rossum" in the year 1991. Most of the code for this project is written in Python Programming Language.
- **PyQt5:** PyQt5 is a Python GUI library that contains many modules to develop an application. It is open-source and developed by "Riverbank Computing". In this project, the GUI code is written in Python Programming Language using the PyQt5 Library.
- **Matplotlib:** Matplotlib is one of the most popular libraries for plotting in the Python programming language. In this project, Matlpotlib is used for plotting graphs.
- **C Programming Language:** C is a low level, general-purpose programming language. It was created by "Ritchie" in the year 1972. It is a structured programming language. C is known for its Speed and Versatility. In this project, the Serial Port Programming code is written in C Language. This C Code is imported by other python files using the Python C Extension Concept.

6.2 Hardware Requirements

- USB-to-Serial Converter
- Sensor-1
- Sensor-2

VII. CONCLUSION

Without proper testing, a device (Sensor) can malfunction. This can be dangerous or harmful to vehicles or devices. So, it is very important to do proper testing of the Sensor to make sure it works properly (giving accurate results).

Earlier it used to take a long time for Testing and Performance Evaluation of Sensor without using Testing software. As the Real-Time software application is developed to Test and Performance evaluation of Sensor, the Testing of Sensor became easy and at the same time, its performance can be recorded for the post data analysis. The developed Real-Time software application also made the testing process simple, just by clicking the buttons in the application. This increased the number of testing devices. It also saved time and human power on testing the Sensor. This explains the use of Real-Time Software Applications for testing the devices. Future work can be extended, to develop the single Real-Time Software Application for testing multiple devices.

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