

Development of GUI Controller for COMINT Scanning Subsystem in Electronic Warfare

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Abstract

Objectives: This paper develops the Graphical User Interface (GUI) controller to control the operation of the scanning subsystem i.e. to intercept and analyze the incoming data for Communication Intelligence (COMINT) in Electronic Warfare.

Methods/Statistical analysis: The Software Development Life Cycle Model phases are carried out to develop this GUI Controller application and the Iteration method is used to test the developed application. The Transmission Control Protocol (TCP)/ Internet Protocol (IP) protocol based socket application programming interface method is used for communication between computer nodes. **Findings:** The controller sets the mode of operation to start and stop scanning by changing system state (operational/standby). The controller also sets the frequency of operation or frequency band to be scanned by Scanning subsystem and the configuration parameters of Scanning subsystem. This controller processes the data i.e. received from the Scanning subsystem (simulator) and plot the data on the display in spectrum view, using the Qt graphical tool. **Application/Improvements:** This will help the user to understand COMINT scenario of the signal presence in the environment and accordingly the military may plan their resources and it works as a force multiplier in the EW.

Keywords: COMINT, Electronic Warfare, GUI, Qt, TCP/IP Socket Program

1. Introduction

“Electronic Warfare (EW) is defined as any military act concerning the utilization of electromagnetic energy to determine, exploit, reduce or prevent hostile utilization of the electromagnetic spectrum”. This EW is organized into 3 major sections as shown in Figure 1.

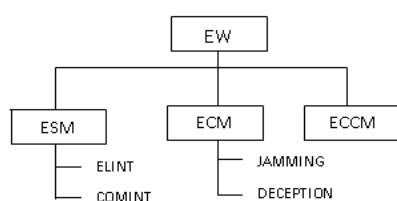


Figure 1. EW classification.

Electronic Support Measures (ESM) is that segment of EW which involves the gathering of EW information through COMINT¹. COMINT actives are related to knowing the information between communicating persons, the main function of the transmitter, the parties where they are located, and the time duration of communication, frequencies and any other technical details in the transmission. In the military, this data should be controlled and operated in the selected frequency range of operation by setting configuration parameters like Absolute threshold value (ATV), Signal to Noise Ratio (SNR), Resolution Bandwidth (RB), and the mode was set to start scanning or to stop scanning. GUI interface will facilitate the operator to command or control the electronic systems through graphical interface and ease of operation of the systems. The GUI Controller

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is the application software used to configure and control the COMINT Scanning Subsystem and provides facility to display² and analyzes the incoming data in the 20MHz-1500MHz frequency range. The GUI controller is controlling the COMINT Scanning Subsystem through the TCP/IP protocol¹² based Socket application programming⁴.

2. System Engineering

System Engineering is the way to enable the successful systems realization. It is used in all aspects of system development with hardware and software requirement engineering. In this paper the system requirements and engineering aspects to implement the controller system to control the scanning subsystem and the following Hardware, Software Engineering requirements are identified.

2.1 Hardware Requirement Engineering

Hardware Engineering deals with all the devices to enable the flow of data between interconnected devices and to provide computing capability. Hardware is in simple manner devices which can touch and feel and provide the required functionality. The Hardware used to develop the Controller System includes Personal Computer (PC), Local Area Network (LAN) Switch, and RJ45 Ethernet cables, etc.

2.2 Software Requirement Engineering

Software Engineering is the use of sound engineering principles and establishment them to obtain the efficient software that works efficiently and reliable on machines existed in the real environment⁵. Software engineering occurs as an effect of system engineering. Requirement Capture, Analysis, Design, Implementation, and Testing phases are carried out to realize the Controller Subsystem as shown in Figure 2.

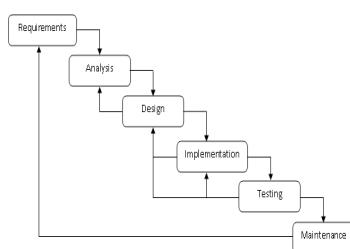


Figure 2. Software development life cycle.

Requirements in this paper are Software Requirement Specifications (SRS) and Interface Requirement Specifications (IRS). SRS defines what all the software

functions it will do. IRS indicates the data flow between two entities. For Command control or data flow between these entities client-server programs have been developed based on TCP/IP protocol. Analysis and Design are defined under Software Design Development (SDD). SDD is having modules, sub-modules, algorithms, and structures. Implementation or coding is defined by source code document. Testing is to test the written code and Maintenance defines any changes in the software validation and verification. Software requirements to realize Controller application are embedded tool Qt, fedora Linux, and TCP/IP.

3. Qt Graphical Tool

Qt is a framework for mobile, desktop and embedded. The developed applications by Qt⁶ are of the cross-platform type. It is a framework written in C++. Qt creator is an Integrated Development Environment (IDE) and it provides the tools to develop (design) applications. Qt creator also provides the tools for accomplishing given tasks during the whole application development lifecycle, from project creation to deploying the application to the target platforms. The GUI Controller application is implemented using Qt graphical tool based on C++ programming language and tested by Qt creator IDE tool.

To represent technical data, the Qt has to be adding the Qt Widgets for Technical Applications (Qwt) library, which contains utility classes and GUI components. It does not only provide 2D plots but also provides dials, scales, sliders, etc. to control values, ranges, or arrays. This Qwt file is configured in the .pro file by adding CONFIG += Qwt. To create a simple plot we have to access following classes. QwtPlot, which provides a 2-D plotting widget. To represent series of points the plot item QwtPlotCurve is used. To draw a coordinate grid QwtPlotGrid is used. For drawing symbols, QwtSymbol is used. The simple plot of triangle wave was shown in Figure 3.

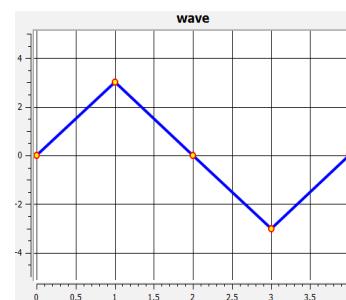


Figure 3. Qwt example plot.

4. Functional Block Diagram of Scanning Subsystem

Scanning Subsystem in the military is the subsystem of ESM and used to generate the data for the controller and to control the electromagnetic spectrum for threat recognition and tactical employment of forces. This scanning subsystem had the simulator for data generation and the controller for controlling operation as shown in Figure 4.

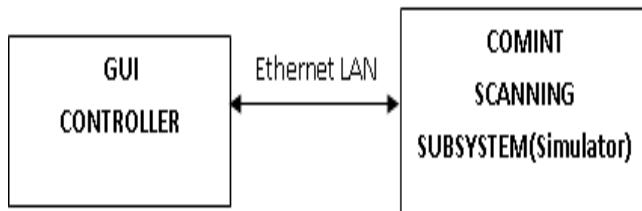


Figure 4. Scanning subsystem.

4.1 COMINT Scanning Subsystem

COMINT Scanning Subsystem is a super heterodyne type of ESM receiver which receives the signals from receiving antenna. The received signal information is gathered from the communications between individuals, including voice conversations, text messages to generate the data for Control system. The data parameters provided to the control system are Amplitude, Frequency, Time of Intercept (TOI), Direction of Arrival (DOA) etc.

4.2 Controller with GUI

The Controller in the military is used to control the operations of the COMINT Scanning Subsystem in Electronic Warfare. GUI is used to communicate with electronic systems through Graphical Interface. The controller with GUI is the application software used to configure and control COMINT Scanning Subsystem rather than command control² and provides facility to display and analyzes the incoming data. To design GUI controller application software the Qt tool is used to implement GUI and socket programming is used to interface TCP stack and controller application. A socket is an end to end communication link between two systems commonly known as Client and Server. In this application, Client is the GUI Controller and Server is the COMINT Scanning Subsystem. The TCP socket was implemented on client and server side by QTcpSocket class. To make a connection with the server, connect system call is implemented under QTcpSocket class, which is having

the combination of a Host IP address and the port number known as socket address. This socket address is used in the TCP/IP suite to make a connection. To request data with the server and to obtain a response from the server, write and read system calls are implemented under QTcpSocket class. This allows applications to be network aware and send & receive data via a network.

The GUI Controller as shown in the results was implemented by Qt tool with the help of Qwt. As shown in the results of GUI Controller application design, the window title name was given as GUI Controller and menu bar, toolbar, and status bar were implemented in this window. In Menu bar configuration settings name was designed to identify the parameters. In toolbar, energy detection tool button was implemented to initiate the scan and to restart scanning process after applying parameters, absolute threshold tool button was implemented to apply absolute threshold value, SNR tool button was implemented to apply SNR, and start, stop frequency labels were created to represent names and corresponding input graphical widgets were implemented to apply start and stop frequency of electromagnetic spectrum. To connect and disconnect with COMINT scanning subsystem button widget was implemented. For operating and standby modes start and stop scan icon widgets were implemented. To represent power level and scanning process scale widgets were implemented. The status bar was implemented to represent the status of connection or disconnection with COMINT scanning subsystem.

This developed GUI Controller can interact with COMINT system and plot the data on the display in spectrum view. Both these systems are connected with Ethernet LAN switch. The developed GUI controller first connects with COMINT Scanning Subsystem and sets the configuration parameters i.e. ATV, RB, SNR and the start and stop frequency to perform the scanning operation. By Energy detection mode selection and clicking on the operation mode, it will start scanning in the applied frequency range as per the command from the GUI Controller. After this GUI Controller requests the simulator to provide data and plots that data on the display. The same process is repeated with different configuration parameters to control the data in the specified range of values. After performing this operation it was disconnected from COMINT Scanning Subsystem. The application software for GUI Controller is developed under the Qt & Linux Environment. This developed GUI Controller can be used for embedded applications.

4.3 Application Level Algorithm and Flowchart

1. Connect with COMINT Scanning Subsystem.
2. Set the configuration parameters i.e. ATV, RB, and SNR etc.
3. Select the mode of operation i.e. starts the scan and stops the scan.
4. Select the Frequency Band of operation i.e. 20MHz-1500MHz to perform the scan operation.
5. Select the configuration parameters values.
6. Request the COMINT Scanning Subsystem (Simulator) to provide data with these specifications.
7. Wait for the data from COMINT Scanning Subsystem (Simulator) and check whether it is in the specified range.
8. If it is in specified range go to step 9 else go to step 5.
9. Show the signal information on the display using Qt graphical tool.
10. If we want to continue the processes go to step 11 else go to step 12.
11. Change the configuration parameters i.e. ATV, RB and SNR, after this go to step 6.
12. Disconnect Controller with COMINT Scanning Subsystem (Simulator).

The Iterative method is used to test the controller application and to represent pictorially; the flowchart was drawn as shown in Figure 5.

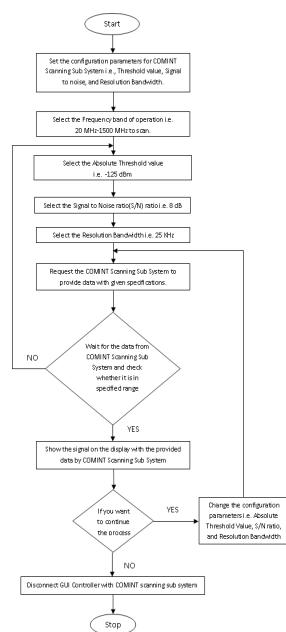


Figure 5. Controller functional flowchart.

5. Results and Discussion

The results indicate that the GUI controller performs the scanning operation in the selected frequency range and the obtained data from COMINT Scanning Subsystem is plotted on the screen with the selected configuration parameters. Figure 6 shows that the setting ATV of a Controller to -125 dBm within the 20 MHz to 1500 MHz frequency range.

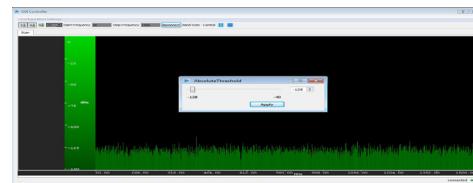


Figure 6. Setting absolute threshold within 20MHz-1500MHz frequency band.

Figure 7 shows that after setting the ATV it removes all the signals below the configured threshold value.

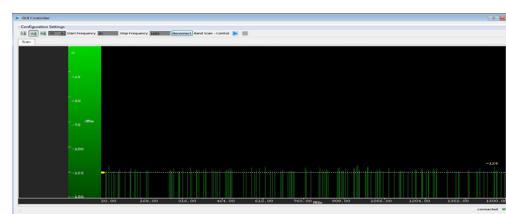


Figure 7. Response after absolute threshold applied.

Figure 8 shows that the response of a controller after applying the SNR within the 20 MHz to 40 MHz frequency ranges.

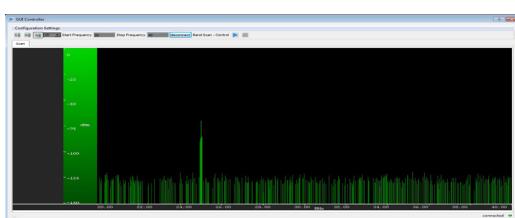


Figure 8. Response after SNR applied with detected signal within 20MHz-40MHz frequency band.

6. Conclusions and Future Scope

This application software can be extensively used to test the functional performance and features of a typical CI system

for EW applications. All the parameters can be tested extensively by modifying the simulator software of the COMINT subsystem. This software can be extended to test all the COMINT Subsystems like Monitoring analysis subsystem and jamming subsystems (ECM systems) of communication electronic warfare. This software can be modified to make libraries of EOB. EOB can be built based on the frequency, DOA, TOI etc parameters. These libraries can be used to evaluate and prioritize the COMINT threat scenario.

7. References

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