GSM Enabled Smart Fire Alarm Controlling System with SMS Alert

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ABSTRACT
This paper describes the development of an economical, convenient, and reliable GSM based automated fire alarm system for remotely alerting fire and smoke incidents to the property owner outside the building or industrial premises quickly by sending short message via GSM network. Along with study of existing fire detecting systems. The proposed system uses N-F-N Gateway which is an intelligent gateway interface for fire monitoring workstation. It also supports full panel programming using embedded c and network diagnostics.

General Terms
This paper is an embedded based, embedded means dumping of software into the hardware. Here, software code is written using Embedded-C. This work makes use of Q26 series GSM based development kit and is used to allow users to create and define applications using the Q2686 embedded module. GSM refers to second-generation wireless telecommunications standard for digital cellular services.

Keywords
Fire detector, Smoke detector, GSM, Mobile, NFN gateway

1. INTRODUCTION
A typical fire alarm control system shall be capable of detecting fire and transmitting it to central monitoring station. Fire points (detectors or sensors) communicate with fire alarm control unit. As part of compliance in case of any fire related event information need to be communicated to monitoring station for just in time response.

Current fire panels are making use of Digital alarm communicator transmitter (DACT) which is responsible for transmitting the information to the central station. Only some panels come along with the DACT, the remaining panels need to have external DACT unit for transmitting the information to the central station. There is obsolescence in using this DACT since it requires more hardware components and interfacing. So, to overcome the obsolescence of the DACT, the transmitting unit is designed to make the system cost effective and eliminate the obsolescence.

The current life safety systems do not have any wireless connectivity to communicate with external world. Detectors or sensors are reported only to Fire alarm control Panel (FACP). A person cannot know the situation inside a building in case of fire, by simply standing outside. Fire Fighter does not know the situation in the fire place till they reach spot. They cannot get the dynamic view of spreading up of fire outside the building. Building owner sitting somewhere in the world can't see the status for fire spreading in his building. Hence fire panel needs a system that transmits the fire events to the central station and the floor map image to the remote server.

A simple automatic fire alarm system for buildings based on wireless sensor networks is designed and implemented in this paper. We focus on the design of network architecture and communication protocol here. Figure 1 shows the structure of traditional fire alarm control system.

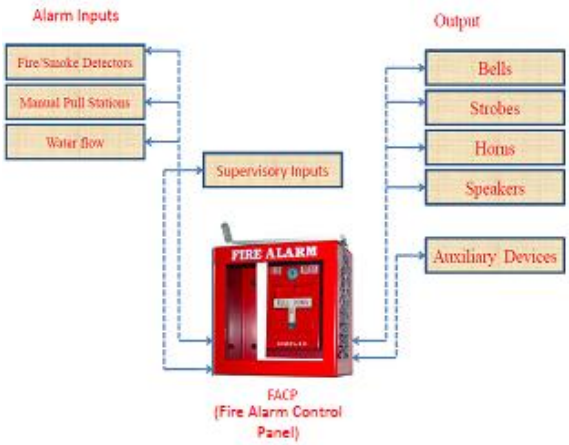

Figure 1: Traditional fire alarm control system

2. LITRETURE REVIEW
C. Luo et.al. [1], the writers deliberate a security robot which is developed using an aluminum frame. The main controller of the security robot is an industrial standard PC (IPC) with a Pentium-III 933 CPU and 256 MB RAM. The hardware devices consist of a touch screen, charge-coupled device (CCD) camera, sensors and sensory circuits, driver system, etc. The sensory system consists of seven subsystems. There are the fire-detection subsystem, intruder-detection subsystem, power-detection subsystem, environment-detection subsystem, motor-control subsystem.

L. Chengqiang.et. al. [2] in this paper a network environment integrating wire and wireless communication is built, and the fire control database with a five-layer (Data source layer, Data Persistence layer, Domain layer Controller/Mediator layer, Presentation layer) structure is established, which is critical to resolve the cooperative control problem in the quick-response fire control system.

H.C. Muller, the authors designed a system which presents an MSbFD [3] (Multi Sensor based Fire Detection) algorithm using two fire parameters (temperature and optical smoke density). These two sensors were chosen since ionization systems may become increasingly difficult to apply because of the environmental regulations being imposed on them. The evaluation and processing of the sensor signals is carried out by the use of Fuzzy Logic.

H. Hu Gang, the authors clarified that a Wireless Multi-Sensor Fire Detection and Alarm System can be performed

based on ARM [4]. The system uses nRF2401 for short-range wireless communications, GPRS for long-distance wireless communications, ARM9 for center console, Wireless Multi-sensor Fire Detector for node, and BP algorithm is used for judging the probability of fire. Wireless Multi-sensor Fire Detector is formed of the low-power electrochemical carbon monoxide sensor, photoelectric smoke detector and semiconductor temperature sensor.

Finally, S. & Y., the researchers [5] illustrate that that Mobile technologies, including the global system for mobile communication (GSM) and the ZigBee short-range wireless data connection technology could be used to monitor and detect fires.

3. PROPOSED SYSTEM

The developed system is having unit that transmits any on premise fire event to a dedicated phone number. As soon as fire detector detects any fire related event, after processing of event in fire panel dialer send out the information to the central station. This system is having less hardware components and the interfacing hence it reduces the cost as well and also we can make use of Reusability of the code that we have developed here. Developed system also provides the visual fire spreading indication to authorized person. Building owner sitting somewhere in the world can see the status for fire spreading in his building. The present work uses N-F-N Gateway, is an intelligent gateway interface for fire monitoring workstation.

4. SYSTEM REQUIREMENTS AND ARCHITECTURE

4.1 System requirements

System requirements involves studying the business processes, gathering operational data, understand the information flow, finding out bottlenecks and evolving solutions for overcoming the weakness of the system so as to achieve the organizational goals[6]. The proposed model requires following system requirements. System requirements of two types and they are Hardware requirements and software requirements.

4.1.1 Hardware requirements:

The main requirements for the PC to support the Developer Studio are:

- Pentium 300MHz (or higher) processor with at least 128 MB of RAM and 500 MB free hard disk space.
- A CD ROM drive (for software installation)
- At least one free COM (serial) port for the communication with the target product.
- Sierra Wireless Development kit along with required power supplies and adaptors
- SIM cards with the following features enabled according to your usage:
    - Basic GSM features such as SMS and voice call
    - PIN1, PIN2, PUK1 and PUK2 code
    - GPRS (if required)
- RS-232 Serial Cables.
- NUP to Serial Cable and Smart Phone.

4.1.2 Software requirements:

- Languages used: Embedded C, Android.
- Simulator used: NFN gateway.
- IDE used: Sierra Open AT development studio and android SDK.
- Operating System: Windows XP or Windows 7.

4.2 System architecture

A typical fire alarm control system shall be capable of detecting fire and transmitting it to central monitoring station. Fire points (detectors or sensors) communicate with fire alarm control unit. As part of compliance in case of any fire related event information need to be communicated to monitoring station for just in time response [7]. The existing life safety system needs transmitting system to transmit on premise event code to central station and wireless connectivity to transmit event information in the form message to the mobile phones. Figure 2 shows the proposed system block diagram which consists of FACP, GSM/GPRS modem, NFN Gateway and other components are shown diagrammatically in the below.

5. SYSTEM DESIGN

Software design is a process of problem solving and planning for a software solution. After the purpose and specifications of software are determined, software developers will design or employ designers to develop a plan for a solution. It includes low-level component and algorithm implementation issues as well as the architectural view. Various designing approaches for our system is given below in the figure 2.

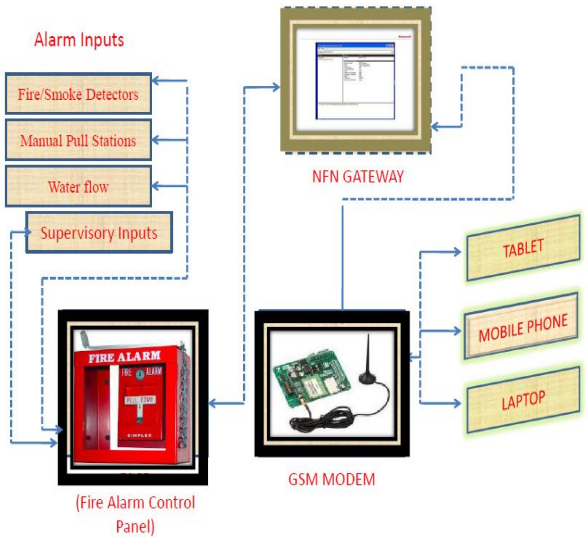

Figure 2: Proposed system architectural diagram.

5.1 Use case diagram

Use case diagram for GSM based mobile system. Figure 3 below depicts the Use Case diagram of GSM based mobile station.

Use case name: GSM based mobile system

Actor: Monitor and User.

Use cases:

- Set up and configure Fire detectors.
- Set up and configure Smoke detectors.
- Set up and configure Supervisory inputs.

- Monitor FACP.
- Monitor NFN gateways.
- Set up GSM embedded module with all the necessary connections.
- Download and install android .apk file on user mobile phone.
- Receive message through Mobile handset.

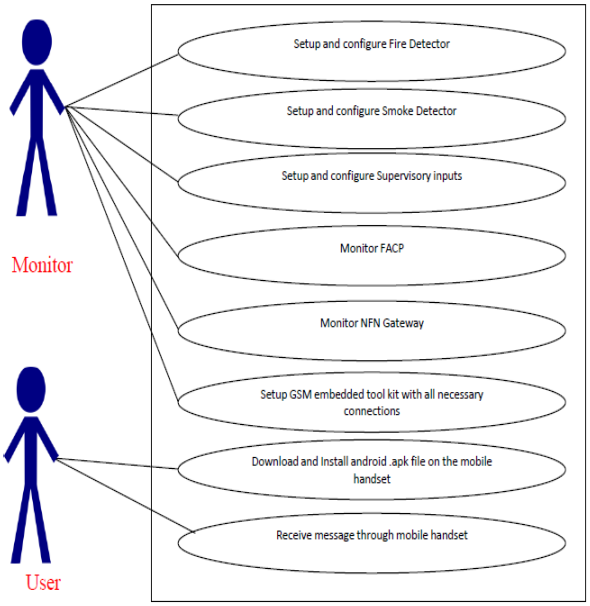

Figure 3: Use case diagram of GSM based mobile station

5.2 Algorithm

Step 1: Download and install the android SDK .apk file on your Mobile device.

Step 2: Set up Fire detector, smoke detectors and supervisory inputs. Connect the Fire detectors, smoke detectors and supervisory inputs to the FACP.

Step 3: Configure FACP, NFN (Noti-Fire-Net) Gateway with all the necessary connections.

Step 4: Set up GSM embedded module with power cable, antenna and RS-232 serial cable. Insert the Mobile cell phone SIM into the slot provided in the GSM board.

Step 5: Check whether the fire exists in the building, then signal FACP and go to step 7.

Step 6: Check if smoke exists in the building, then signal FACP and go to step 7.

Step 7: Check if supervisory action required in the building, then signal FACP and go to step7.

Step 8: FACP will receive the data from Fire detector, Smoke detector and supervisory inputs send it to NFN gateway.

Step 9: NFN gateway interprets the data from the FACP into the form which GSM can understand.

Step 10: GSM receives the data from NFN gateway, processes the data using AT commands.

Step 11: Processed data send to building owner mobile in the form of message, even though he is outside the building.

6. IMPLEMENTATION

This chapter gives the details of language, tools used, platform used and other implementation details of the project.

6.1 Languages used

The major reason for using C in this project is the ease and the control, the language gives control over the system and interface to input and output modules. C is best suitable for system level programming for example a medium-level programming language to handle memory, I/O and peripheral devices. Android is used for user interface part in smart phones or tablets.

6.2 Platform used

Windows 2000 or higher version. Windows XP is used for implementing the project. Open AT platform for Embedded C for simulation.

6.2.1 Tools used

- Sierra Wireless Open AT Software Suite Sierra Wireless Software Suite is an application development framework that allows designing an Open AT application [8]. Sierra Wireless Software Suite includes:
- An IDE (Integrated Development Environment) named Developer Studio, which has been developed on top of Eclipse-provided tools
- The set of embedded module software components packaged into the Open AT Embedded Software Suite (OASiS).

6.2.2 Q26 Series GSM Development Kit

The Q26 Series Development Kit box contains [7]:

- 1 Q26 Series Development Kit board
- Air Prime Q2687 Refreshed embedded modules
- Antenna
- 1 SMA Antenna for GSM and WCDMA
- 1 GPS Antenna
- Connectors
- 1 2-pin power supply connector
- 5 100-pin board to board connectors
- 5 100-pin board to board connectors
- 1 130-pin board to board connector for the test board
- Cables
- 1 Power cable
- 3 UFL-SMA RF cables
- 1 RS232 cable
- 1 USB cable
- 1 RJ9 cable (for handset)
- 1 AC/DC adapter
- 1 Handset
- 1 Pen drive containing the SDK + documentation.

The following figure 4 shows the top view of the Q26 Series Development Kit board. It enumerates the locations of the several ports and interfaces available.

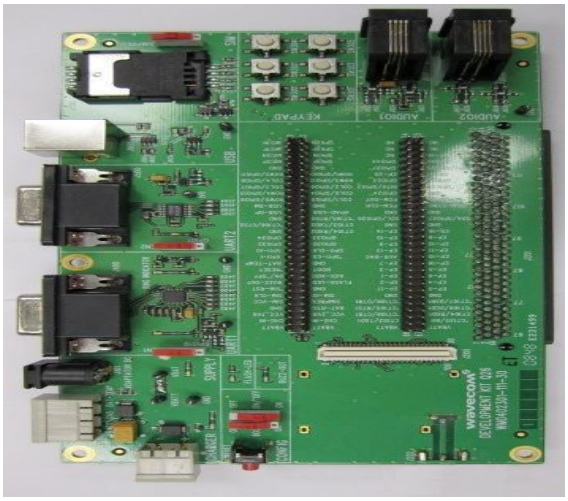

Figure 4: Sierra wireless GSM tool kit

6.3 Setting the Accessories

Follow the instructions shown below step by step: *a.Sim holder:* Insert a SIM or USIM card into the SIM card holder shown in the figure 5. **J700**, when using a Q2686 refreshed, embedded module. Following figure 5 shows the sim holder of Sierra Wireless GSM tool kit. *b.Switch*: The "ON/OFF" switch is in the "ON" position. The "BOOT" switch is in the "OFF" position shown in the figure 6 below. *c. GSM ports:* The UART1 switch is in the "EN1" position. The UART2 switch is in the "EN2" position displayed below in the figure 7. *d.Power supply* :J101 or via the external power supply, J100 at 4V/2.5A as shown in the following figure 8.

Figure 5: Sierra wireless GSM Sim holder

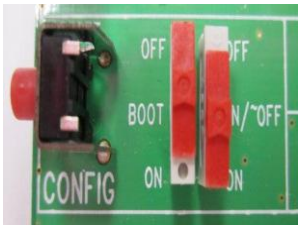

Figure 6: ON/OFF Switch

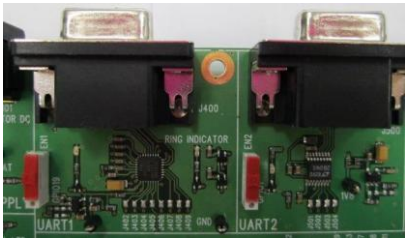

Figure 7: UART1 and UART2 ports

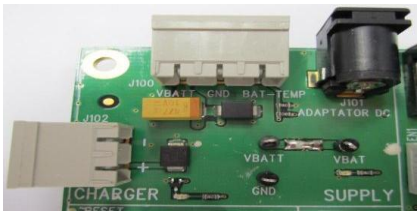

Figure 8: Sierra Wireless GSM Power supply unit

6.4 Communication Test

To perform a communications test after setting the Q26 Series Development Kit with a Q26 series embedded module, do the following:

1. Using a PC terminal emulator, send the following command on the COM port to communicate with the Q26 series embedded module: AT

2. When communications is established between the PC and the embedded module, the embedded module replies with an "OK". The message is displayed in the terminal emulator window.

7. RESULTS

Step1: Setup the NFN Gateway on Host system, Host system is the system which is connected to the GSM board through RS-232 serial cable. Open NFN Gateway configuration window and enter the Password as “000000” and click Login. The Gateway configuration window is as displayed in the figure 9 with node numbers N001 and N002 of FACP components as shown in figure 10.

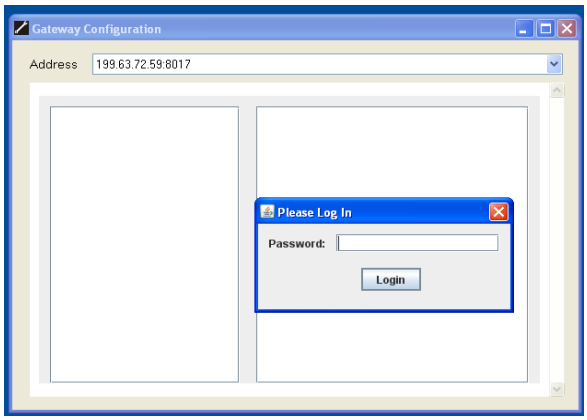

Figure 9 Snapshot of NFN Gateway

Step2: Run the Test Client solution by opening the VC++ IDE. Test client is used for simulation purpose and we can identify the events from FACP through NFN gateway.

Step 3: Set up the NFN simulator in the remote system, remote and host system should be connected through RS-232 serial cable. Extend the Node1 and extend Loop1 and right click on the events to select the ‘Activation Event’ as shown in the figure 10.

Step 4: Installation of Open AT Developer Studio. Run the Open_AT_Framework_v2-35-5_Full_Installer.exe file to install the Open AT Developer Studio. Set up the GSM tool kit as shown in the figure 11.

Step 5: Connections between the Host and the GSM board is as follows: a. Host-GSM is connected through USB cable. b. Host-UART2 of GSM is connected through RS-232 serial

cable. c. Insert the sim in the sim holder of the GSM board. d. Connect the Power supply to the GSM board.

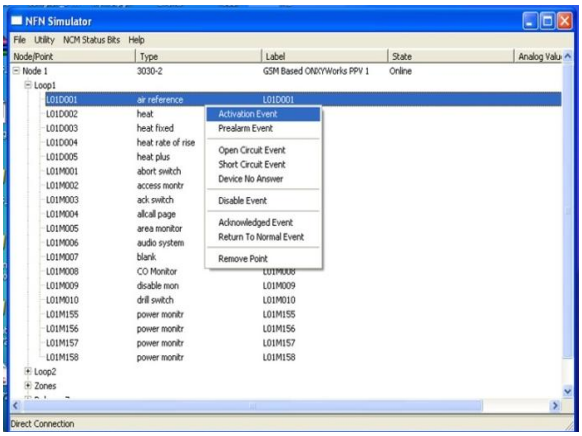

Figure 10: Snapshot of Gateway configuration window

Step 6: Open, Open AT Developer Studio (GSM IDE). Open the source code. Hard code the target mobile number in the source code. Select "Target Management" on the right top of the IDE, now select USB(COM) in the port list available under devices. Select the "Open port" option in the development mode.

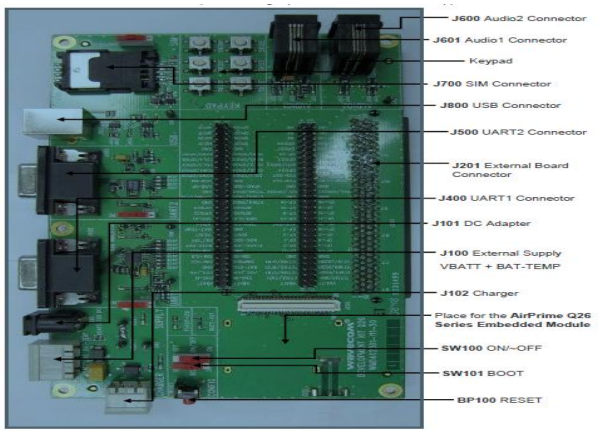

Figure 11: Snapshot of GSM Tool Kit

Following IDE displays the sent message acknowledgement and message count to user mobile phone as shown in the figure 12.

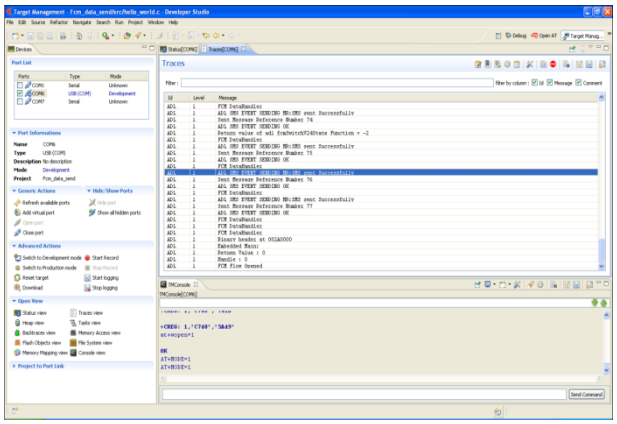

Figure 12 Snapshot of Final Message Sending Window

8. CONCLUSIONS AND FUTURE SCOPE

The designed fire alarm system is simple but it has wide area of application in household and industrial safety, especially in developing countries like India where internet is a major issue. Using this system, quick and reliable alert response is possible to initiate preventive measures to avert danger of fire

small scale industries where cost is the major issue for them to buy internet. This is a cost effective fire alarm system which performs reliably to ensure safety from fire, and can be installed in houses, industries, offices, ware-houses etc. very easily. Large industrial or residential area can be monitored through the proposed system installing multiple modules, each for one floor or unit. The system can be further developed with added features like web server interconnect, fire area tracking and fire extinguisher interfacing etc.

9. REFERENCES

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