AUTOMATION OF GUEST HOUSE BUILDING

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

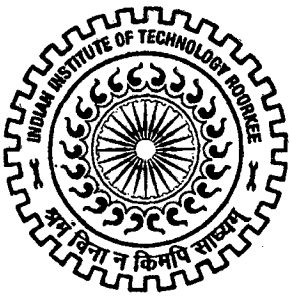
in

ELECTRICAL ENGINEERING

(With Specialization in Measurement and Instrumentation)

By

G.SANTOSH



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CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in the dissertation entitled **"AUTOMATION OF GUEST HOUSE BUILDING"** in partial fulfillment of the requirements for the award of the degree of Master of technology in Electrical engineering with specialization in Measurements and Instrumentation, submitted to the Department of Electrical engineering, Indian Institute of Technology Roorkee, India is an authentic record of my own work carried out during a period from July 2007 to June 2008 under the guidance and supervision of **Dr. H.K.VERMA**, Professor, Electrical Engineering department, Indian Institute of Technology, Roorkee.

The matter presented in this project has not been submitted by me for the award of any other degree of this Institute or any other Institute.

Dated: 30, June 2008
Place: Roorkee

G. Santosh
(G. SANTOSH)

CERTIFICATE

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

30/6/08
Dr.H.K.VERMA
Professor,
Department of Electrical Engineering,
Indian Institute of Technology Roorkee,
Roorkee-247667

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DEDICATED TO

MY TEACHERS AND MY PARENTS

ABSTRACT

The developments in the field of Industrial automation, various open and interoperable network protocols for sensor networking , data and computer communications, Mobile communications ,data processing software's , web based technology(internet) have given a birth to Building Automation System(BAS). *"Building automation systems (BAS) is programmed, computerized, and intelligent network of electronic devices that monitor and control various subsystems (Lighting, Security, HVAC(Heating, Ventilation And Air Conditioning) , data communications) in the building. The main goal of BAS is to provide security and comfort to occupants, and to reduce energy and maintenance costs when compared to a non-controlled building".*

Before start of actual design of a BAS, IP camera and stand-alone security control system were implemented in laboratory. Later BAS was designed for N.C.Nigam Guest House Building (GHB) of IIT Roorkee.

For design of BAS for GHB , first the architectural design of GHB was analyzed and then a hierarchal network was designed. For the latter a study of various wired and wireless sensor network technologies suitable for BAS was carried out. Based on comparative study of network protocols ,Modbus has been selected for data acquisition from various sensors(smoke, glass break, motion, pet immune, and door sensors) and controlling of various external electrical appliances(light, fan, AC etc.) through actuators. The other networks in BAS for GHB are Ethernet, WiFi, and Mobile telephone network. Ethernet is used to create a wired LAN (local area network) so that it connects server , client and any network device like IP camera, thus allowing a user(client) to monitor and control the BAS from the main program front panel, and to control IP camera, both remotely. WiFi serves similar purpose of remote monitoring and control like Ethernet , but it is used to implement a wireless LAN so that client or any WiFi compatible network device(like WiFi-capability IP camera) connects to server through an access point and allows flexibility for network devices to move from one place to other. Mobile telephone network is used to have

communications between any mobile phone and GSM modem connected to server. The main software's used are NAPOPC DA, an OPC(OLE(Object Linking and Embedding)for Process Control) Server for configuring modbus devices, Labview for data processing, and IP camera access software to configure, monitor and control the camera.

The main program developed with Labview allows monitoring of sensor status in any room or corridor on the server or on any client front panel. If any event occurs, it displays event message on front panel and on excel sheet (datalog), sends audible alarm in that area, also sends voice alarm through speaker , email and SMS to the master. The program enables control any appliance in any room, corridor or lawn either by sending command through local server or from any client or mobile phone through SMS.

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CHAPTER 1

INTRODUCTION

1.1 BASIC CONCEPT OF BUILDING AUTOMATION SYSTEM:

Due to developments in the field of Industrial automation, sensor networking ,Information Technology, data and computer communication,web based technology(internet) has given a birth to Building Automation System(BAS). *"Building automation systems (BAS) is programmed, computerized, and intelligent network of electronic devices that monitor and control various subsystems in the building. The main goal of BAS is to provide security and comfort to occupants, and to reduce energy and maintenance costs when compared to a non-controlled building".*

1.1.1) SUBSYSTEMS IN BAS :

i. HVAC(Heating, Ventilation And Air Conditioning) system: Environment control
ii. Lighting system: Lighting control based on occupancy or intensity or time based.
iii. Security: motion detection alarm, fire alarm, video monitor(IP camera), glass alarm
iv. Transportation system: Elevator and Escalator control system
v. Audio system: Audio distribution system
vi. Communication system: Sensor network , computer network(internet), and mobile network .

1.1.2) MODULAR ARCHITECTURE OF BAS

The two level functional hierarchal for building automation system is shown in fig 1.1, Which classifying devices into three classes called SAC's, ICD's and CMD's.

i. **Sensor, Actuators and Controllers(SAC)** are located at the control level. Representatives of this device class interact directly with the physical environment and are responsible for data acquisition and for controlling the behavior of the environment. Additionally, they include controller functionality.

ii. **Interconnection Devices (ICD)** link different networks and network segments together. This device class enable BAS devices to interact either using the same network protocol (e.g.,Building automation network (BAN) to BAN) or via different protocols (e.g., BAN to IP(Internet Protocol)). ICDs operate at different layers of the OSI Model. To extend the maximum physical network cable length, repeaters and bridges can be used acting at the physical and data link layer, respectively. While a router operates on protocols at the network layer, a gateway ensures transparency to applications that run on top of the protocol stack. A special form of interconnection is called tunneling [1].

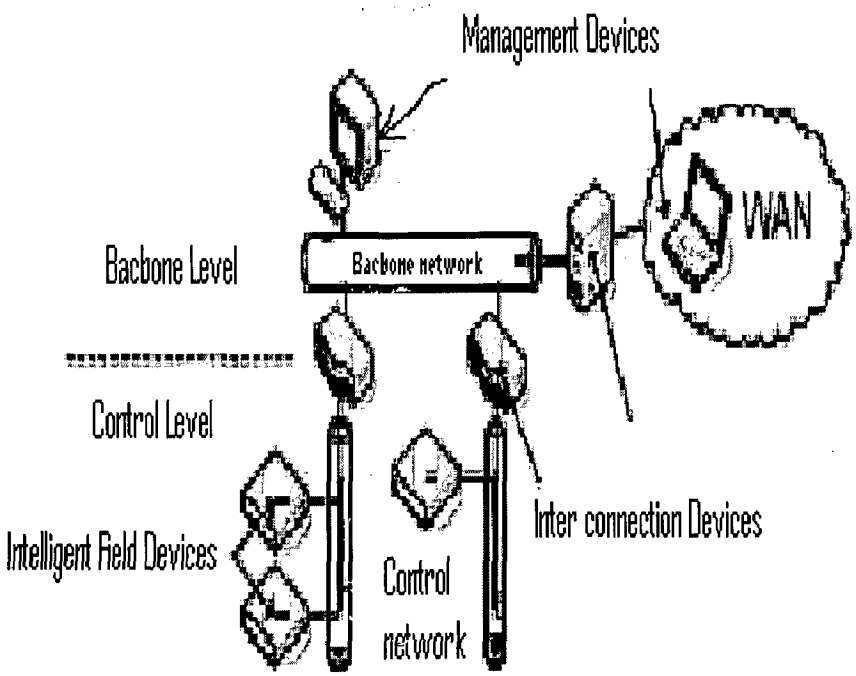


Fig 1.1 Building automation system, two level functional hierarchy[1]

Using a tunneling protocol, whole packets of one protocol are wrapped into packets of another protocol. These encapsulated packets are transmitted through logical tunnel to another ICD where the packets are unwrapped.

iii) **Configuration and Management Devices (CMD)** are used to configure and maintain a BAS. CMDs implement tasks like monitoring ,controlling, logging and

archiving of process data values. CMD class will be located at the backbone level. The other important task of CMD is to provide good and easily understandable Graphical User Interface (GUI) for a user to monitor sensor status,control various low level devices (eg., light,fan e.t.c),providing alarm indications and also some extra features needed for a user.

1.2 PROBLEM STATEMENT

The main task of dissertation is to design a Building Automation system(BAS) for N.C. NIGAM GUEST HOUSE BUILDING (GHB) located inside the IIT Roorkee campus. To design this system the main task is divided into following subtasks.

- To study about various Building automation network protocols(wired and wire less) and selecting one of it for implementation. This means selecting any network based compliant modules (selecting Hardware i.e. ICD's of BAS) for connecting to sensors and actuators(SAC's of BAS).
- To select additional hardware required apart from above(i.e., sensors, actuators, GSM Modem, IP Camera).
- To choose the software required (CMD's for BAS) for configuring, programming and provide data communications between master and modules and hardware selected.
- To analyze the GHB architecture and to decide the distribution of hardware modules .
- To design a hierarchal Network design for GHB.
- Writing Software code with selected data processing software according to design requirements.
- At last and foremost important thing is to design good and easily understandable Graphical User Interface(GUI)for user .

1.3 ORGANIZATION OF REPORT:

i. Chapter 1:This chapter includes introduction to basic Building automation system, and defining problem statement.

ii. Chapter 2: This chapter describes about OSI model, various wired and wireless network protocols for BAS, selection of protocols, Design approaches for GHB.

iii. Chapter 3: This chapter includes the details of various software's used in server PC, and hardware used for development of BAS.

iv. Chapter 4 : This chapter includes the details of IP camera, and Security control panel.

v. Chapter 5: This chapter describes about architecture of GHB design, Network hierarchy in GHB, labview programs and algorithms, Remote monitor and control ,and lab set up for main program.

vi. Chapter 6 : This chapter includes various results consists of front panels of labview programs written in chapter 5

vii. Chapter 7:This chapter concludes the work done and scope for future work.

CHAPTER 2

DESIGN STUDY

2.1 WIRE NETWORK PROTOCOLS FOR BUILDING AUTOMATION

2.1.1 OSI REFERENCE MODEL[2]: OSI(Open System Interconnection) reference Model developed by ISO(International Standards Organisation) has seven layers as shown in table 2.1. Protocols define OSI layers for describing various features of that protocol.

Table 2.1: OSI Reference model

LAYER NUMBER	LAYER NAME
7	**Application**
6	**Presentation**
5	**Session**
4	**Transport**
3	**Network**
2	**Data Link**
1	**Physical**

Layer 1-Physical: Electrical Connection :layer specifies electrical ,mechanical ,data characteristics of transmission channel(twisted pair, power line, fiber optic, and RF.)

Layer 2-Data Link: This layer defines the rules of access to the physical layer. A media access sub layer provides CSMA, collision avoidance, and collision detection access schemes. Link layer provides framing data encoding, and CRC(cyclic redundancy Check) error checking.

Layer 3-Network (Destination addressing):This layer specifies the destination of a message on the network. This layer ensures the correct delivery of messages or packets from one source to one or more destination devices.

Layer 4-Transport (end to end reliability):

Transport layer ensures complete data transfer and includes services such as acknowledge and unacknowledged, unicast and multicast messages, an authentication server, duplicate detection,and repeated service.

Layer 5-Session (Remote Actions):

Session layer sets up, coordinates, and terminates conversations, exchanges, and dialogs between applications. This layer also handles session and connection coordination.

Layer 6-Presentation (Data Interpretation)

This layer provides translation of the network data for the application. Examples of services provided in this layer include:

- Input, output, and configuration variables for the node
- Standard data representations for physical quantities
- Network variable description

The standard data representations are important to assure interoperability between products from different manufacturers.

Layer 7-Appliaction (Sensor/Actuator application compatabilty) :

This layer includes services to simplify development of application programs to interface to specific sensors, actuators, and external microprocessors.

2.1.2 BACNET[3,4]

BACnet is a Open Data Communications Protocol for "Building Automation and Control Network".It is an ISO (International Organization for Standardization)standard in 2003, maintained by the ASHRAE Standard, American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) .

- The BACnet protocol defines a Bacnet object,Bacnet device and services that act on objects. The objects include Analog Input, Analog Output, Binary Input, Binary Output.Collection of objects defines a Bacnet device.
- Defines OSI layers 1,2,3 and 7.
- Physical media: ARCNET,Point to point,Master Slave/Token Passing,LONTalk,Ethernet.
- Data rates: Twisted Pair- 76kbps,ARCnet-156kbps,Ethernet-10Mbs.

2.1.3 LONWORK[5]

- Lonworks(local operating network) system is an open protocol has been originally designed by Echelon Corporation in 1988. Lonworks system is distributed control system that enable peer to peer and master/slave communication among the intelligent devices.
- The major elements of Lonworks are Lontalk Protocol, Neuron chip and Lonwork Transceiver. All Lonworks devices communicate with one another using the LonTalk protocol. Lonworks nodes usually contain a Neuron Chip to process all LonTalk protocol messages, sense inputs and manipulate outputs, implement application-specific functions and store installation-specific parameters. Each Neuron chip has three resident 8-bit processors: two processors dedicated to Lontalk protocol processing, and a third dedicated to the node's application program. Transceivers allows you to build networks to large distance.
- Lontalk protocol defines seven layers of OSI model.
- Physical Media: Twisted pair(TP),Power line(PL),Radio Frequency(RF),Coaxial, Fiber Optics.
- Data rate: 78kbps(TP),5.4 or 2.6kbps (PL)

2.1.4 X10 [6,7]

- X10 is a communication language that allows compatible products to talk to each other using the existing electrical wiring in the home. The main advantage of this protocol is rewiring is necessary. It is developed by Pico electronics in 1975.
- Installation is simple, a transmitter plugs (or wires) in at one location in the home and sends its control signal (on, off, dim, bright, etc.) to a receiver which plugs (or wires) into another location in the home. Up to 256 different addresses are available and each device you use usually requires a unique address.
- X-10 signal is a low voltage signal that is passed through the electrical wires of our homes.X-10 signals are transmitted at the zero degree crossing of the sine wave. This is where the least electrical noise is present. A binary 1 is represented by a 1 millisecond burst of 120 kHz, at the zero crossing point and a binary 0 by the absence of 120 kHz.
- Signal Transmission: All transmissions commands consists of Start code(1110)-letter code –number code –start code –letter code- number code, then three cycles of silent sine waves and then "start code" – "letter code" – "command code" – "start code"- "letter code" – "command code". A full X-10 transmission consists of 47 cycles and takes approximately .8 seconds.
- Physical media: Power line.
- Data rate: 50bps

2.1.5 KNX[8]

- KNX(konnex) is an open, a Wordwide standard (ISO/IEC 14543). KNX is convergence of three previous standards called the European Home Systems Protocol (EHS), Batibus, and the European Installation Bus (EIB).EIB is available since 1980 and KNX is from 1999.Maintained by Konnex Associasion.
- Provides three different configuration modes :

  a)S-mode (System mode): This configuration mechanism is intended for well trained KNX installers to realize sophisticated building control functions. An installation consisting of "S-mode" components can be planned by a common software tool (ETS-Engineering Tool Software).

b) E-mode (Easy mode) : This configuration mechanism is meant for installers with basic KNX training. E-mode compatible products offer limited functions compared to S-Mode. E-Mode components are already pre-programmed and loaded with a default set of parameters.

c))A-mode (Automatic mode): The Automatic configuration mode (A-Mode) is intended for the configuration of domestic appliances, such as washing-machine or fridge, plugged in and automatically configured even by the non KNX qualified end customer or home/building owner.

- Defines OSI layers 1,2,3,4,7 .
- Physical Media: Twisted Pair, Power Line, RF(Radio frequency) ,IF(Infrared), Ethernet.
- Data rates: $\mathbf{TP_0}$(Twisted pair, type 0)- 4.8kbits/s , $\mathbf{TP_1}$(Twisted pair, type 1) - 9.6 kbits/s, $\mathbf{PL_{110}}$, (Power-line, 110 kHz) =1200 bits/sec; $\mathbf{PL_{132}}$ = 2400 bits/sec, RF:16.4kbps(FSK)@868.3Mhz.

2.1.6 C-BUS[9,10]

- **C-Bus** is a home and building automation protocol that is used primarily in Australia, was created by Clipsal's *Clipsal Integrated Systems during 1990's.*
- Each C-Bus device has its own in-built microprocessor and "intelligence", allowing units to be individually programmed. Each device is allocated a specific time frame to broadcast its status, synchronised by a self-generated system clock pulse. This allows large amounts of data to be transmitted in a very small time frame, effectively and reliably on the network, leading to low processing overheads and low bandwidth requirements.
- The maximum length of cable used on a C-Bus network is 1000 metres, however this is easily extended using C-Bus Network Bridges. Up to 100 units can be installed on a C-Bus network and this can also be extended using Network Bridges.
- Each C-Bus network requires at least one system clock generating unit for data synchronization.

- Physical media: Standard category 5 UTP (Unshielded Twisted Pair) cable .
- Data rate:500 bps.

2.1.7 MODBUS

- Modbus is a open,serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers. . Implementation of Modbus over using TCP/IP ,modbus over serial line (wire : EIA/TIA-232-E, EIA-422, EIA/TIA-485-A; fiber, radio, etc.), Modbus over a high speed token passing network called modbus plus is possible.In modbus over serial line there are two transmission modes are possible, which are Modbus RTU, and Modbus ASCII.[11]
- Modbus Serial Line protocol is a Master-Slave protocol. Only one master (at the same time) is connected to the bus, and one or several (247 maximum number) slaves nodes are also connected to the same serial bus. Modbus communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node.
- The master node issues a modbus request to the slave nodes in two modes :
  i. **Unicast mode**: the master addresses an individual slave. After receiving and processing the request, the slave returns a message (a 'reply') to the master .
  ii. **Broadcast mode:** the master can send a request to all slaves.No response is returned to broadcast requests sent by the master. The broadcast requests are necessarily writing commands. All devices must accept the broadcast for writing function. The address 0 is reserved to identify a broadcast exchange.
- Fig 2.1 shows modbus defined layers 1,2,7 of OSI Model.Fig.2.2.shows modbus frame.

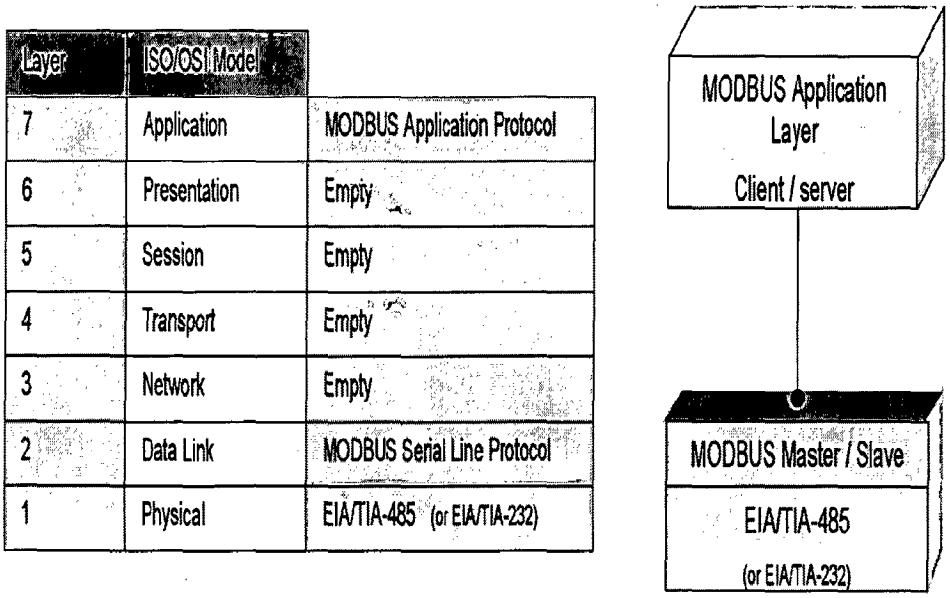
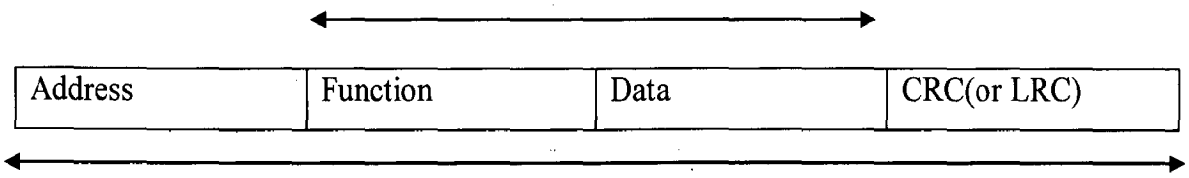


Fig 2.1 Modbus defined osi layers [11]

0	From 1 to 247	From 248 to 255
Broadcast address	Slave individual addresses	Reserved

Modbus Addressing Space

Modbus PDU(Protocol Data Unit)



Modbus Serial Line PDU

Fig 2.2 Modbus frame description

Address: Slave Address(1 to 247)

Funtion Code: Indicates to the server what kind of action to perform

Data: contains request and response parameters.

CRC/LRC: Error checking code based on Transmission mode(RTU or ASCII).

- **SERIAL TRANSMISSION MODES[12]**

A)RTU MODE

When devices communicate on a MODBUS serial line using the RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate. Each message must be transmitted in a continuous stream of characters.The format for each byte in RTU mode is:

Coding System : 8–bit binary, hexadecimal 0–9, A–F
Two hexadecimal characters contained in each 8–bit field of message

Bits per Byte : 1 start bit
8 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if parity is used; 2 bits if no parity

Error Check Field: Cyclical Redundancy Check (CRC)

Each character or byte is sent in this order (left to right):

Least Significant Bit (LSB) . . . Most Significant Bit (MSB)

Start	1	2	3	4	5	6	7	8	Par	Stop

Bit sequence in RTU mode(With Parity Checking)

Start	1	2	3	4	5	6	7	8	Stop	Stop

Bit sequence in RTU mode (Without Parity Checking)

RTU Message Frame:

Slave Address	Function Code	Data	CRC
1 byte	1 byte	0 up to 252 byte(s)	2 bytes CRC Low, CRC Hi

Fig 2.3 : RTU Message Frame

B)ASCII MODE

When controllers are setup to communicate on a Modbus network using ASCII(American Standard Code for Information Interchange) mode, each 8–bit byte in a message is sent as two ASCII characters. The main advantage of this mode is that it allows time intervals of up to one second to occur between characters without causing an error.The format for each byte in ASCII mode as shown in fig : Fig 2.4 a)(or)b).

Coding System: Hexadecimal, ASCII characters 0–9, A–F
One hexadecimal character contained in each
ASCII character of the message

Bits per Byte: 1 start bit
7 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if parity is used; 2 bits if no parity

Error Check Field: Longitudinal Redundancy Check (LRC)

Each character or byte is sent in this order (left to right):

Least Significant Bit (LSB) . . . Most Significant Bit (MSB)

Start	1	2	3	4	5	6	7	Par	Stop

Fig 2.4 a)Bit sequence in ASCII mode (With Parity Checking)

Start	1	2	3	4	5	6	7	Stop	Stop

Fig 2.4 b)Bit sequence in ASCII mode(Without Parity Checking)

ASCII Message Frame:

Start	Address	Function	Data	LRC	End
1 char :	2 chars	2 chars	0 up to 2x252 char(s)	2 chars	2 chars CR,LF

Fig 2.4 : ASCII Message Frame

- Physical media : RS-232,RS-485, Ethernet, Fiber.
- Data rates :9.6kbps, 19.2kbps

2.1.8 DIGITAL SIGNAL INTERFACE(DSI):[13]

This protocol is used Dimming stage Lighting.It was developed by an Australian company "Tridonic ATCO" in 1991. It is based on Manchester coding 8-bit protocol, data rate of 1200 baud, 1 start bit, 8 data bits (dimming value), and 4 stop bits.It is Proprietary standard.

2.1.9 DIGITAL ADDRESSABLE LIGHTING INTERFACE(DALI):[14]

The technical standard for this protocol is IEC 60929.It is open,Digital protocol and dedicated to only Lighting System.It has two bus wire, bidirectional data exchange, low data rate, maximum of 64 Devices and high signal SNR.This protocol is based on DSI.

2.1.10 DYNET:[15]

This protocol was developed by Australian company "Dynalite Control System". It is used for Lighting control ,Energy conservation.It uses RS-485 serial bus for transmitting 9600 baud, and peer to peer model. Each device is PLC.It is proprietary Protocol but it has interfaces for RS-232,Ethernet,Lonwork,DALI.

2.1.11 oBIX(OPEN BUILDING INFORMATION EXCHANGE):[16]

This Protocol is developed by Organization for the Advancement of Structured Information Standards (OASIS). This standard is XML- and Web service protocol to enable communications between building mechanical and electrical systems, and enterprise applications. oBIX will instrument the control systems for the enterprise.oBIX works with Bacnet and Lonworks group to enable their system to TCP/IP Layer.

2.1.12 INSTEON:[17]

This protocol is developed by Smart Labs. It is compatible with X10. Devices are networked with power line or RF or both. Insteon uses advanced digital signal processing to encode and transmit messages, enabling rapid transmission of control data between devices. It sends data at rate 2400 bps. X10 commands start transmitting from the zero crossing point but

Insteon commands start before the zero crossing point. It works on peep to peer mesh network. It automatically retransmits the corrupted messages providing high reliability.

2.1.13. CEBUS(CONSUMER Electronic bus):[18]

It is Developed by EIA and Consumer Electronics Manufacturers Association. It also known as EIA-600, is a set of electrical standards and communication protocols for electronic devices(in home) to transmit commands and data. It is an Open architecture and devices communicate through 110V AC power line (PLC), twisted pair (TP) cable, coax cable, RF and Infrared.

2.1.14. UPNP(UNIVERSAL PLUG AND PLAY):[19]

The UPnP architecture offers pervasive peer-to-peer network connectivity of PCs, intelligent appliances, and wireless devices. The UPnP architecture is a distributed, open networking architecture that uses TCP/IP and HTTP to control and data transfer among networked devices in the home or office.It has Media, Operating system and programming language independence.

2.2 WIRELESS NETWORK PROTOCOLS FOR BUILDING AUTOMATION

2.2.1 ZIGBEE:[20]

- Zigbee is developed by Zigbee alliance. Zigbee is wireless network. It is used for networking of field devices. Zigbee targets on low power consumption,low data rate, security.
- Dual PHY (2.4GHz and 868/915 MHz)
- Data rates of 250 kbps (@2.4 GHz), 40 kbps (@ 915 MHz), and 20 kbps (@868 MHz)
- Optimized for low duty-cycle applications (<0.1%)
- CSMA-CA channel access Yields high throughput and low latency for low duty cycle devices like sensors and controls.
- Topologies: star, peer-to-peer, mesh

- Addressing space of up to :
  - 18,450,000,000,000,000,000 devices (64 bit IEEE address)
  - 65,535 networks
- Fully hand-shaked protocol for transfer reliability
- Range: 50m typical (5-500m based on environment)
- Messages: Periodic data, Intermittent data, Repetitive low latency data

2.2.2 Z-WAVE:[21]

- Z-wave is developed by Z-wave Alliance. Z-Wave the new standard in wireless network that lets all your home electronics talk to each other, and to you, via remote control. It uses simple, reliable, low-power radio waves that easily travel through walls, floors and cabinets.

- Data rate:9.6Kbps,40kbps.
- Interoperable.
- Modulation: GFSK(Gaussian Frequency-Shift Keying).
- Topology: Mesh.
- Frequency Band:900 MHz ISM .
- Range: Approximately 30meters .

2.2.3 BLUETOOTH: [22]

- Bluetooth is a radio standard and wireless communications protocol primarily designed for low cost, low power, a short range (1m,10m,100m)distance and allows devices in proximity to communicate with each other.
- Simultaneously handle both data and voice transmissions.
- FHSS,2.4Ghz ISM band .
- Data rate of 1Mbps to 3Mbps.

2.2.4 WIFI(IEEE 802.11)[25]

- The IEEE 802.11 specification (ISO/IEC 8802-11) is an international standard describing the characteristics of a wireless local area network (WLAN). WIFI is developed by WIFI alliance.
- 802.11 standard reserves the low levels of the OSI model for a wireless connection.

  a)Data Link Layer: Logical link control(IEEE 802.2),Media Access Control(IEEE 802.11)

  b)Physical Layer: DHSS(Direct sequence spread spectrum) and FHSS(Frequency hopping spread spectrum)[OFDM: Orthogonal frequency division multiplexing in table 2.2.
- IEEE 802.11 standard defines IEEE 802.11a,802.11b,802.11g standards.
- Following Table 2.2 shows various properties of IEEE 802.11 Standard:

Table 2.2 IEEE 802.11 Standard[25]:

WLAN:IEEE 802.11 Standard							
802.11 Protocol	**Release year**	**Operating Freq. (GHz)**	**Throughput (Mbit/s)**	**Data Rate (Mbit/s)**	**Modulation**	**Radius $_{in.}$ (m)**	**Radius$_{out.}$ (m)**
Legacy	1997	2.4	0.9	002	-	~20	~100
802.11a	1999	5	23	054	OFDM	~35	~120
802.11b	1999	2.4	04.3	011	DSSS	~38	~140
802.11g	2003	2.4	19	054	OFDM	~38	~140
802.11n	2009	2.4, 5	74	248	-	~70	~250

2.3 SELECTION OF NETWORK PROTOCOLS

2.3.1 **MODBUS:** The Modbus is selected to acquire data from sensors and control external electrical appliances. This protocol is selected because of various advantages as shown.

- It is Open Protocol and having interoperability function.
- It is simple and effective. It requires very little hardware to run it – thus allowing for smaller, less expensive electronic components.
- It is fairly simple to learn and program into new and existing hardware – thus significantly reducing development and programming time for end users. This feature allows a Modbus system to be implemented and running within days.
- Modbus typically utilizes RS-232 and RS-485 to physically connect to PLC's, I/O, and other hardware – connection ports that remain the standard on today's industrial equipment.
- In single network over 256 modules can be attached without repeater.

2.3.2 **ETHERNET:** The Ethernet is selected for following reasons.

- In order a develop a Wired Local area network(LAN)/Intranet to connect server ,client, and any other LAN devices like IP Camera and provide communications among them. The LAN installation allows data to be transferred over high speed network.
- Installation of Ethernet is easier and less expensive than other network protocols.
- Widely available.

2.3.3 **WIFI:** WIFI is selected for following reasons.

- In order a develop a Wireless Local area network(LAN)/Intranet to connect server ,client, and any other LAN devices like IP Camera with WIFI compatabilty and provide communications among them.
- Because of the comfortable and quick installation replace of old wired LANs with Wi-Fi is become popular.
- No installation wires is requires which acts to less cost of installation and also provides flexibility in moving the network devices with in accusable range.

2.4 DESIGN APPROACH:

2.4.1 DESCRIPTION: The figure 2.5 shows the basic BAS design for GHB that is implemented in Laboratory. It consists of four networks. a)Modbus RS-485 network: At one end modbus Digital input(DI) module(eg.,i-7053D) and Digital output(DO) module(eg.,i-7044D) module connected to sensors and relays respectively, at another connected to server through RS-232 to RS-485 converter. b)Ethernet: It acts as Wired LAN and connects Server, Client and IP -Camera and provide communications among them.So that any client in network can monitor the front panel. c)WiFi: In order a develop a Wireless Local area network to connect server ,client, and IP Camera with WIFI compatibility and provide communications among them. d)Mobile Network: It is used to provide communications between mobile and GSM modem attached to server.

There are main four software's used by server. a)NAPOPC DA server, b)LABVIEW c)IP camera access software d)GSM drivers.

The Fig 2.6 shows advance BAS proposed BAS design for GHB ,which consists of main six extra blocks than basic design shown in fig 2.5.

a) Analog Input (AI) module(eg.,i-7019R) connected to analog sensors at one end and other end to Modbus RS-485 network.

b) Anolog output(AO)(eg.,i-7021) module connected to dimmers at one end and other end to Modbus RS-485 network.

c) IP based door Access control module connected to Ethernet(eg.,AX200 Plug & Play Ethernet TCP/IP Access Control).

d) RS-485 to Ethernet Gateway(eg: ADAM-4570,2-port Serial to Ethernet Data Gateway [27]) which connects Modbus RS-485 network and Ethernet network.

e) RS-485 to wifi gateway(eg.,ADAM-4570W 2-port RS-232/422/485 to 802.11b WLAN Serial Device Server [27])which connects Modbus RS-485 network and WiFi network.

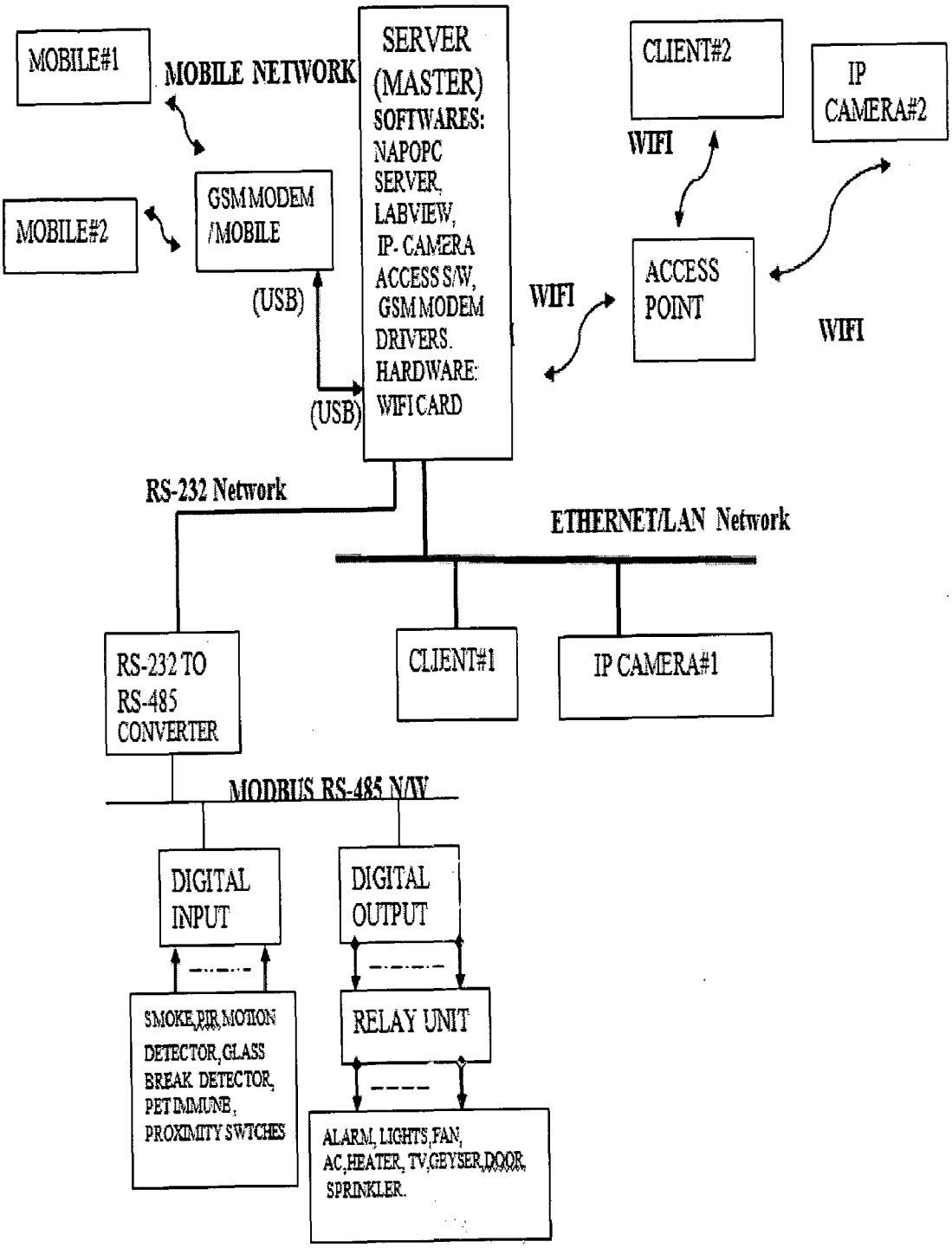


Fig 2.5: Basic BAS design for GHB

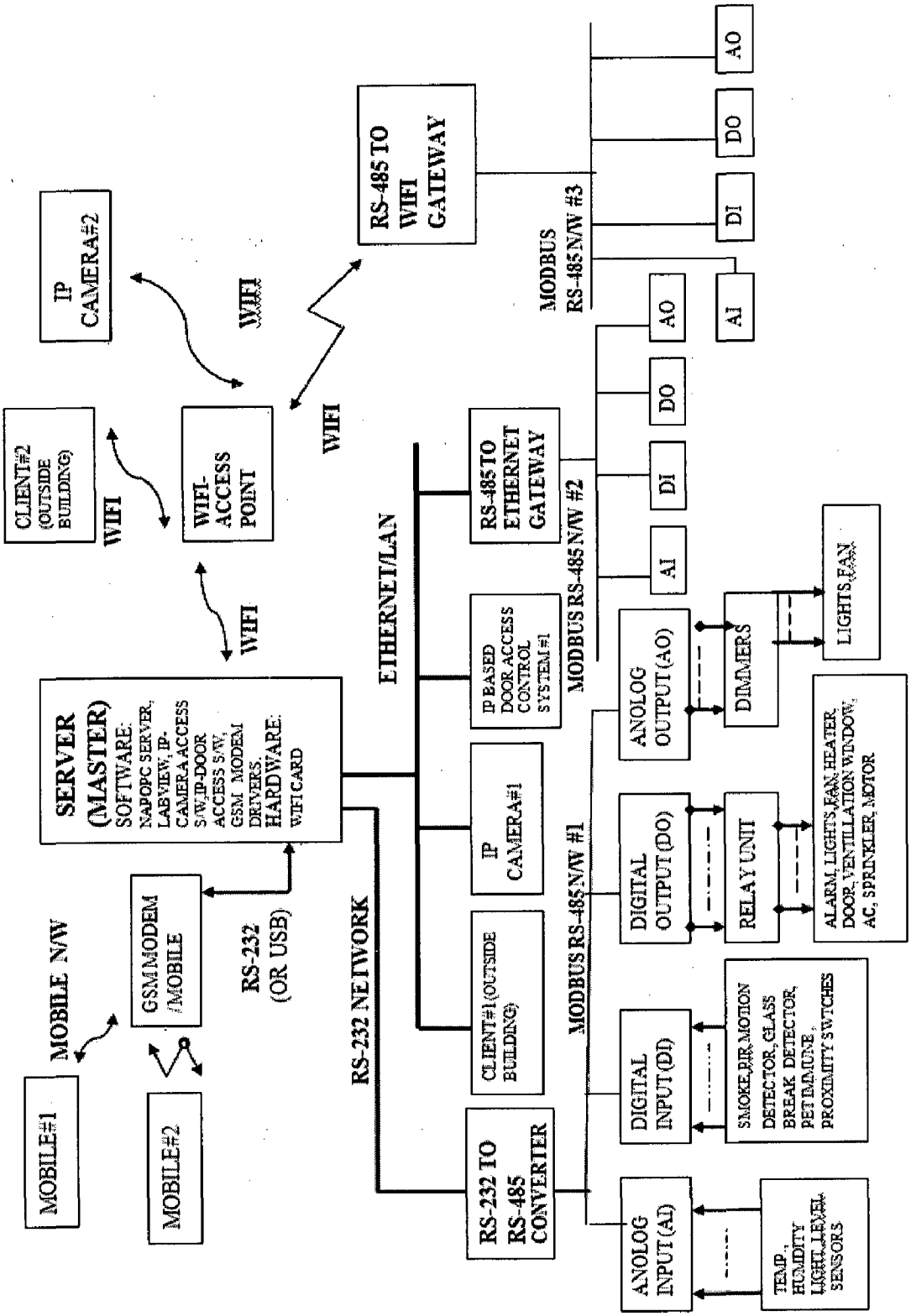


Fig 2.6: Advanced BAS design for GHB

CHAPTER 3

HARDWARE AND SOFTWARE

3.1 HARDWARE

3.1.1 SENSORS AND RELAYS

i. **Smoke Sensor:**

Model : 2351E, Photoelectric Smoke Detector.

Description : An Photoelectric Smoke detector includes a light source (infrared LED), a lens to collimate the light into a beam, and a photodiode or other photoelectric sensor at right angles to the beam as a light detector. In the absence of smoke, the light passes in front of the detector in a straight line. When smoke enters the optical chamber across the path of the light beam, some light is scattered by the smoke particles, and some of the scattered light is detected by the sensor. An increased input of light into the sensor sets off the alarm. LED Indication is there for alarm.

ii. **Glass Break detector:**

a) **Model :** GBS-210, "VIVO" glass break detector.

Description : The GBS-210 glass break detector detects the breaking of glass windows. A dual technology detection method that includes air pressure and sound analysis is used. Used processing guarantees high sensitivity to the breaking of all types of glass. The sensitivity can be adjusted to compensate for various window sizes and mounting distances. LED Indication is there for alarm [28].

b) **Model:** PS 922, Vibration Sensor.

Description : This sensor uses Piezo electric detection method .It has adjustable Dual Sensitivity Range, high False Alarm Immunity and selectable LED Indication[28].

iii. **PIR Pet Immune sensor:**

a) **Model:** IR-530P, IR Tech PIR Motion sensor.

Description: Passive motion sensors do not emit energy, but can identify possible burglars by reading relative changes in the energy in the surrounding medium. Passive motion sensing detectors work by measuring the incoming infrared energy. They are widely known as PIR (passive infrared) sensors, or pyroelectric detectors. The signal processing circuits like amplifier and comparator is used to put ON the relays. Heat can be transmitted by contact, convection or radiation. Infrared light is responsible for transmitting heat through radiation, and because the human body is a heat source it also emits infrared radiation. The outside skin temperature of a human body is usually about 34 degrees Celsius, meaning it is radiating energy in the infrared spectrum between 9 to 10 micrometers.The PIR sensors have in fact a much wider range, between 8 to 12 micrometers. The detector itself is a photo detector able to convert light in these specific wavelengths into a small electrical current that is then amplified and processed through a filter , comparator circuits. The alarm will only trigger when the motion detector observes rapid variations in infrared energy distribution, such as those associated with the normal movement of human.Any smaller variations in energy reading are being filtered out, so that the sensor is not being triggered accidentally by natural events such as the slow heat variations in the supervised area. Infrared light emitted by the objects is focused with the help of a plastic lens, since glass is opaque to infrared light.Sensor uses Target Size Verification (TSV) technology, Up to 18 kgs pet immunity detection, Noise reduction circuit, Sealed optics protection, Ultra wide wiring space, and NC/NO selectable alarm output[28].

iv) **Door Sensor:**

Models:PS-901M,PS-902M,PS-904M,PS-905M,PS-906M.[28]

Description: Magnetic Proximity switches can be used as Door sensors.when ever door is closed/open switch will be closed/open provided the swith is connected to door on a proper manner[28].

v i) Relay: Model ID:O/E/N 58-12-1C.

Description : A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Relay is used to control appliance either ON/OFF.

3.1.2 SECURITY CONTROL SYSTEM:

i)Model: NX-8V2 Control Panel.

ii)Features:

- This is a standalone security control system made by GE security systems.
- It has 16 zones and zones can be expandable to 48 zones with zone expandable module.
- NX 1192E LCD keypad is used to program each zone for specific function.
- Has 206 Memory Locations for feature selection.
- It allows 8 partitions. A Partition can be cover any group of zones.A zone can be covered by one or more partitions.
- It allows maximum of 3 number of phone numbers
- Most flexible, durable, and user-friendly control.
- Featuring sophisticated software, which allows up to 99 users to interface with 48 zones, 8 partitions, and a host of integrated fire, access, verification, and input/output modules, all reported with the most comprehensive and fast SIA and Contact ID.
- Up to 32 modules can be added to expand the capabilities of the NX-8V2.

3.1.3 I.P CAMERA

i) PheeNet IP Camera, Model: MCAS-300PTW :

a)Main Features

- Advanced Video & Audio Synchronization
- Pan: range ± 135°, 10°~50°/sec.
  Tilt: range +90°~-45°, 7°~25,°/sec .
- Resolution :640 x 480 pixel.
- Voice data rate : 24kbps ,8kbps(option).
- Sensor :1/4" color CCD sensor.
- Direct Ethernet Network Connectivity.
- Standard :IEEE 802.11g, Frequency:2.400~2.4835GHz, 54Mbps.
- Alarm I/O & Motion Detection with three windows.
- Allows Password Protection .

- Automatic transfer of snapshots via email and FTP with event triggering.
- High performance and fully configurable MPEG4 compression.
- 16-Channel Software, including Monitor & Playback program, for instance, alert with video, save to Internet / HardDisk, Cycle recording, .avi format available.

3.1.4 MODBUS COMPLIANT MODULES[26]

i) Digital I/O Module, Model: i-7050D:

a) Main Features:

- Channels :7 Digital Input , 8 Digital output.
- Interface: RS-485.
- Input type: Sink, non-isolated channel with common ground.
- Output Type: NPN, Sink, Open collector
- Baud rate: 1200 ~ 115200bps
- 7 LEDs as Digital Input indicators, and 8 LEDs as Digital Output indicators .More features are shown in APPENDIX-A.

b) Block diagram: FIG 3.1 shows block diagram for 7050D module.

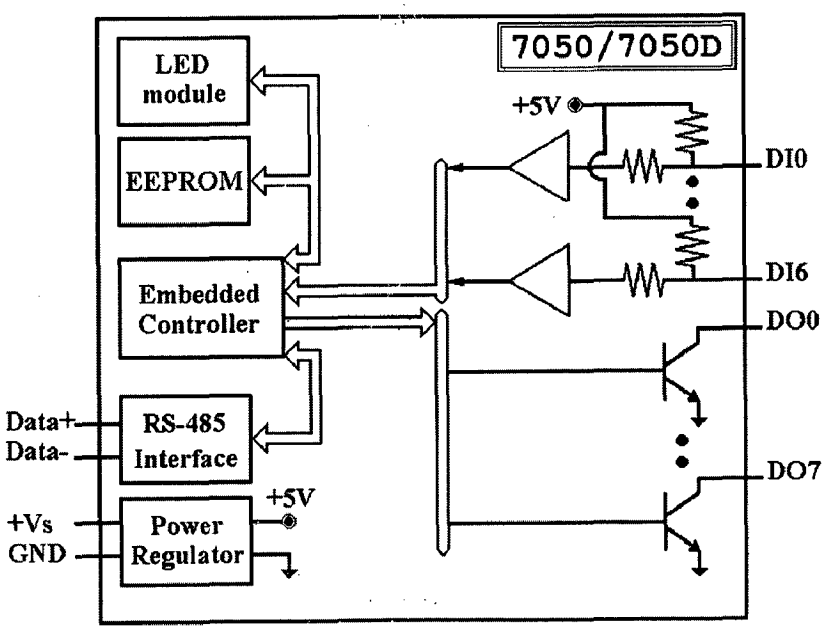


Fig 3.1 Block diagram for 7050D[26]

a) Wiring Diagram: FIG 3.2 shows wiring diagram for Digital input. FIG 3.3 shows wiring diagram for Digital output. FIG 3.4 shows wiring diagram for Digital output with relay.

- For Digital Input:

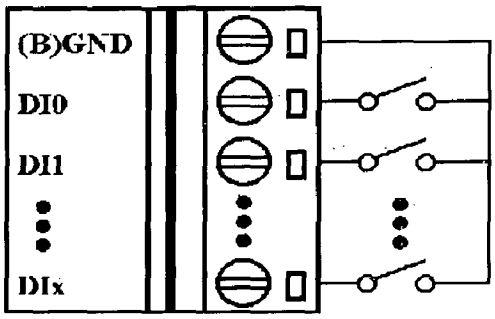


Fig 3.2 Wiring diagram for DI[26]

- For Digital output:(Open Collector Output)

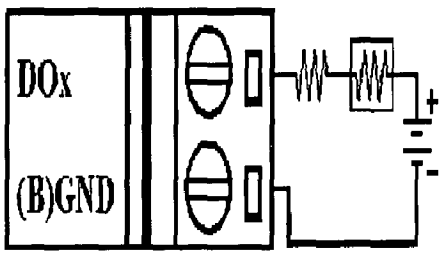


Fig 3.3 Wiring diagram for DO[26]

- For Digital Output With Relay:

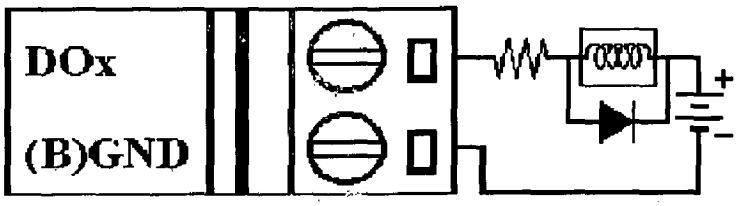


Fig 3.4 Wiring diagram for DO with relay[26]

ii) Digital Input Module, Model: i-7053D:

a) Main Features:

- 16 Digital Input Channels .
- Interface: RS-485.
- Input type: non-isolated channel with common ground.

- Baud rate: 1200 ~ 115200bps
- 16 LEDs as Digital Input indicators.

b) BLOCK DIAGRAM: FIG 3.5 shows block diagram for 7053D.

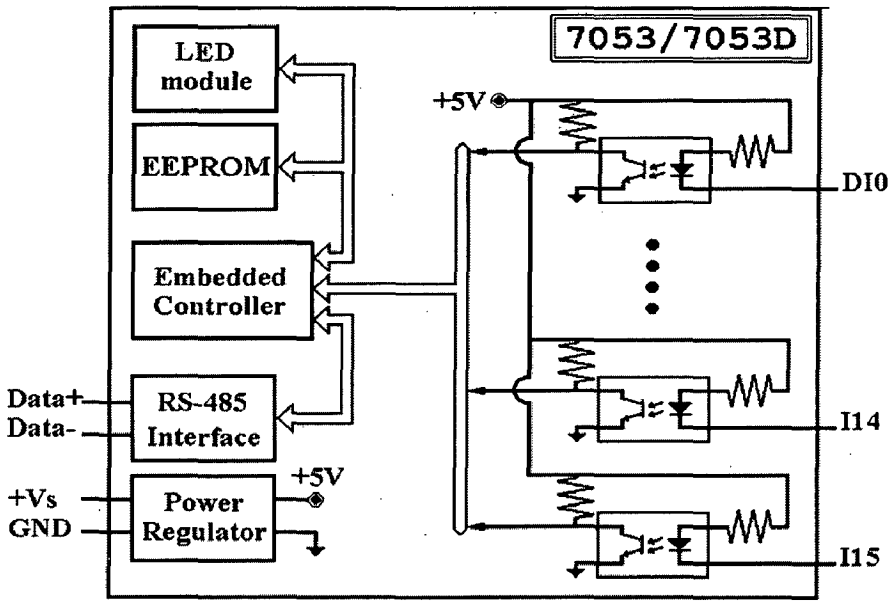


Fig 3.5 Block diagram for 7053D[26]

c) Wiring Diagram: It is same as fig:3.2

iii) Digital Output Module, Model: i-7042D:

a) Main Features

- 13 Digital Ouput Channels.
- Output type: Isolation Open Collector.
- Interface :RS-485.
- Baud rate: 1200 ~ 115200bps.

b) Isolation Voltage:3750V Block diagram: FIG 3.6 shows block diagram for 7042D.

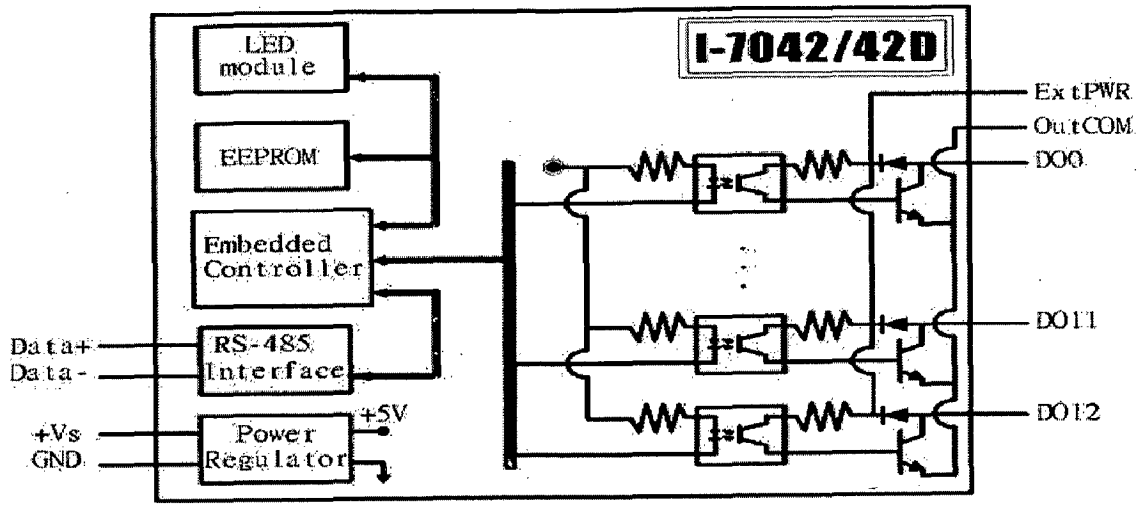


Fig 3.6 Block diagram for 7042D[26]

c) Wiring Diagram: it is same as fig:3.3.

ii) RS-232 to 485 Converter,i-7520 :

a) Main Features:

- Protocol: Differential 2-wire half-duplex RS-485.
- Speed: "Self Tuner" inside, auto switching baud rate, from 300 to 115200 bps
- 256 modules max in one RS-485 network without repeater.
- 2048 modules max in one RS-485 network with repeater.
- Isolation voltage: 3000V .
- More features are explained in APPENDIX -B .

b) Block diagram: FIG 3.7 block diagram shows for 7520

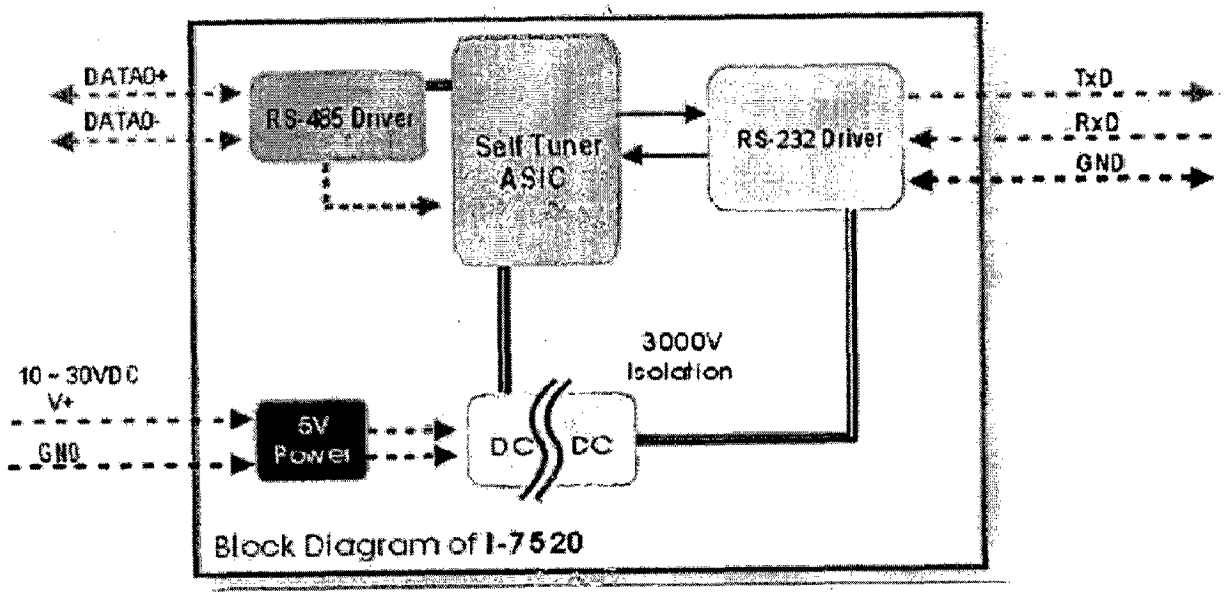


Fig 3.7 Block diagram for 7520[26]

c) Wiring Diagram: Fig 3.8 shows wiring diagram for 7520

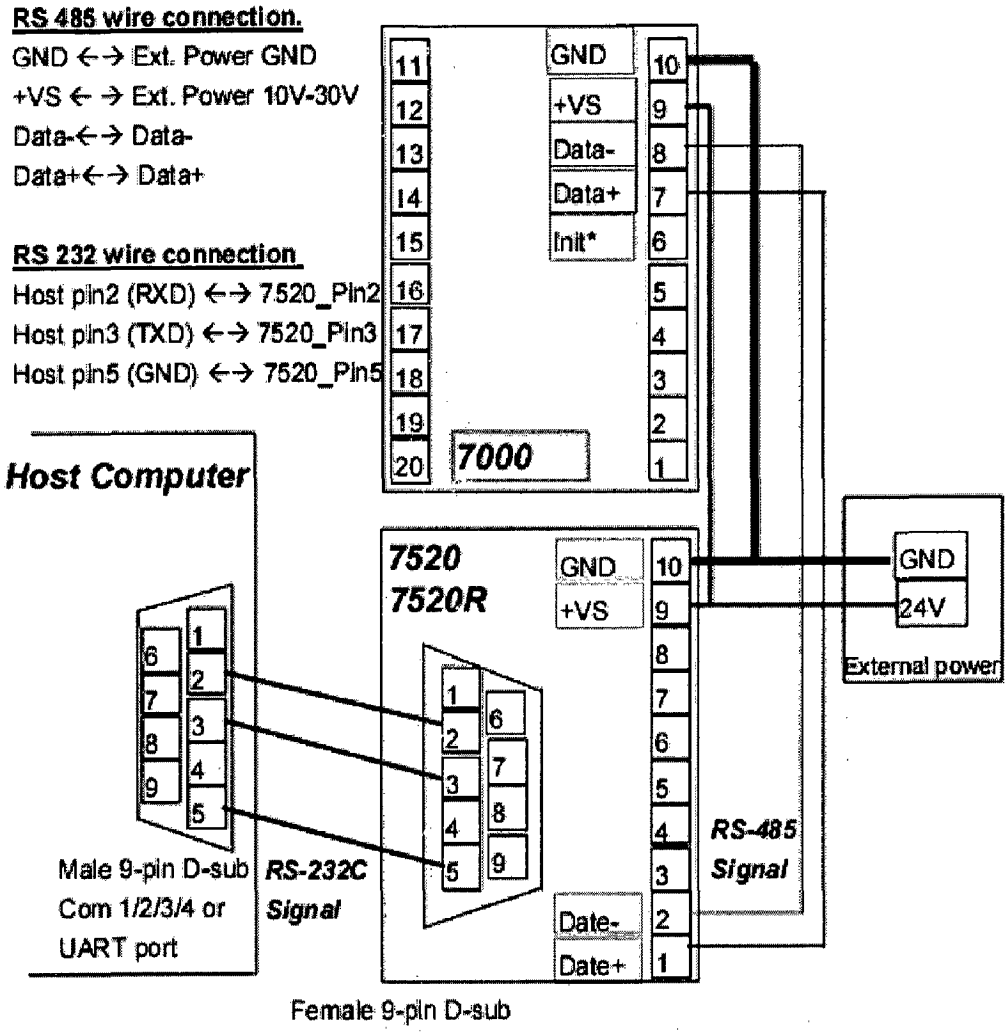


Fig 3.8 Wiring diagram for 7520[26]

3.1.5 GSM MODEM:

a)Model: Motorola L6

b)Description: The GSM modem/Mobile is a powerful and flexible device that can be used in a wide range of telemetry applications that rely on the remote exchange of data, voice, SMS or faxes via the GSM cellular network. A SIM has to be inserted into GSM Modem /Mobile before used for application. In order to send sms (short message service) if any event occurs in any room or corridor and receive sms to receive Commands from remote Mobile to server computer, a GSM Mobile or GSM Modem can be used . A model specific AT (attention) Command set, which is given by Product provider is used to communicate between computer and GSM Modem /Mobile. In the present work the Motorola GSM Mobile Phone is used as Modem.

3.2 SOFTWARES

3.2.1 NAPOPC DA SERVER:

Description: In order to access the data from Modbus Compliant Modules OPC server is user. OPC server used is NAPOPC DA server. The "OPC" stands for "OLE for Process Control" and the "DA" stands for "Data Access".OLE means "Object Linking and Embedding". The NAPOPC DA Server uses an Explorer-style user interface to display a hierarchical tree of modules and groups with their associated tags[26]. A group can be defined as a subdirectory containing one or more tags. A module may have many subgroups of tags. All tags belong to their module when they are scanned for perform I/O. This software is used to configure COM port, and address of modules .This software also allows to test communication status between Server PC and Modules. This test can be done by monitoring the channels value. If it gives any valid value,then communication is good, and if it shows "bad" then there exists Communication failure. To access the data provided by OPC server and do further processing on data and to visible the data in a user friendly manner an OPC Client software must be used. In the present work LABVIEW is used as OPC Client software.

3.2.2 I.P CAMERA ACCESS SOFTWARE

Description:The IP Camera Access Software is used for following actions:

- To Monitor and control camera in pan- tilt directions, to control ON/OFF alarm, view Data Log file.

  To configure the IP camera parameters such as,
- To set IP address to camera.
- Provide security for user access
- Network settings
- Upnp and DNS
- Audio and video
- Motion Control
- Application settings

3.2.3 LABVIEW

i)VERSION: LABVIEW 8.0

ii)Description:

LabVIEW (Laboratory Virtual Instrument Engineering Workbench)[34] is a graphical programming language that uses icons instead of lines of text to create applications. In contrast to text-based programming languages, where instructions determine the order of program execution, LabVIEW uses dataflow programming, where the flow of data through the nodes on the block diagram determines the execution order of the VIs (Virtual Instrument :any Complete functional Unit) and functions.

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. Every VI uses functions that manipulate input from the user interface or other sources and display that information or move it to other files or other computers[34].

A VI contains the following three components:

a) Front panel—Serves as the user interface: The *front panel* is the face that the user of the system sees. It contains *controls* and *indicators*. LabVIEW has a very rich selection of both (you can even design your own) and this permits a wide range of options to the designer. A *control* can take many forms. Many of the forms are themselves "pictures" of real controls used on real instruments - rotary knobs for example. Others are strictly digital in concept. All controls have some form of visual feedback to show the user what state they are in. This helps enormously as you do not have to make explicit allowance to show the state of the controls in your design. A second extremely useful property of controls is that you can specify how they are to react if the input given is unsuitable. To give a specific example - if a control should have an input range of 0 to 10 in integer numbers, you can specify what should happen if the value 3.5 is given or -1 or "zero" as a character string. Since a great deal of time can be consumed in "bulletproofing" a user interface against these sorts of problems, this can be a big timesaver. *Indicators* take a large number of forms. Again some are "pictures" of real indicators -lights and meters. Some are more designed for the computer

screen. The concept of indicator also includes graphs and charts which is a second major timesaver as you do not have to design any of these elements explicitly.

By intelligent design of the *front panel* of a VI it is fairly simple to produce a simple clean and friendly design for the user.

b)Block diagram—Contains the graphical source code that defines the functionality of the VI:The *block diagram* of the VI is almost the "backside" of the *front panel*. It shows how all the controls and indicators fit together as well as the hidden modules where all the work gets done. It looks somewhat like an electronic schematic diagram and is at least conceptually wired up in the same way. Like a real piece of instrumentation, it is easy for the wiring to look very complex and untidy. One of the major issues in Lab VIEW programming is to allocate the timing and ordering of operations. In a conventional Programming language this is handled by the order of the statements along with the use of various loop constructs (FOR, WHILE, etc). LabVIEW works in exactly the same way, but the way in which you specify the ordering is more subtle. The concept in LabVIEW is "dataflow" - any item executes when all it's inputs are available. This implies parallelism (or at least pseudo-parallelism). The standard execution is left-to-right because inputs are generally on the left of an item and outputs on the right, but this is a convention, not a requirement. Looping and ordering is handled by structures which look like books with a number of pages .

c) Icon and connector pane: (Creating SubVI):The icon and connector pane correspond to the function prototype in text-based programming languages. Every VI displays an icon, such as the one shown as follows, in the upper right corner of the front panel and block diagram windows.An icon is a graphical representation of a VI. It can contain text, images, or a combination of both. If you use a VI as a subVI, the icon identifies the subVI on the block diagram of the VI. You can double-click the icon to customize or edit it.

iii)Labview Program example :

Let 'x' and 'y' are inputs and 'z' is output where z=sqrt(x*x+y*y).mulint is subVI,then

Fig 3.9,3.10,3.11 shows block diagram,front panel,SubVI for this example.

Block Diagram:

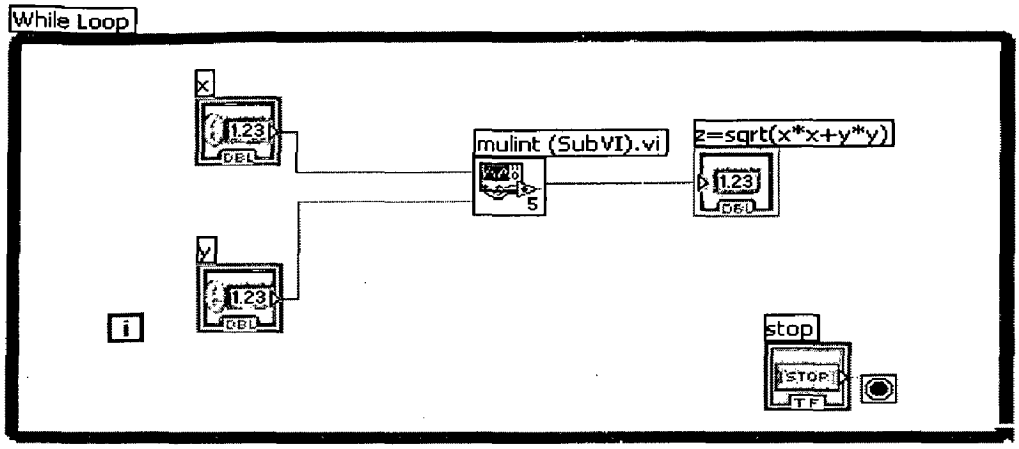


Fig 3.9 Block diagram for simple labview program

Front Panel:

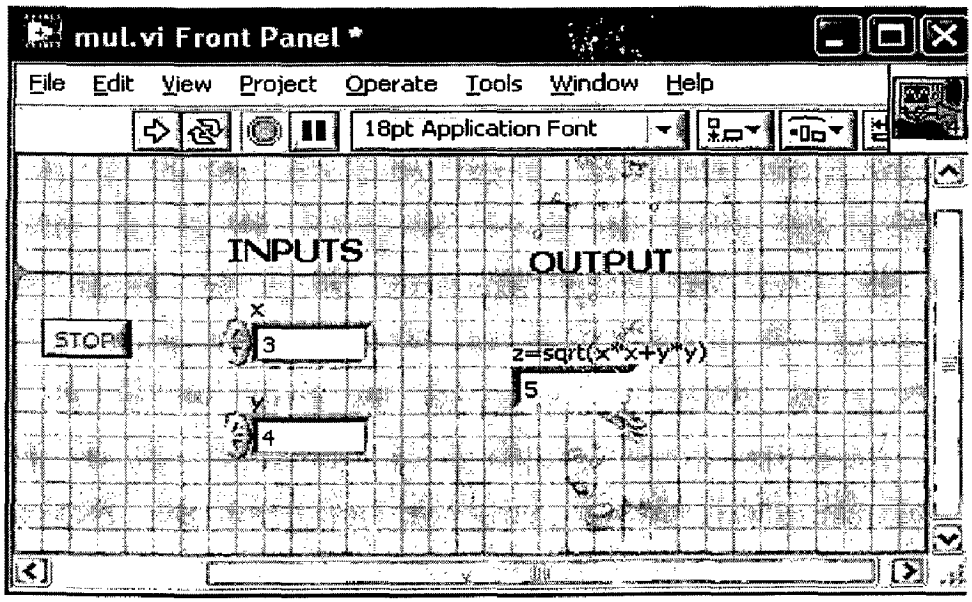


Fig 3.10 Front panel for simple labview program

mulint SubVI Block diagram:

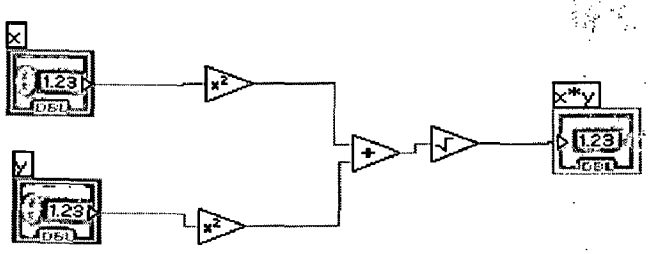


Fig 3.11 Block diagram for mulint SubVI

3.2.4 GSM MODEM DRIVERS SOFTWARE:

In order to have a communication between GSM modem/Mobile and server PC, GSM Modem drivers which is given by modem manufacturer is to be installed in a server PC.The drivers installed for present application is Motorola Phone Tools drivers software. Once this software is installed , testing of communications can be done using HyperTerminal.Goto Start>All programs>Accessories>Communication>Hyperterminal.The hyperterminal window is as shown in fig 3.12. Type "AT" in Hyperterminal window,then if "Ok" comes Communication is going on, if it returns "ERROR" then there is no communication between PC and modem.

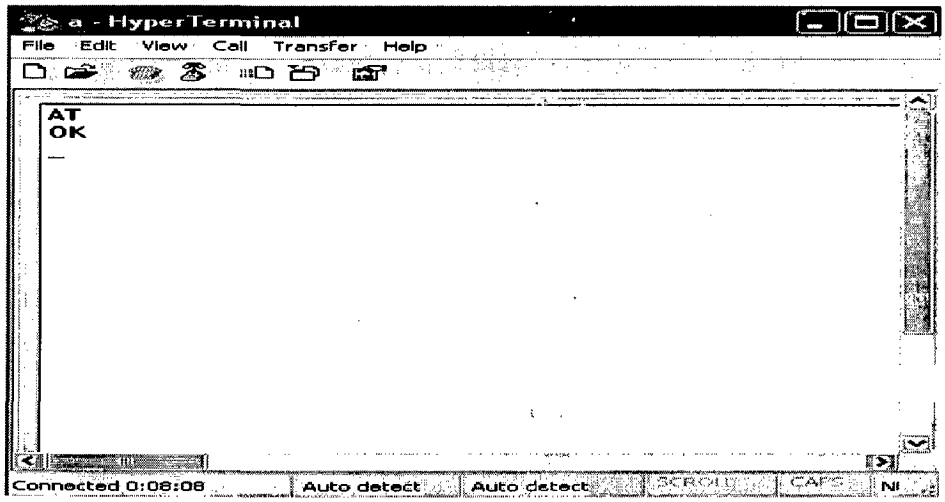


Fig 3.12 Hyperminal window to test modem –PC communication

Once this drivers is installed and communication is going between PC and modem then a program can be written in Labview for reading and writing AT commands.

Finally, concluding that hardware sensors and relays acts as SAC's of BAS ,Modbus Digital I/O,Rs-232 to Rs-485 convertor, GSM modem acts as ICD's of BAS ,and Softwares explained above in section 3.2 acts as CMD's of BAS(Where SAC's,ICD's,CMD's are explained in section 1.12).

CHAPTER 4

LABORATORY IMPLEMENTATION OF AUTOMATION SYSTEMS

4.1IP CAMERA:

4.1.1INTRODUCTION:

IP Cameras can be used for surveillance and security of both homes and businesses. With the ability to record live video to a remote location, IP Cameras allow you to make sure your recorded video is safe by storing it at a location that only you can access. They are directly network connected cameras with their own IP address. That means the camera has intelligence and can be connected in network without the need of a PC. Genarally the manufacturer provided software "IP camera Access software is used to configure and control the camera. The camera used is present application is Pheenet IP Camera(Model: MCAS-300PTW) and Pheenet IP camera access software[31].Detail specifications of IP camera are shown in APPENDIX-C.

4.1.2 IMPORTANT CONFIGURATION WINDOWS

i. **NETWORK CONFIGURATION:** Fig 4.1 shows IPCamera network settings.

For "Reset IP address at next boot", the default status is checked to avoid erroneous entries during installation. This can be tedious having to perform software installation whenever the Network Camera starts. Therefore, once the network settings, especially the IP address, have been entered correctly, uncheck this option. If this option is disabled, the Network Camera will skip installation at the next boot. The Network Camera can automatically restart and operate normally after a power outage.

General network settings:

- "IP address": This is necessary for network identification.
- "Subnet mask":it is used to determine if the destination is in the same subnet. The default value is "255.255.255.0".
- "Default router" This is the gateway used to forward frames to destinations in a different subnet. Invalid router setting will fail the transmission to destinations in different subnet.
- "Primary DNS" The primary domain name server that translates hostnames into IP addresses.
- "Secondary DNS" Secondary domain name server that backups the Primary DNS.

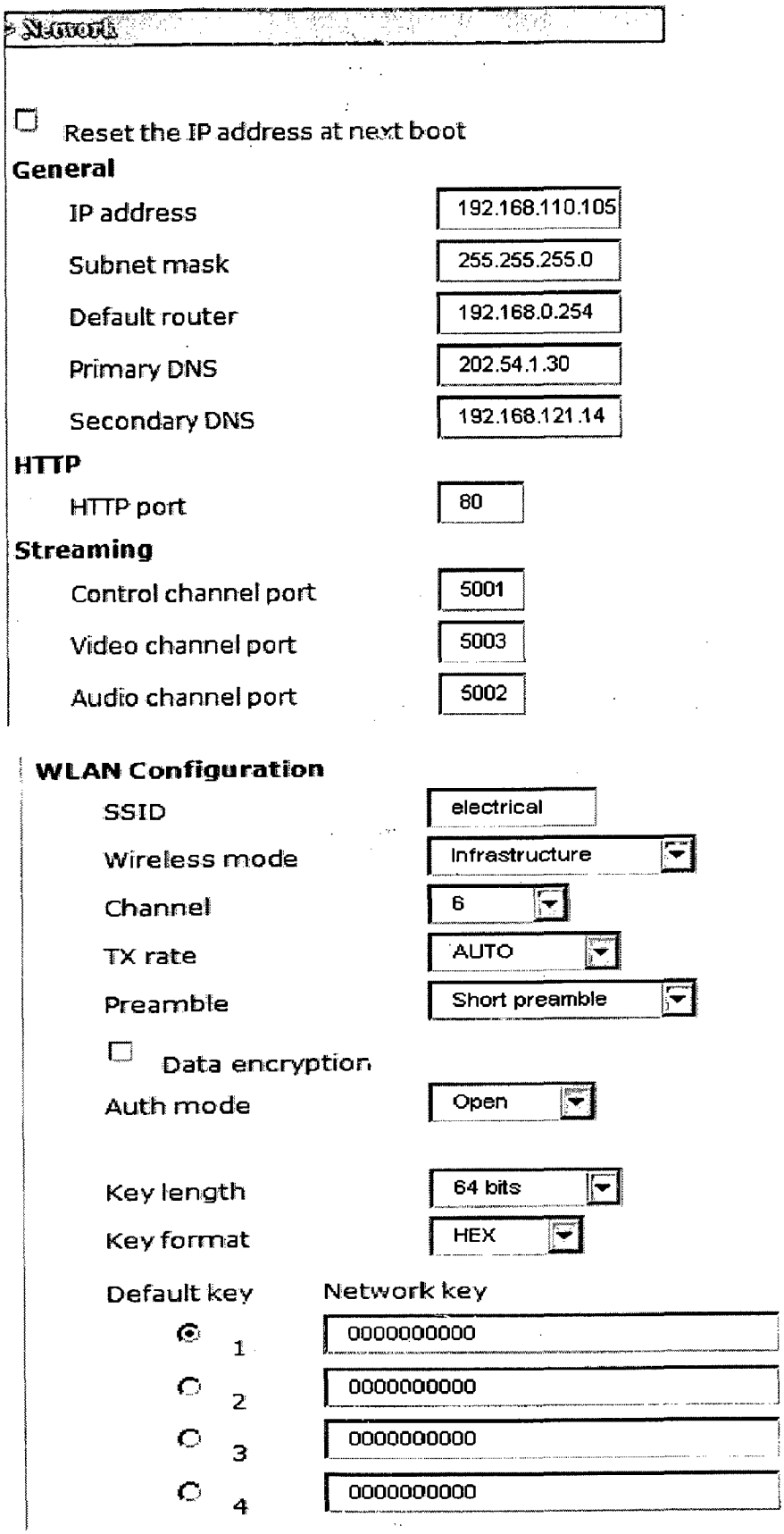


Fig 4.1: IP camera network settings

ii)NETWORK SECURITY:

After opening the Web browser and typing in the URL of the Network Camera, a dialogue window pops up to request a username and password of administrator. Upon successful authentication, allows enter into IP camera home page.Fig 4.2 shows login window to camera.

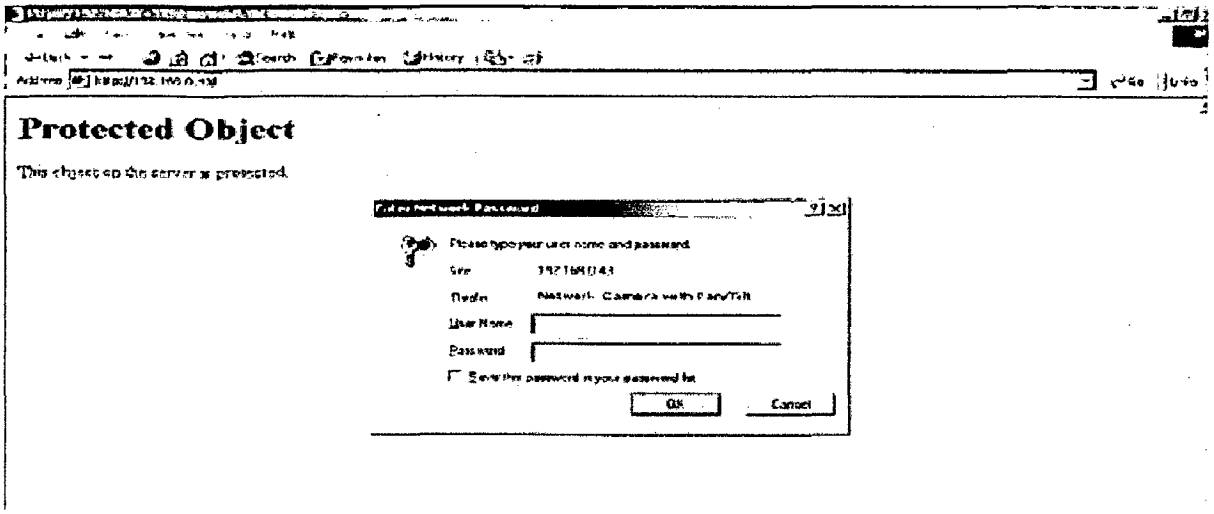


Fig 4.2 Login window

iii)CAMERA MAIN WINDOW: The main window is shown in fig:4.3,where we can monitor and control pan-tilt and ON/OFF alarm, and route to configurations window.

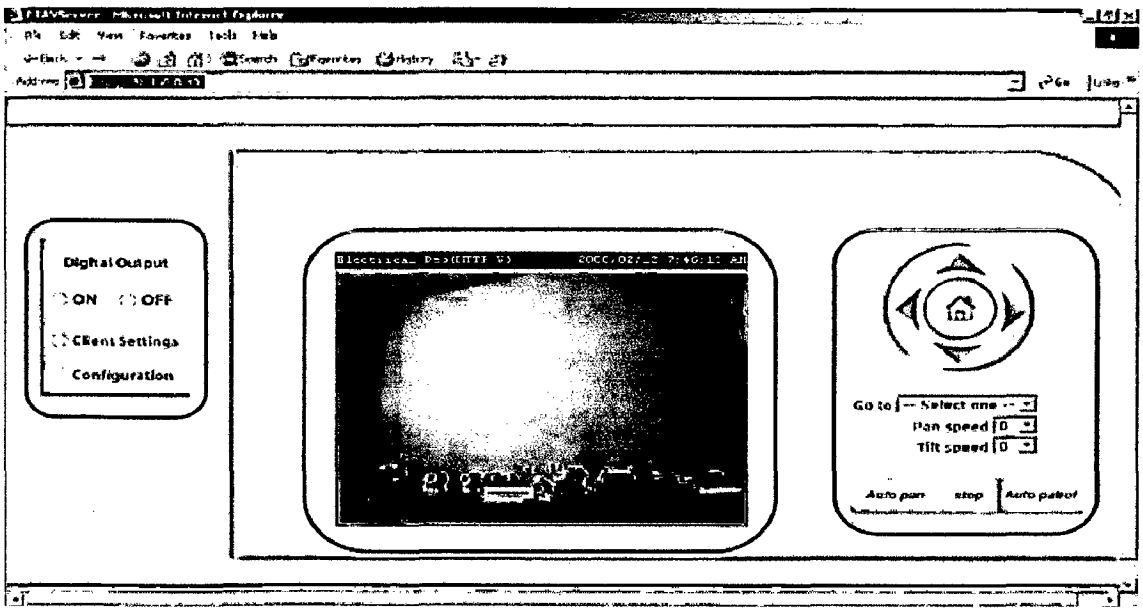


Fig 4.3 Camera main window

iv)CAMERA CONTROL: The fig 4.4 shows to set pan ,tilt ,Autopan/tilt speed and to select preset function area.

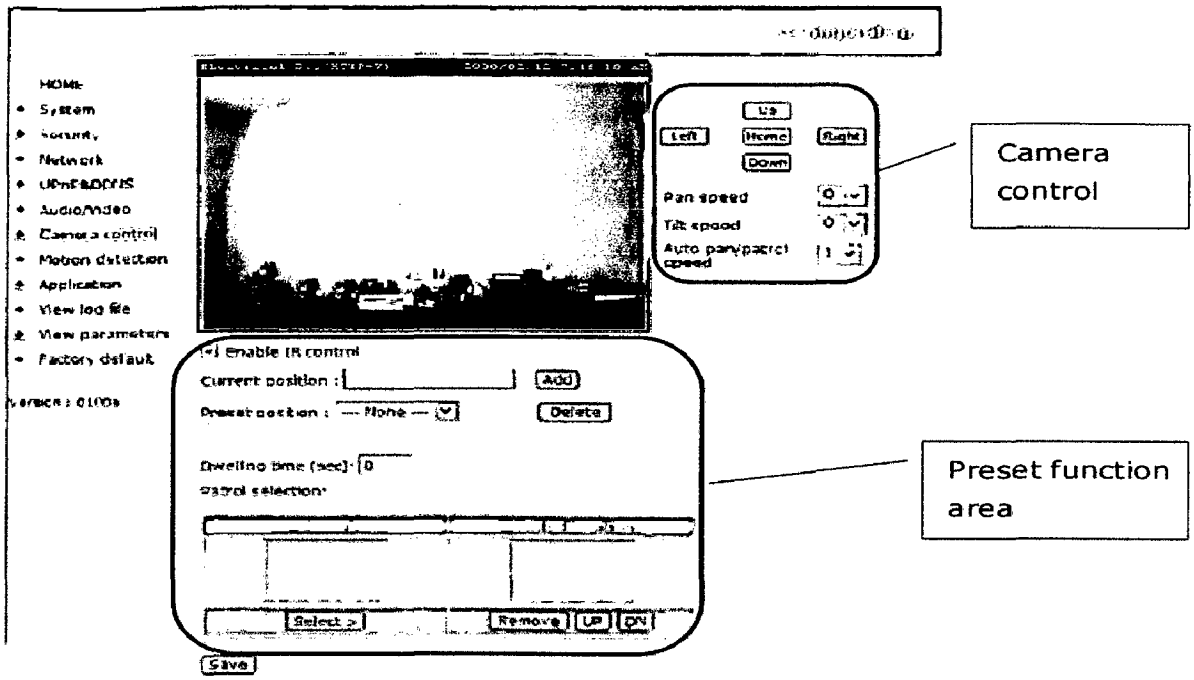


Fig 4.4: Camera control

v)MOTION DETECTION: Fig 4.5 shows how to set locations for motion detection. It allows maximum of three locations to be set.Here door and area1 is selected as motion detection locations.

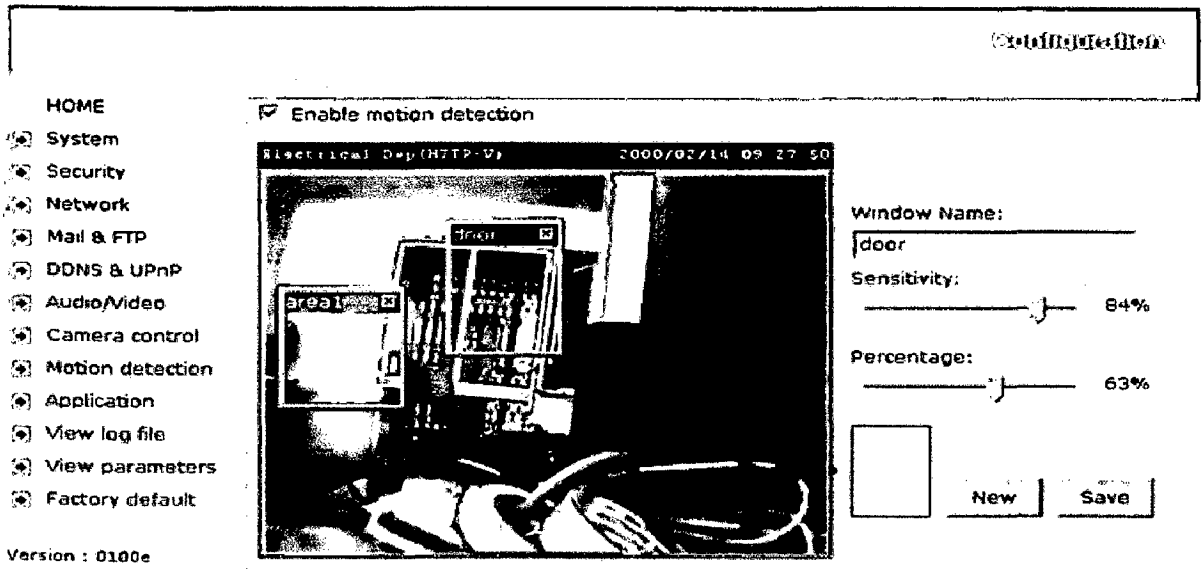


Fig 4.5: Motion detection

vi) APPLICATION WINDOW:

The user application features has to be selected here like when to ON/OFF the alarm based on sensor status,when motion occurred sending the uploaded snapshots to master through e-mail.Fig 4.6 shows application options.

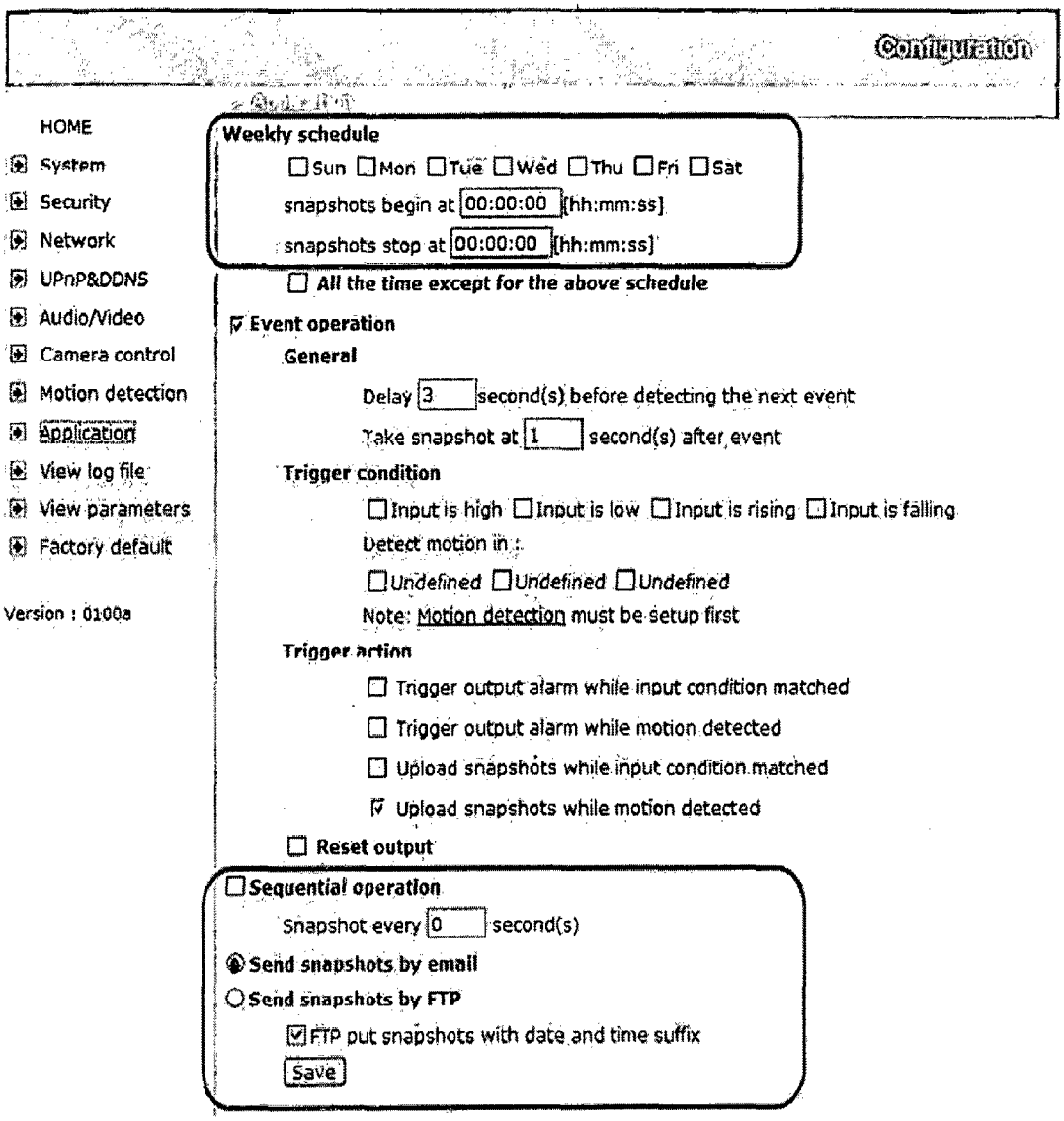


Fig 4.6:Application window

Vii)VIEWING SYSTEM LOG :

The content of this file provides useful information about configuration and connections after system boot-up.Fig4.7 shows View system log file.

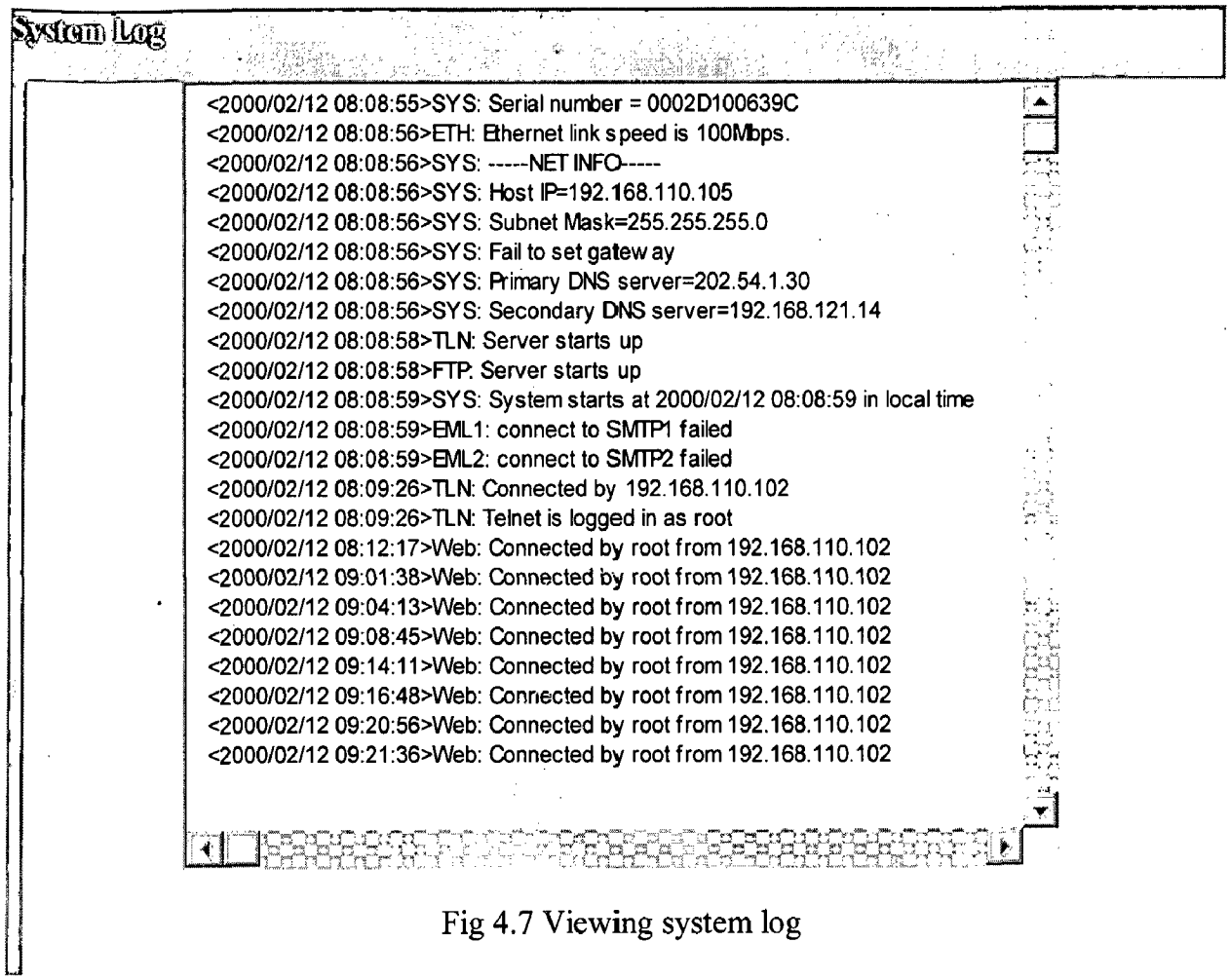


Fig 4.7 Viewing system log

VIII)VIEWING SYSTEM PARAMETERS

To view the entire system's parameter set.The following are the mail parameters.

<smtp mail server>

192.168.121.26

<SMTP account name 1>

cgargpee

<SMTP password 1>

abc123

<mail recipient address>

santupee@iitr.ernet.in

4.1.3 MERITS AND DEMERITS:

i)Merits:

a)Less weight and easy Installation as IP camera can be integrated to either wired(Ethernet) or Wireless (WiFi)network.

b) Provides Remote access easier.

ii)Demerits

a) Higher cost :Because of the additional technology that is built into each camera, the cost is generally higher that analog versions.
b) Higher bandwidth required : IP cameras require more bandwidth than analog cameras.

4.2SECURITY SYSTEM:

4.2.1 INTRODUCTION: The implementation of standalone security system is done with the help of GE made security Control Panel (Model:NX-8v2)and along with Programming keypad(NX-1192E). It has 16 zones and zones can be expandable to 48 zones with zone expandable module. It allows 8 partitions and data logging facility. A Partition can be covering any group of zones. A zone can be covered by one or more partitions. It has 206 Memory Locations for feature selection**[29]**.

- ENTERING THE PROGRAM MODE :

To enter the Program Mode, press [*]-[8]. At this time, the five function LEDs (Stay, Chime, Exit, Bypass, & Cancel) will begin to flash. Next, enter the "Go To Program Code" (FACTORY DEFAULT IS [9]-[7]-[1]-[3]). If the "Go To Program Code" is valid, the "Service" LED will flash and the five function LEDs will illuminate steady. You are now in the Program Mode and ready to select the module to program.

- SELECTING THE MODULE TO PROGRAM :

Since all modules connected to the NX-8V2 are programmed through the keypad, the module you are programming should be the first entry. To program the NX-8V2 Control Panel, enter [0]-[#]. The [0] is the module number of the control and [#] is the entry key.

- PROGRAMMING A LOCATION :

Once the number of the module to be programmed has been entered, the "Armed" LED will illuminate, indicating it is waiting for a programming location to be entered. Any location can be accessed by directly entering the desired programming location followed by [#]. If the location entered is a valid location, the "Armed" LED will extinguish, the "Ready" LED will illuminate and the binary data for the first segment of this location will be shown by the zone LED's.

- MASTER CODE:

  Once the desired locations are programmed ,then the system should be armed with 4 master code:[1]-[2]-[3]-[4].

4.2.2 **WIRING DIAGRAM**:The wiring diagram for control panel is shown in fig 4.8

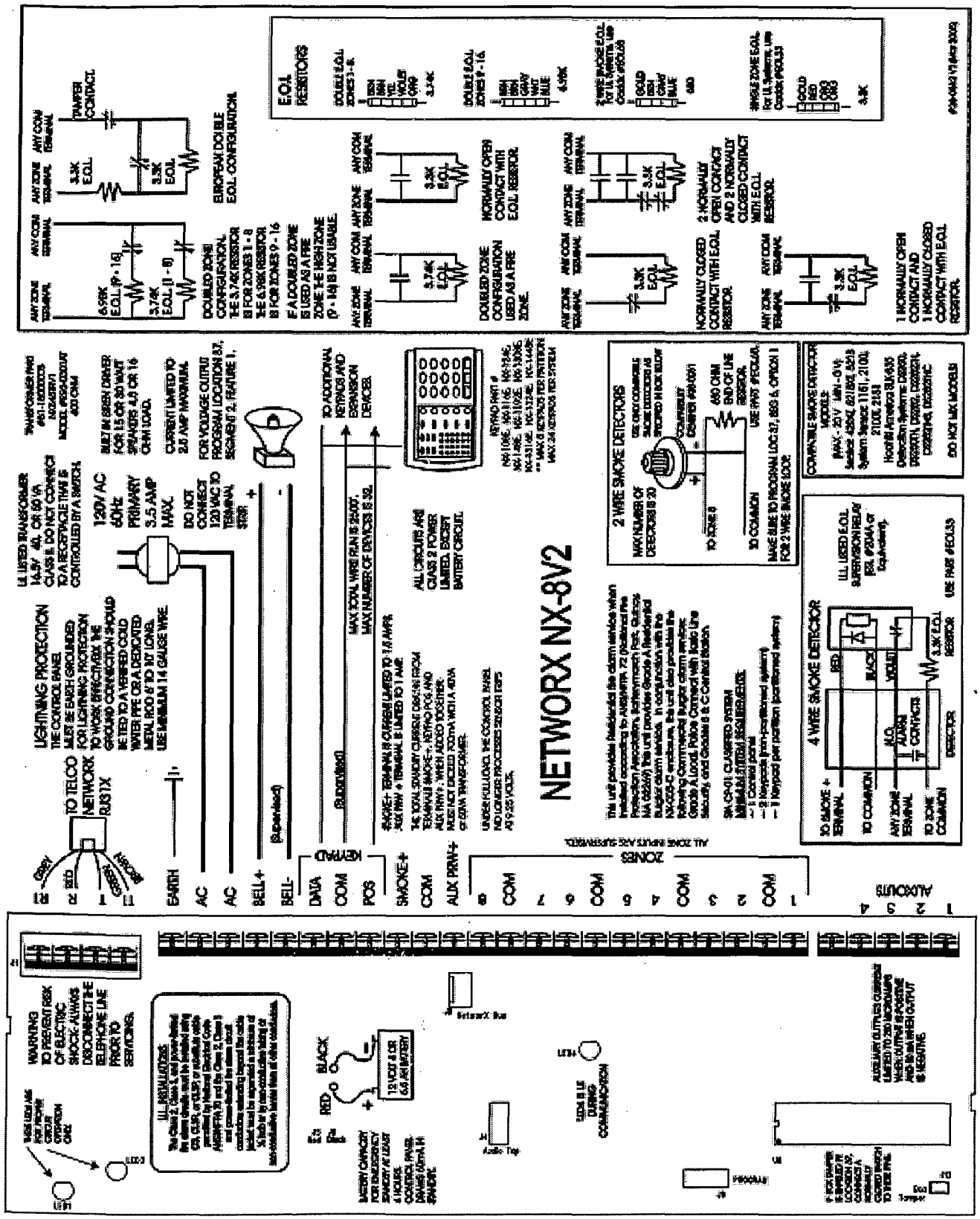


Fig 4.8 Wiring diagram[29]

4.2.3 LABORATORY SET UP INCLUDING SECURITY CONTROL PANEL , SENSORS,RELAYS AND ALARM:

The laboratory set up for security control , sensors, relays, and alarm are shown in fig :4.9

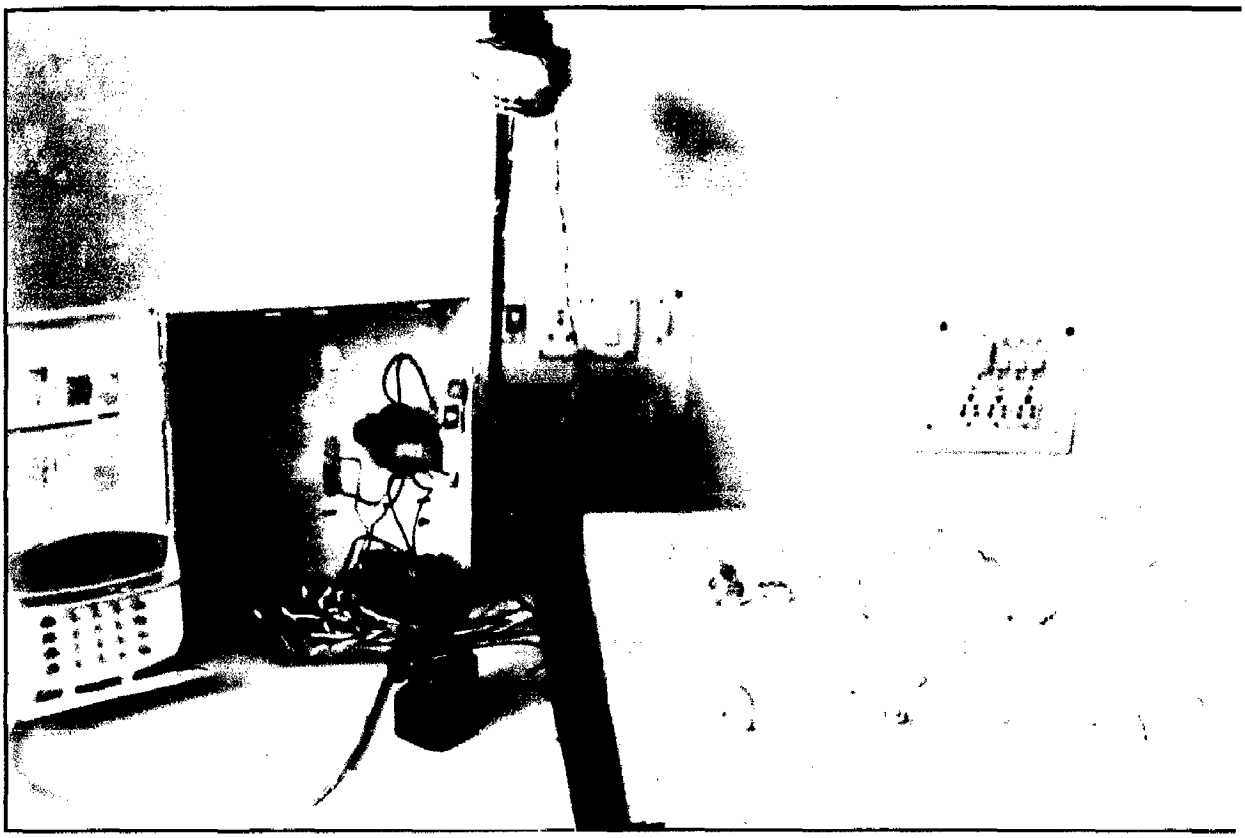


Fig :4.9: Lab set up for security panel

The Tx and Rx of panel is connected to telephone line to initiate calls.The Auxillary ouputs AUX1 and AUX2 is connected to two relays and AUX1 is programmed for AUX1 keypad zone(POLICE key) and AUX2 is for Panic keypad zone(FIRE). The sensors in zone locations are given in table:4.1

Table: 4.1:Sensors location

ZONE NUMBER	SENSOR
1	DOOR/WINDOW
2	PANIC
3	OCCUPANCY(PIR)
4	GLASS(AIR+ACOUSTIC)
5	GLASS(ACOUSTIC)
6	OCCUPANCY(PIR)
7	OCCUPANCY(PIR)
8	SMOKE

All the zones are programmed to partition1,the programming is done such that if any Sensor becomes open from short condition then an a FAULT in that particular zone is indicated in keypad,alarm is enabled, telephone call is initiated to preprogrammed number. Here only blank call is initiated.

4.2.4 IMPORTANT PROGRAMMED LOCATIONS USED:

i. **Location 0:** PHONE NO:The first telephone number is programmed in location 0. A "14" indicates the end of the phone number. Delays of four seconds can be programmed at any point in the phone number by programming a "13" in the appropriate segment. If tone dialing is desired, program a "15" in the segment where tone dialing should begin. If the entire number should be tone dialing, program a "15" in the first segment.

ii. **Location 23:** PARTITION 1, FEATURE & REPORT SELECTIONS : is used to enable certain features that can be accessed or are visible to the user from the keypad of the system. In addition, certain communicator reports are enabled in location 23. Each of these features can be enabled by partition.

Segment 1:

- 1 = On enables the Quick Arm feature.
- 2 = On enables the Re-exit feature.
- 3 = On enables the Automatic Bypass feature.
- 4 = On enables the Silent Keypad Panic feature (overrides the audible panic selection).
- 5 = On enables the Audible Keypad Panic feature.
- 6 = On enables the Keypad Aux 1 feature (FIRE).
- 7 = On enables the Keypad Aux 2 feature (MEDICAL).
- 8 = On enables the Keypad Multiple Code Attempt Tamper feature.

Segment 2:

- 1 = On enables the LED Extinguish feature.
- 2 = On enables the Require Code for Bypassing feature.
- 3 = On enables the Zone Bypassed Sounder Alert feature.
- 4= On enables the AC Power/Low Battery Sounder Alert feature.
- 5= On enables Bypass toggle.
- 6= On enables Silent Auto Arm.
- 7= On enables the Automatic Instant feature.
- 8= On enables Instant mode toggle.

Segment 3:

- 1 = On enables Opening and Closing reports.

- 2 = On enables Zone Bypass reporting.
- 3 = On enables Zone Restore reporting.
- 4= On enables Zone Trouble reporting.
- 5= On enables Zone Tamper reporting.
- 6= On enables the Cancel reporting.
- 7= On enables the Recent Closing report.
- 8= On enables the Exit Error report.

iii) **Locaion 24:** ENTRY / EXIT TIMER:Location 24 is used to program the Entry/Exit times. There are 2 separate Entry/Exit times.

Segment 1, Entry time 1: This is the entry time that will be used when a delay 1 zone type initiates an entry delay. Valid entries are 30-255 seconds.

Segment 2, Exit time 1: This is the exit time that will be used for all zones designated as delay 1. Valid entries are 45-255 seconds.

Segment 3, Entry time 2: This is the entry time that will be used when a delay 2 zone type initiates an entry delay. Valid entries are 30-255 seconds.

Segment 4, Exit time 2: This is the exit time that will be used for all zones designated as delay 2. Valid entries are 45-255 seconds.

iv) **Location 25:** Location 25 contains the Zone Type for zones 1-8. Segment 1 is for zone 1, and Segment 8 is for zone 8. Default Zone Types are found in the table D.1 in Appendix-D.

v) **Location 26:** It is used to select the partition(s) that zones 1 - 8 reside in. A zone may reside in any combination of the 8 partitions. If a burglary zone resides in more than 1 partition, it will only be active when all partitions it resides in are armed. Location 26 has 8 segments. Segment 1 corresponds to zone 1, and Segment 8 corresponds to zone 8.

Segments 1 - 8: 1 = Partition 1 3 = Partition 3 5 = Partition 5 7 = Partition 7

2 = Partition 2 4 = Partition 4 6 = Partition 6 8 = Partition 8.

vi)**Location 46:** AUXILIARY OUTPUT 1 - 4 SPECIAL TIMING: It contains special timing feature activation for the four auxiliary outputs. Segment 1 corresponds to output 1; Segment 4 corresponds to output 4.

Segments 1 - 4:

- 1 = On if output should be timed in minutes; Off if timed in seconds.
- 2 = On if output should latch; Off if output should be timed.

- 3 = On if output should stop timing upon code entry; Off if the output should continue to time upon code entry.
- 4= On if output should activate between closing and opening time in loc. 52 and 53.
- 5= On if output should activate between the opening and closing time in loc. 52 and 53.

vii) **Location 47:** TO SET AUXILIARY OUTPUT 1, EVENT & TIME :

Segment 1: Use Table E.1 in APPENDIX-E, to select the event that will activate Auxiliary Output 1. Segment 2: Program the timing from 0-255 (minutes or seconds, depending on data programmed in Segment 1, Location 46). Programming a "0" makes the output follow the event.

viii) **Location 48:** AUXILIARY OUTPUT 2, EVENT & TIME:

Segment 1: Use Table in appendix to select the event that will activate Auxiliary Output 2. Segment 2: Program the timing from 0-255 (minutes or seconds, depending on data programmed in Segment 2, Location 46). Programming a "0" makes the output follow the event.

4.2.5 MERITS AND DEMERITS:

i)MERITS:

a) NX8 v2 security control panel can provide security to single home by creating partitions for zones.

b) Up to 32 modules can be added to expand the capabilities of the NX-8V2.

ii)DEMERITS:

a)It is a standalone control so that it cannot be integrated to any network .

b)It cannot be effectively used for larger buildings. For eg.,GHB.

CHAPTER 5

DESIGN OF GHB AUTOMATION SYSTEM

5.1 ARCHITECTURAL DESIGN OF GHB

5.1.1 HIERARCHAL BUILDING DESIGN:

The N.C Nigam Guest House Building(GHB) consists of 16 rooms and 12 suits. Room is a single bed room and Suite is having bed room attached with another entrance room. For design consideration assuming both room and suit is considered as same and assumed building divided into four blocks and describing the GHB design in hierarchal way as shown in fig. 5.1. (Note: R-Room, C-Corridor, S-Stairs).

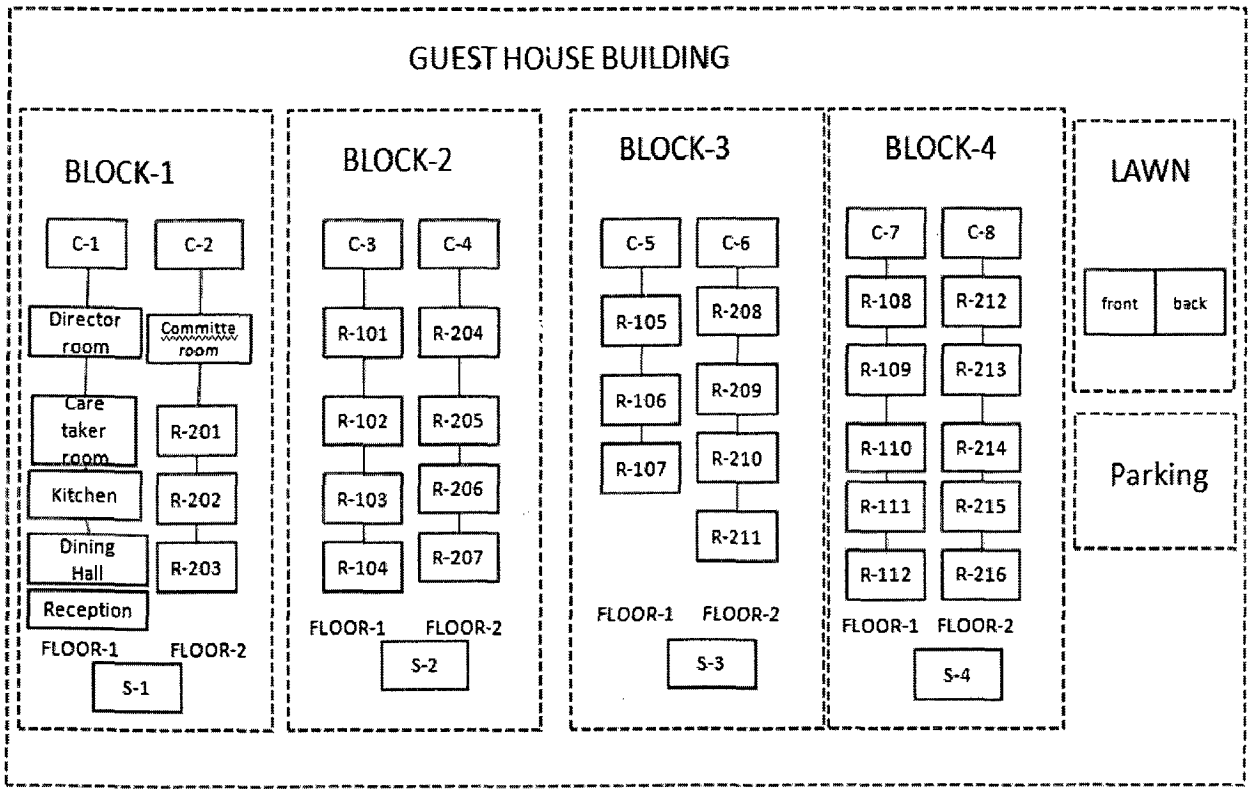


Fig 5.1: Hierarchal building design

5.1.2 GHB DESIGN DIAGRAMS: The basic outline deigns are shown from fig 5.2 to 5.6.

i. Fig 5.2 shows GHB building layout:

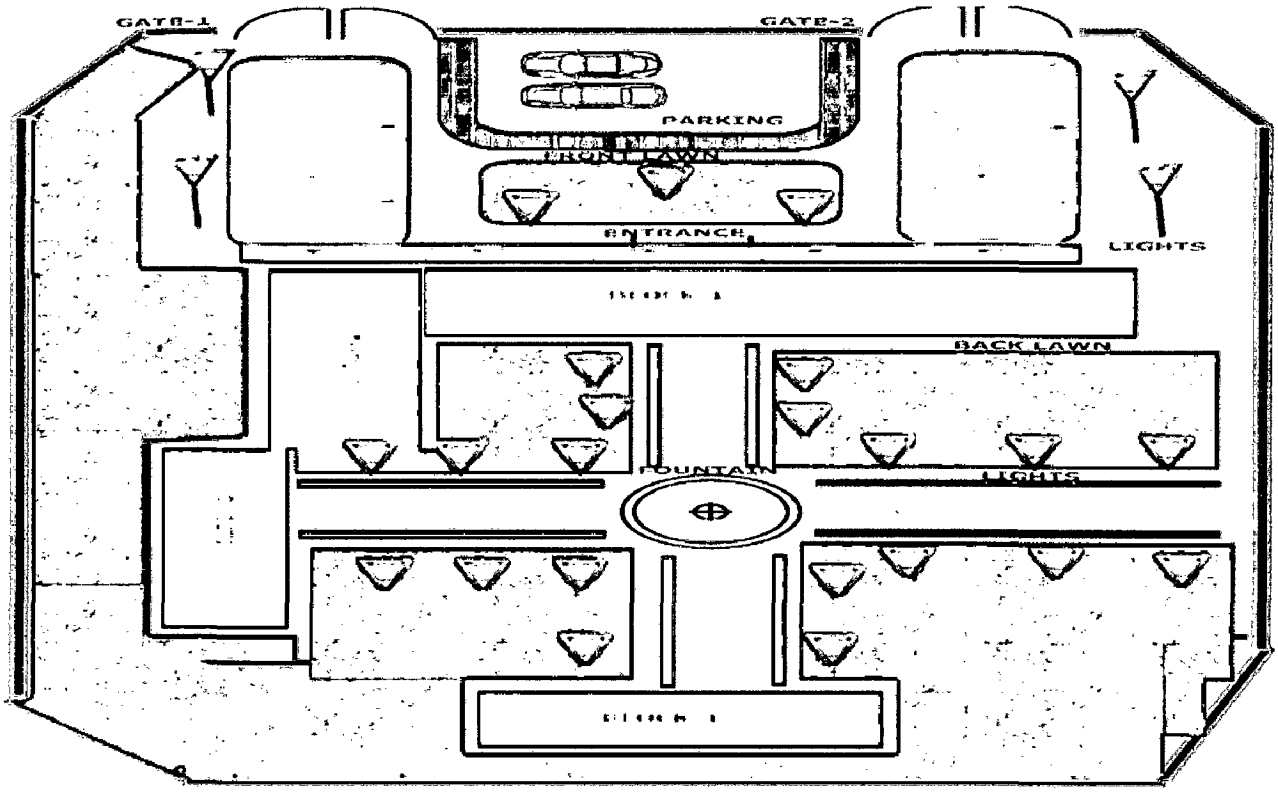


Fig 5.2 Building layout

ii. Fig 5.3 shows Block-1of GHB:

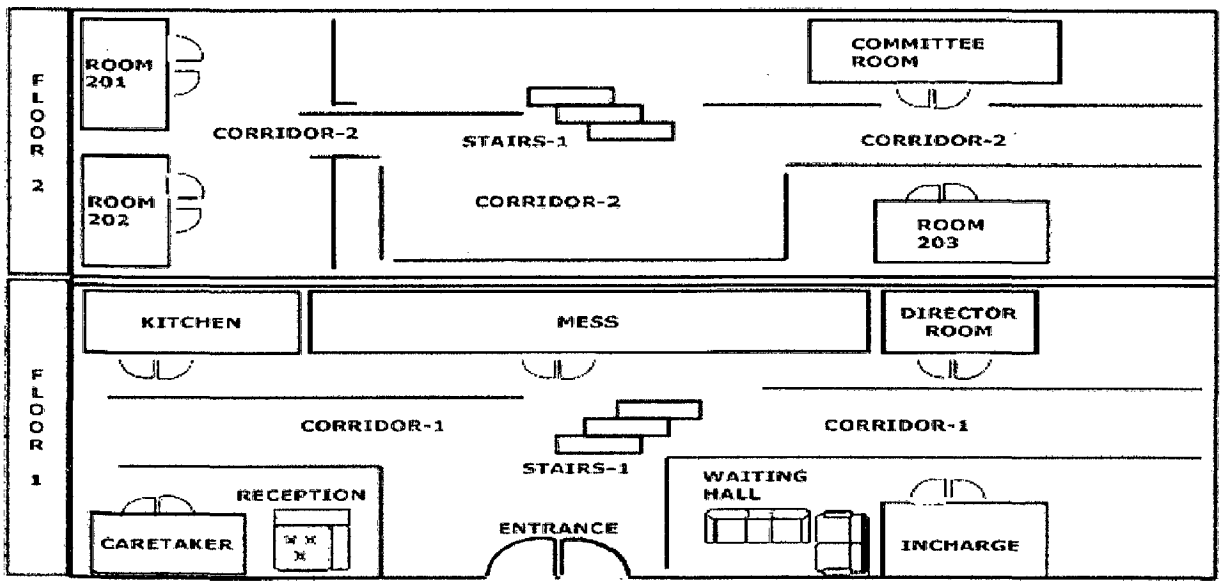


Fig 5.3 Block-1

iii. Fig 5.4 shows Block-2 of GHB :

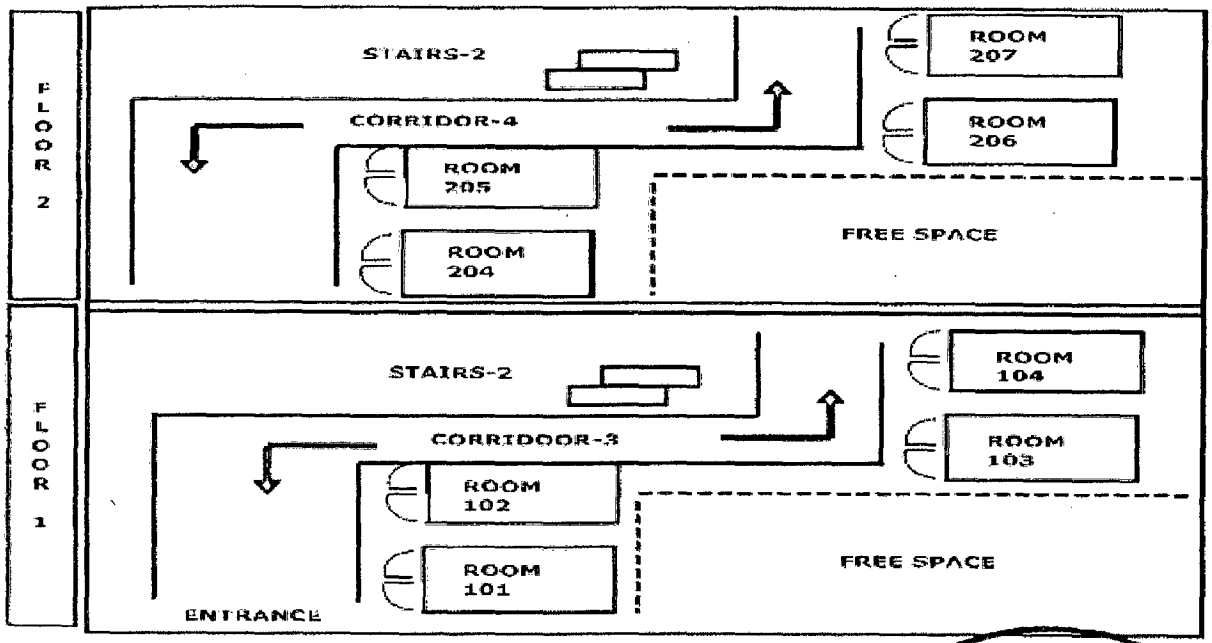


Fig 5.4 Block-2

iv. Fig 5.5 shows Block-3 of GHB

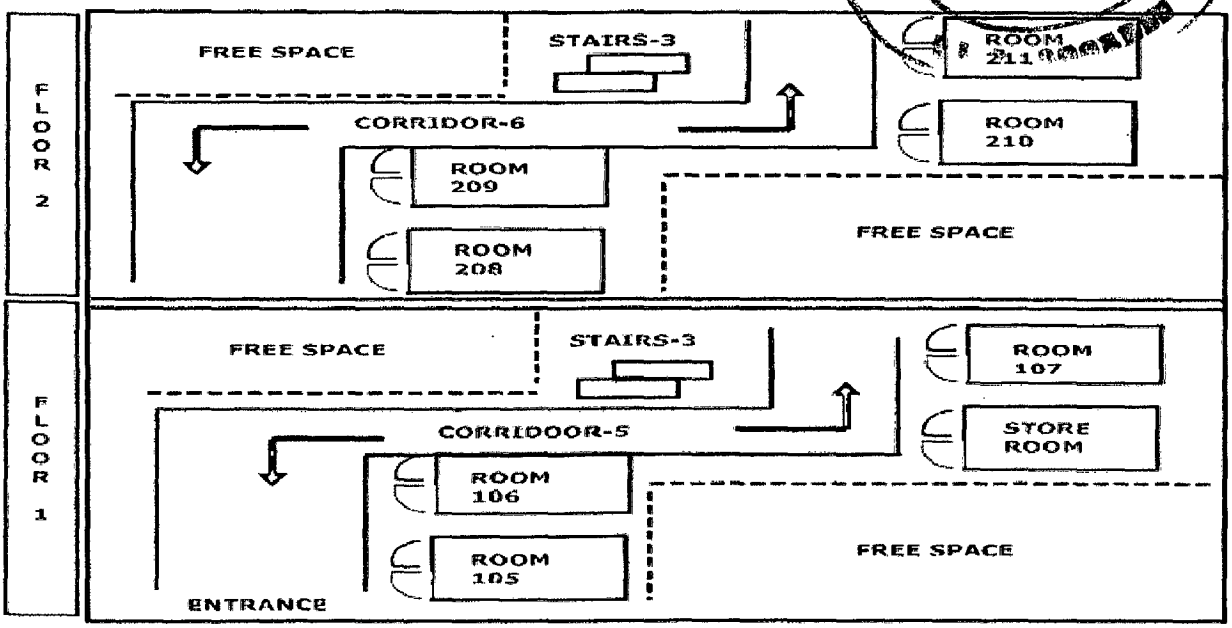


Fig 5.5 Block-3

v. BLOCK-4 of GHB is shown in fig 5.6 :

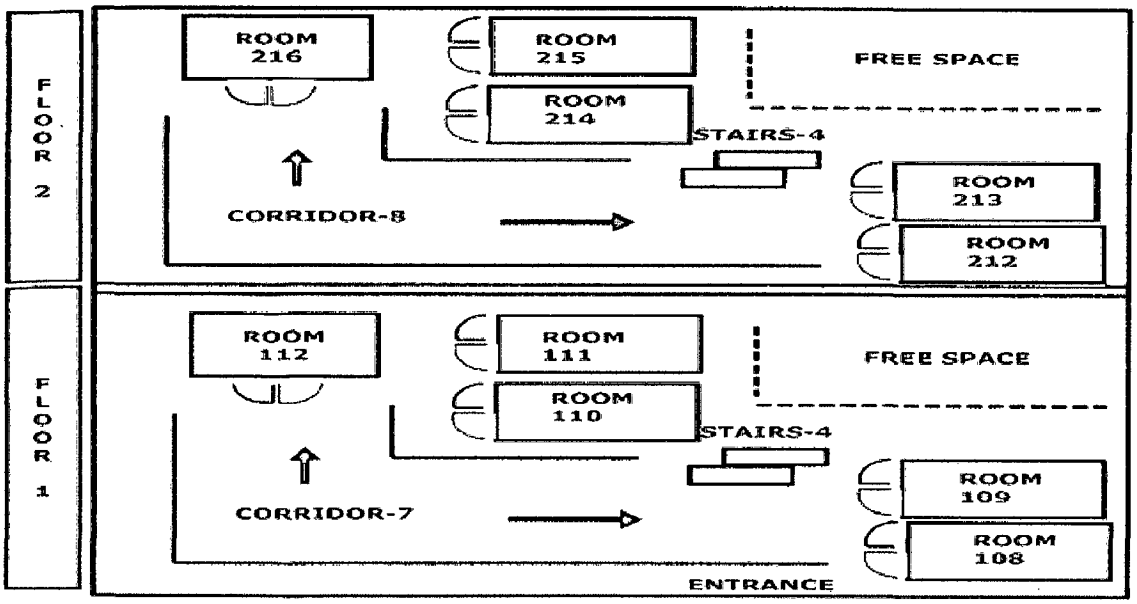


Fig 5.6 Block-4

5.2 PLACEMENT OF DEVICES

5.2.1 IN SINGLE ROOM:

a) Sensors:

- One Smoke Sensor at top of room.
- One Glass break detector should be attached to glass window.
- One Motion detector can be placed near to entrance door, inside the room.
- Optionally, One Pet Immune detector can also be placed at adjacent to door, inside the room.
- One Door sensor should be attached to door open corner.

b) Six Relays: to connect to Light, Fan, AC, Heater, TV, Geyser.

c) One Modbus Digital I/O module (Module No:i-7520) to connect sensors and relays.

d) Network Diagram: FIG 5.7 shows modbus n/w in room.

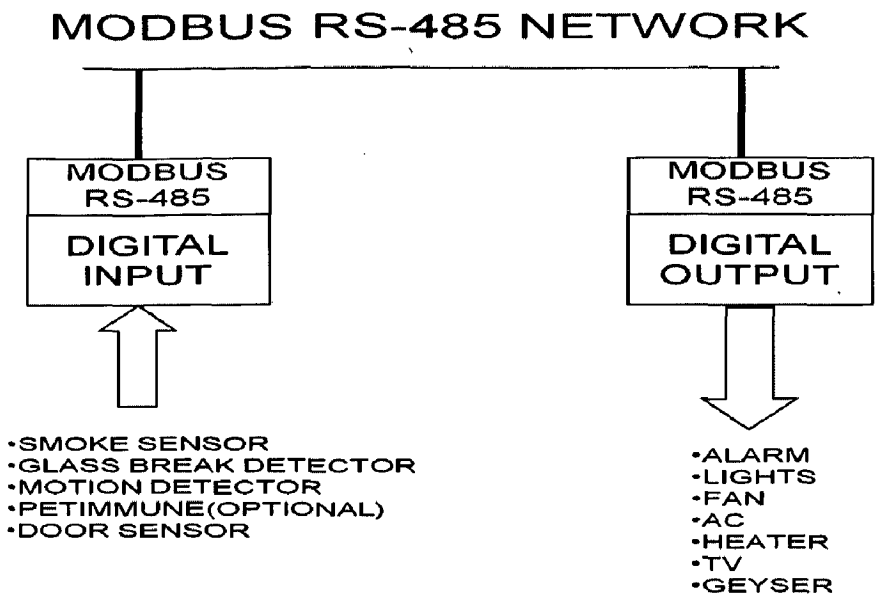


Fig 5.7 Modbus n/w in room

5.2.2 IN SINGLE CORRIDOR

a) Sensors:
   - ➢ At least three Smoke sensors should be placed in single corridor by maintaining related distance between two sensors.
   - ➢ One glass break detectors to each glass window. (Glass windows are two to three in each corridor)

b) One to Three Relays based on requirement: connect to Light, Fan, and AC.

c) One Modbus Digital I/O module(Module No:i-7520) to connect sensors and relays.

d) Network Diagram: FIG 5.8 shows modbus n/w in corridor.

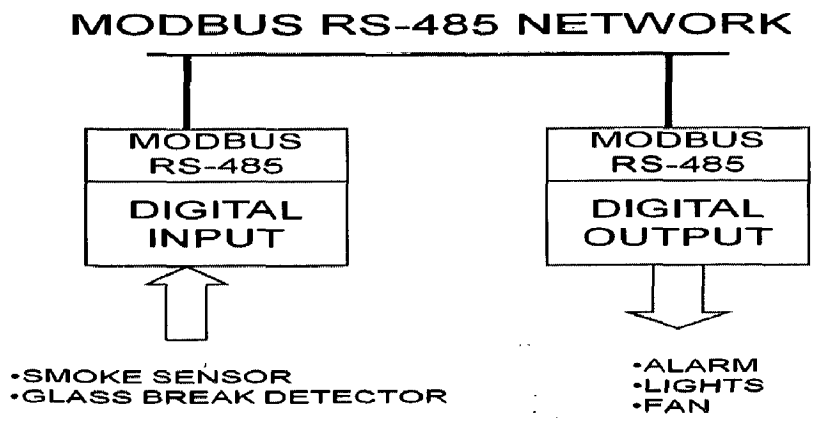


Fig 5.8 Modbus n/w in corridor

5.2.3 IN SINGLE LAWN

a) One to Three Relays based on requirement: connect to Lights, water Sprinklers, and

Fountain switch connections.

b) One Modbus Digital I/O module(Module No:i-7520) to connect relays.

c) Network Diagram: FIG 5.9 shows modbus n/w in lawn.

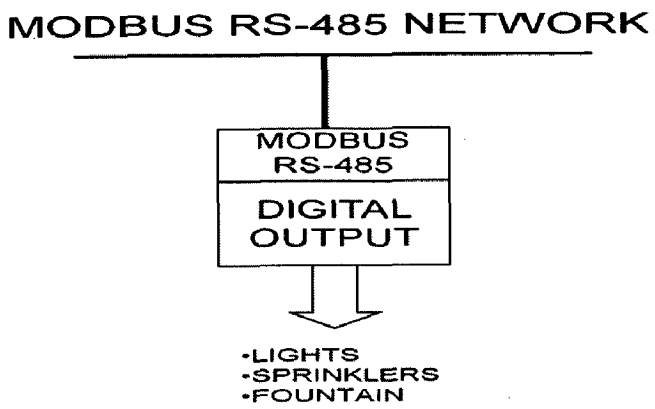


Fig 5.9 Modbus n/w in lawn

5.2.4 AT RECEPTION AND ENTRANCE:

a) To Place One IP Camera at Reception area, and another IP camera at Main Entrance of building.

b)Network Design: FIG 5.10 shows Ethernet LAN for IP camera

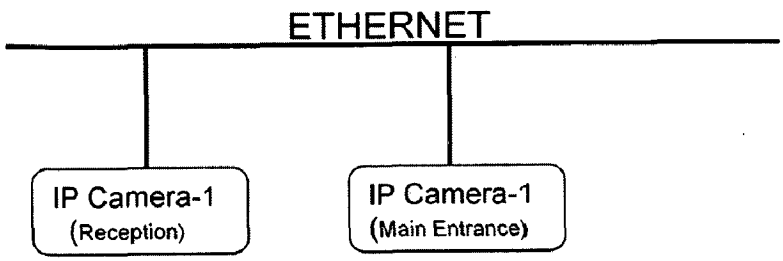


Fig 5.10 Ethernet lan for ip camera

5.3 HIERARCHAL NETWORK DESIGN:

The hierarchal distribution of modbus Rs-485 Network, Ethernet, WiFi and mobile network in GHB is shown in fig:5.11

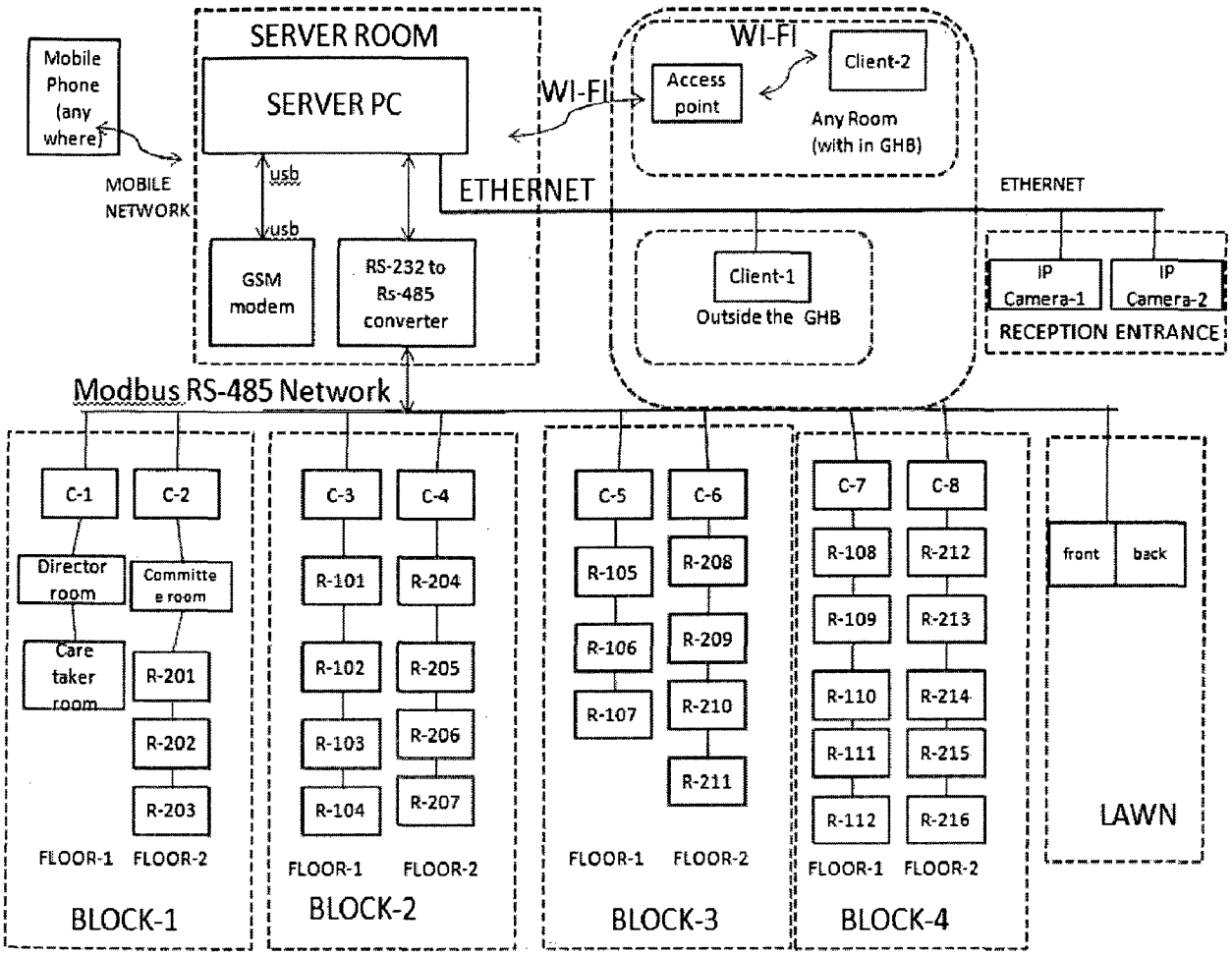


Fig 5.11 Hierarchal network design

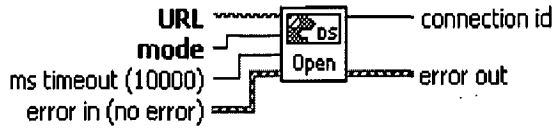
5.4 LABVIEW PROGRAMS

5.4.1 DATA ACQUISITION PROGRAM

i. Purpose: This program is used to acquire the data from five sensor inputs(smoke, glass break, motion, pet immune, Door) placed in a single room(say Room 101).

ii. Description: Some of main blocks used are data socket open and data socket read

a) Data socket Open block:



URL: Identifies the data source to read or data target to write. URLs begin with the name of the protocol you want to use to read or write the data, such as psp, dstp, opc, ftp, http, and file.

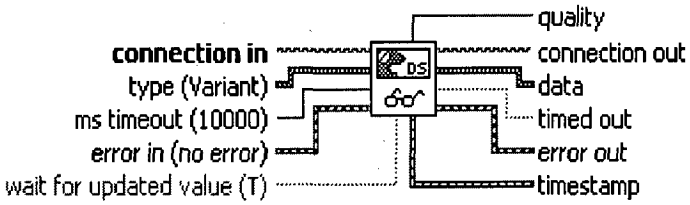
Mode: specifies the mode of the data connection (read, write)

connection id : uniquely identifies the data connection

error in describes error conditions that occur before this VI or function runs

error out contains error information

b) Data socket Read Block:



connection in identifies the data source to read.

type (Variant) specifies the type of data you want to read.

ms timeout specifies how long to wait for a value update to become available in the connection buffer

connection out is the data source that specifies the data connection.

data is the result of the read.

Fig 5.12 shows Algoithm and fig 5.13 shows block diagram for this program .

iii. Algorithm:

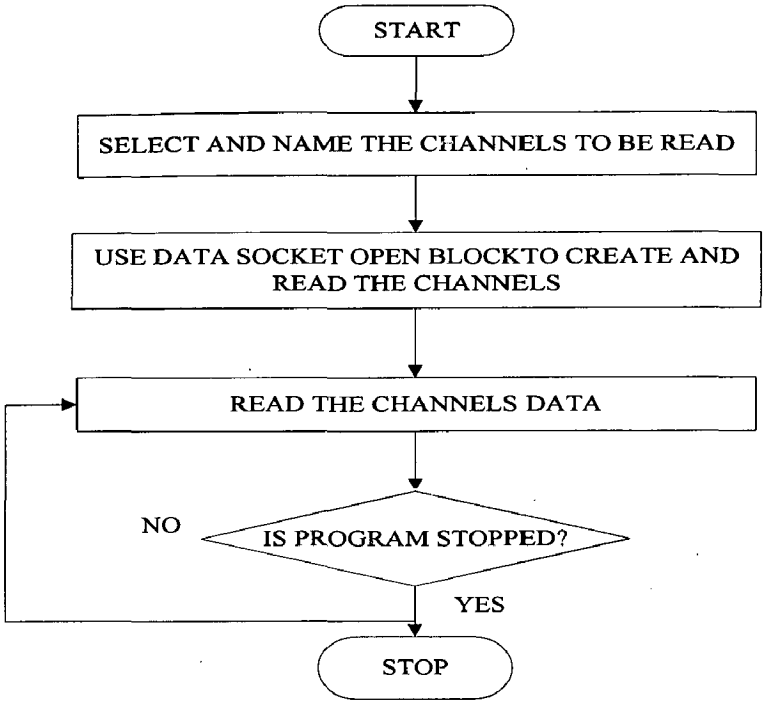


Fig 5.12 Algorithm for data acquisition

iv. LABVIEW PROGRAM BLOCK DIAGRAM

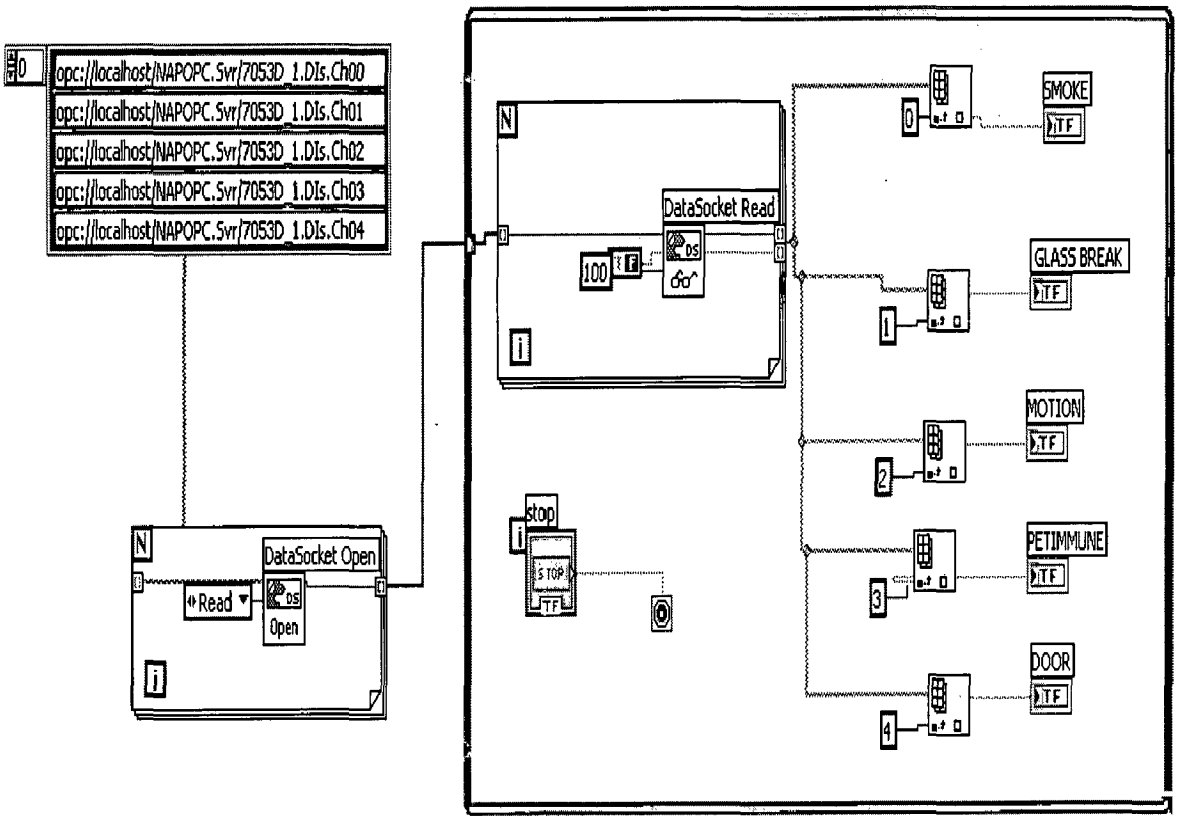


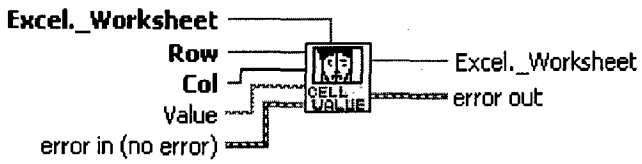
Fig 5.13 Block diagram for data acquisition

5.4.2 STATUS DISPLAY AND EXCELPROGRAM

i. Purpose: This program is used to display the event occurred in any input(i.e., any one of five sensor input value changed from '0' to '1' or '1' to '0' but here program is shown only for two inputs because of complexity in representation of program in single page) in front panel and also in excel sheet showing date/time and alarm message.

ii. Description: **Fig 5.15 shows Algorithm and fig 5.16 shows block diagram for this program** .Some of main blocks used are open Excel Application, Open Excel work book, Open Excel work sheet, Set Cell Value are shown in table 5.1.Actually these are labview pre defined subprograms(Sub VIs).

Table 5.1 : Status display and excel program subvi's

Sub VI's	Use
Open Excel and Make Visible.vi 	Opens Excel application object
Open New WorkBook.vi 	Opens new work book. It takes excel_application ref. no as input.
Open New WorkSheet.vi 	Opens new work sheet. Takes workbook ref. no as input.
Set Cell Value.vi 	Sets value at cell whose row and coloumn is specified.

iii. Algorithm:

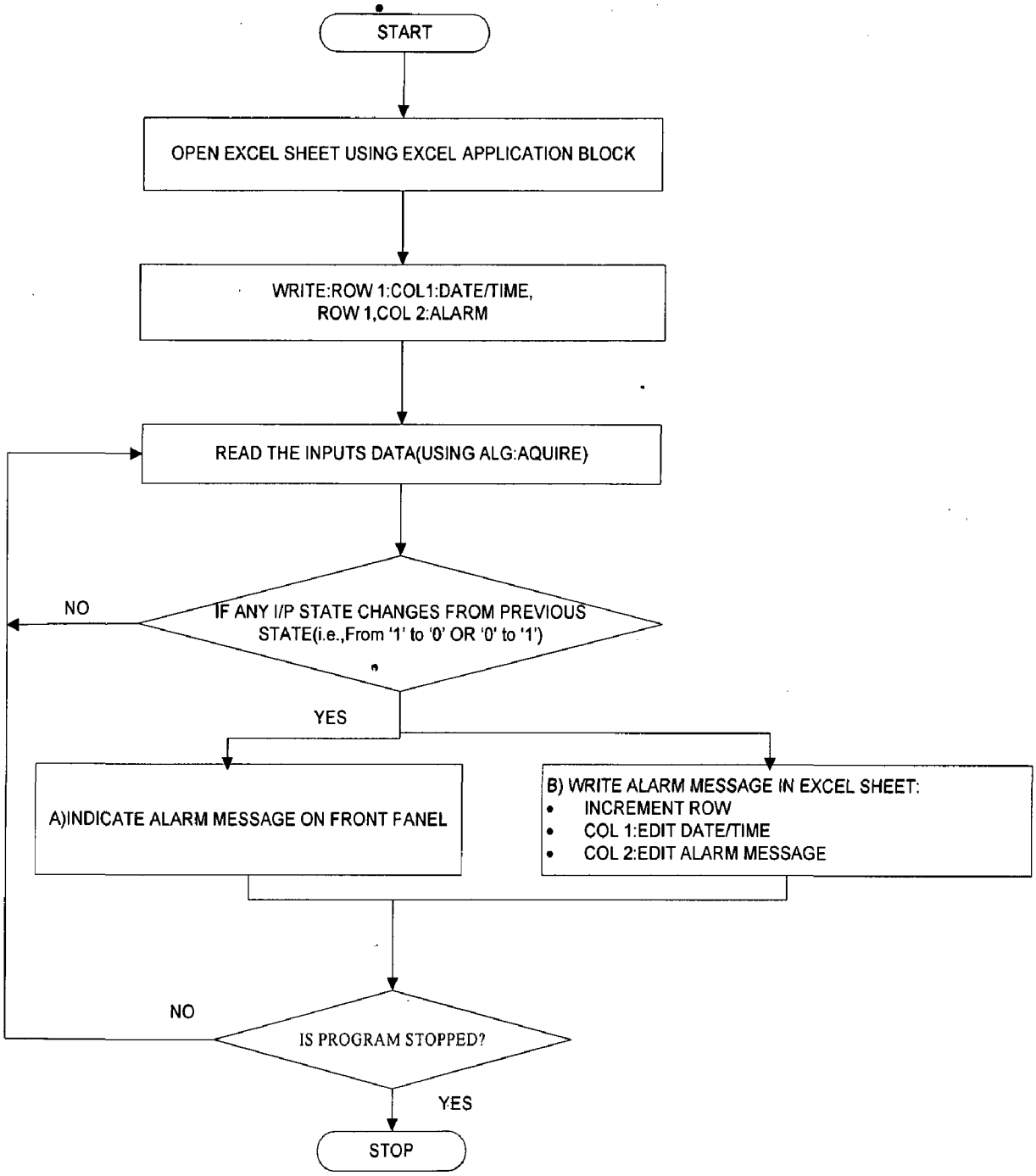


Fig 5.15: Algorithm for status display and excelprogram

iv. Labview program Block Diagram

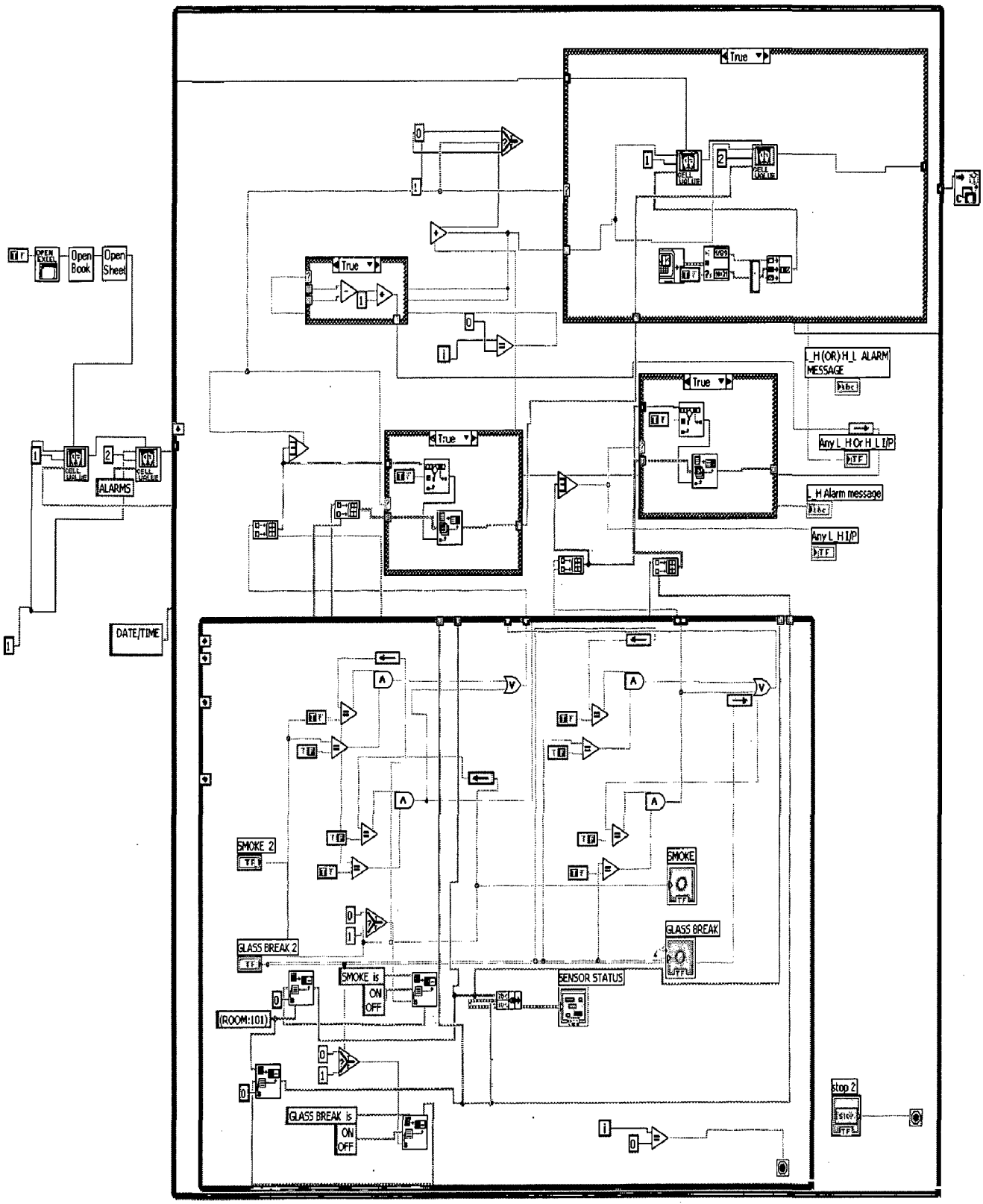


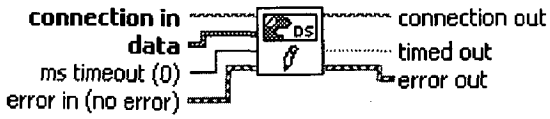
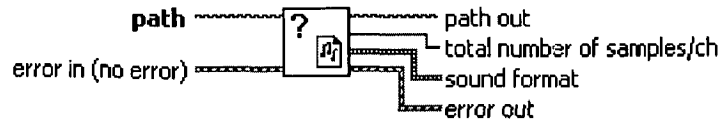
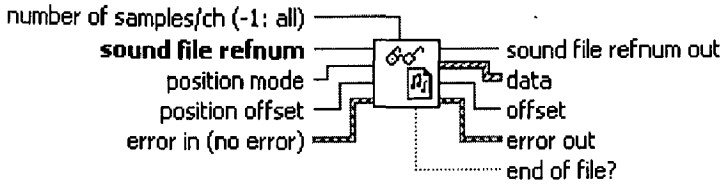
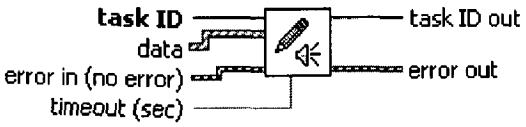
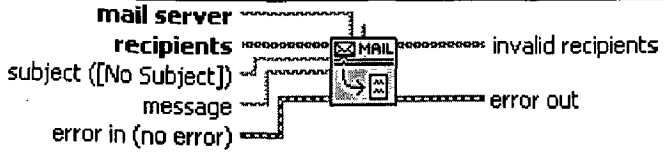
Fig 5.16: Block diagram for status display and excel program

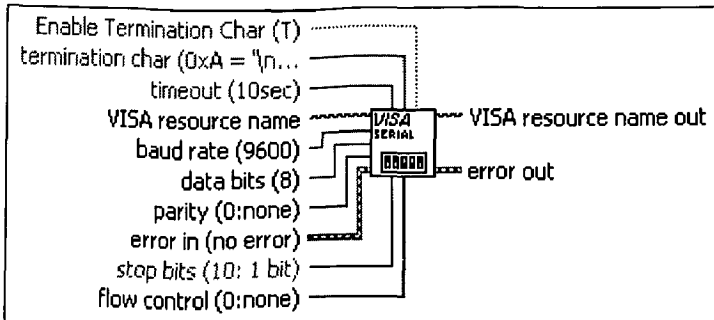
5.4.3 SEND ALARM,E-MAIL, AND SMS PROGRAM

i. Purpose: This program illustrates how to send an alarm to particular room and also indicate alarm to master through speaker sound signal, and how to send a E-mail , SMS if any high input event(i.e., if any input changes from '0' to '1' state).This program uses both programs as indicated in algrithm.

ii. Description: a)Some of main blocks or subVI's used are shown in table 5.2.

Table 5.2 :Send alarm,e-mail, and sms program

Blocks or subVI's	Program	Use
	Alarm in room	Writes data to the connection you specify in **connection in**
	Speaker Sound alarm	Retrieves data about a .wav file
	Speaker Sound alarm	Reads data from a .wav file into an array of waveforms.
	Speaker Sound alarm	Writes data to a sound output device.
	Send Email	Sends a text email to a list of recipients

	Send SMS	Initializes the serial port specified by **VISA resource name** to the specified settings
	Send SMS	Writes the data from **write buffer** to the device or interface specified by **VISA resource name**
	Control with Mobile SMS.	Reads specified no. of bytes from device specified by **VISA re- source name** & returns data in **read buffer**.

b) AT Commands:

AT commands are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at". AT commands can be tested in hyperterminal command window(start>All programs>Accessories>Communications >hyperterminal)Here are some of the tasks that can be done using AT commands with a GSM/GPRS modem or mobile phone:

- Get basic information about the mobile phone or GSM/GPRS modem. For example, name of manufacturer (AT+CGMI), model number (AT+CGMM), IMEI number (International Mobile Equipment Identity) (AT+CGSN) and software version (AT+CGMR).

- Get basic information about the subscriber. For example, MSISDN (AT+CNUM) and IMSI number (International Mobile Subscriber Identity) (AT+CIMI).
- Get the current status of the mobile phone or GSM/GPRS modem. For example, mobile phone activity status (AT+CPAS), mobile network registration status (AT+CREG), radio signal strength (AT+CSQ), battery charge level and battery charging status (AT+CBC).
- Establish a data connection or voice connection to a remote modem (ATD, ATA, etc).
- Send and receive fax (ATD, ATA, AT+F*).
- Send (AT+CMGS, AT+CMSS), read (AT+CMGR, AT+CMGL), write (AT+CMGW) or delete (AT+CMGD) SMS messages and obtain notifications of newly received SMS messages (AT+CNMI).
- Read (AT+CPBR), write (AT+CPBW) or search (AT+CPBF) phonebook entries.
- Perform security-related tasks, such as opening or closing facility locks (AT+CLCK), checking whether a facility is locked (AT+CLCK) and changing passwords (AT+CPWD).
- Control the presentation of result codes / error messages of AT commands. For example, you can control whether to enable certain error messages (AT+CMEE) and whether error messages should be displayed in numeric format or verbose format (AT+CMEE=1 or AT+CMEE=2).
- Get or change the configurations of the mobile phone or GSM/GPRS modem. For example, change the GSM network (AT+COPS), bearer service type (AT+CBST), radio link protocol parameters (AT+CRLP), SMS center address (AT+CSCA) and storage of SMS messages (AT+CPMS).
- Save and restore configurations of the mobile phone or GSM/GPRS modem. For example, save (AT+CSAS) and restore (AT+CRES) settings related to SMS messaging such as the SMS center address.

Note that mobile phone manufacturers usually do not implement all AT commands, command parameters and parameter values in their mobile phones. Also, the behavior of the implemented AT commands may be different from that defined in the standard.

Commands used in send SMS Program:

- AT+CMGF=1: To keep modem in SMS message mode.
- AT+CMGS : To send message to mobile number specified.

Fig 5.17 shows Algoithm and fig 5.18,5.19,5.20,5.21shows block diagram for the send alarm,send speaker alarm,send email and send SMS program respectively.

iii. Algorithm

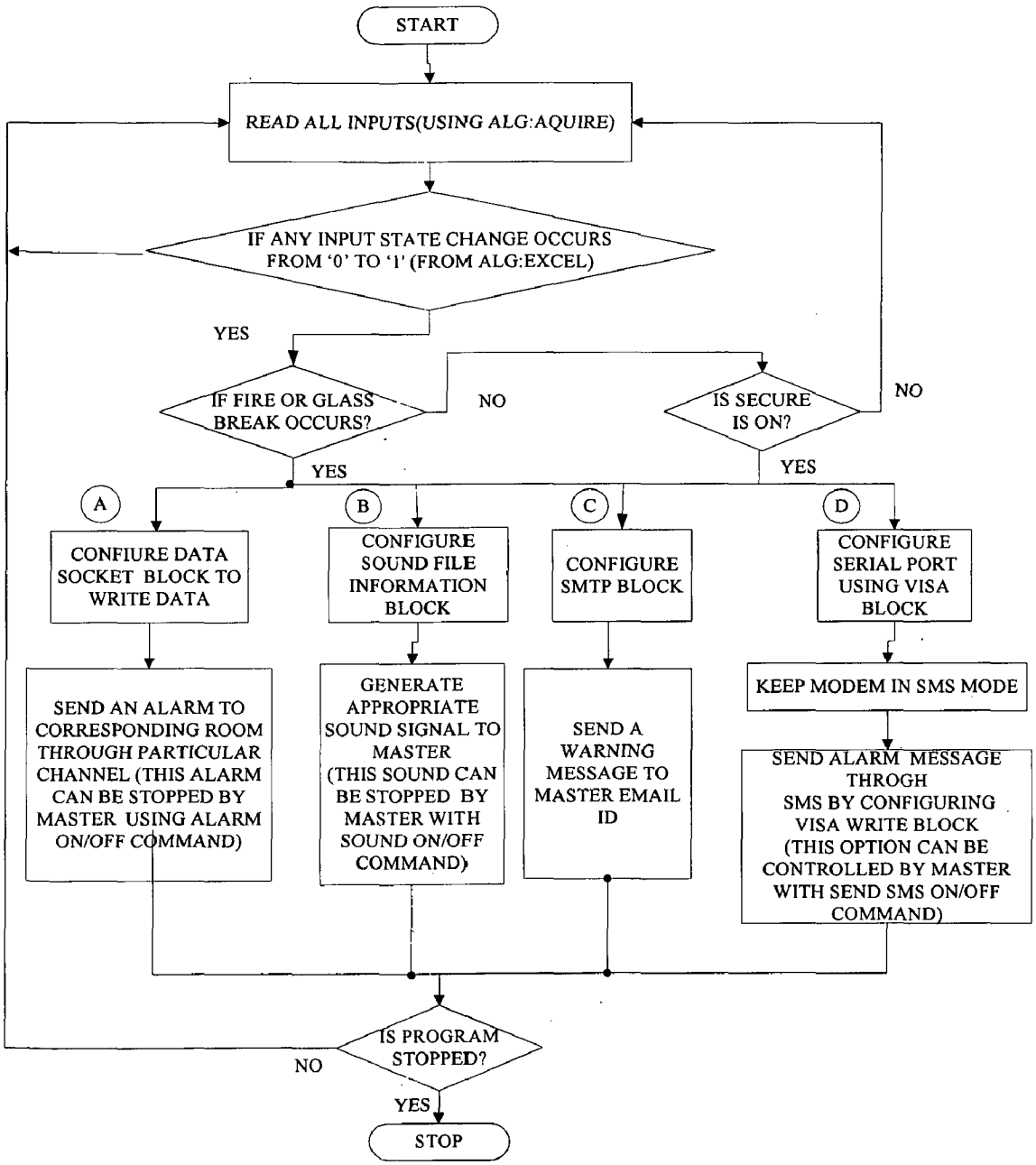


Fig 5.17: Algorithm for send alarm,e-mail, and sms program

iv. Labview programs block diagram

A. Block diagram to send an Alarm

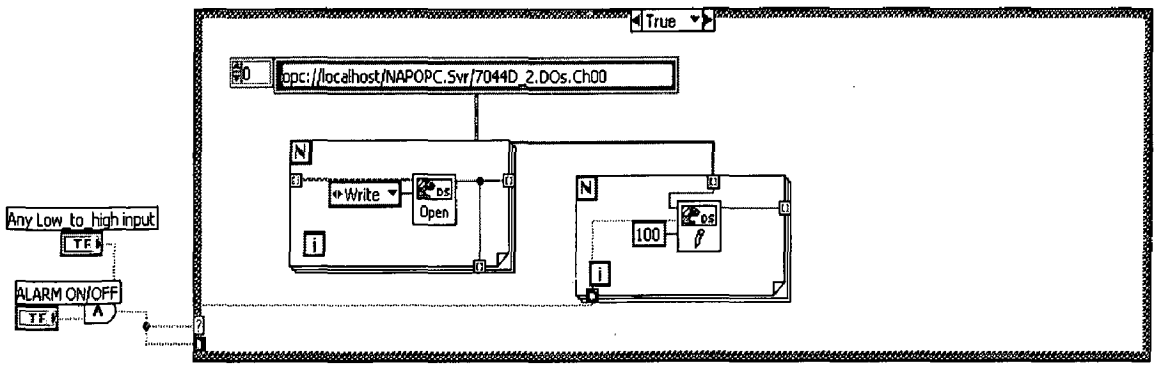


Fig 5.18: Block diagram for send alarm program

B. Block diagram to play speaker sound signal to master

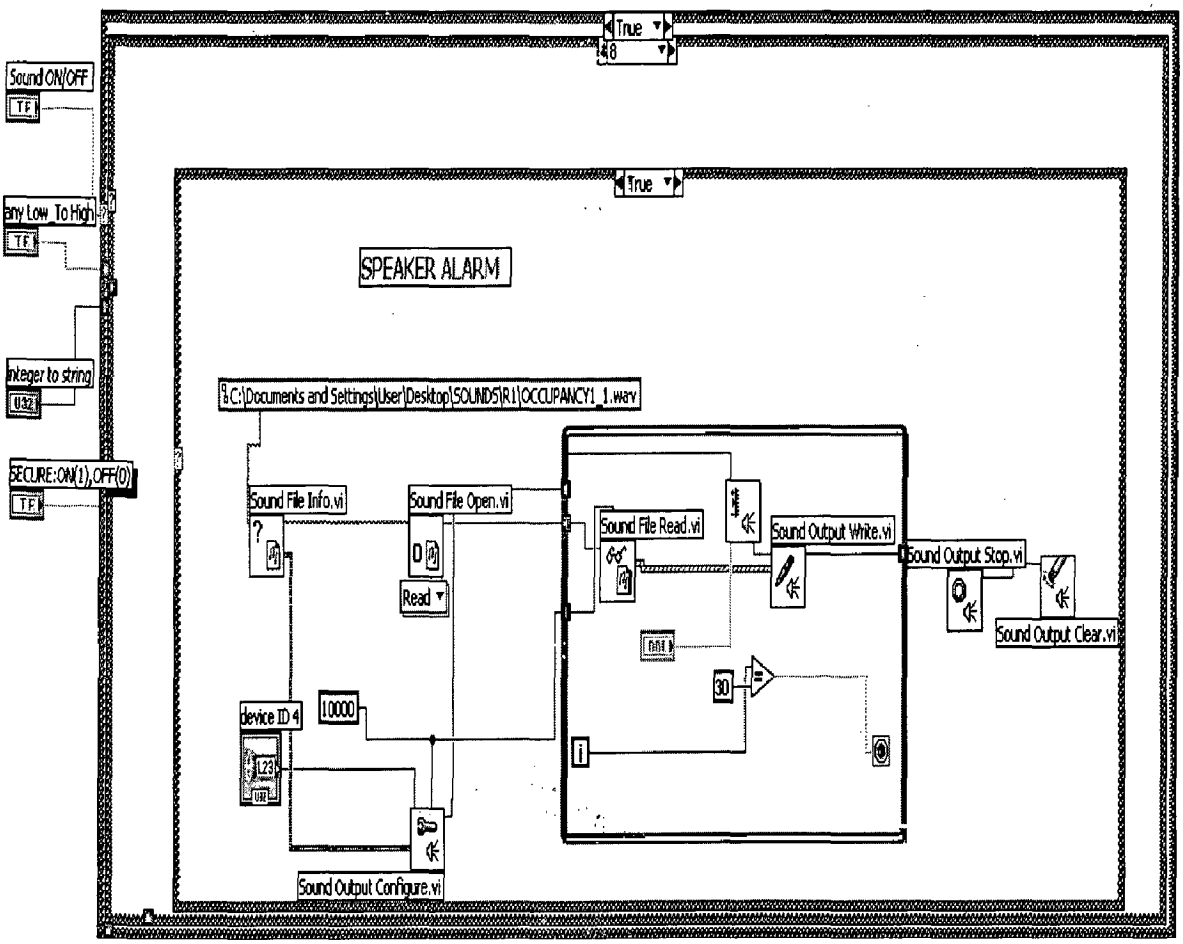


Fig 5.19: Block diagram to send speaker program

C. Block diagram to send E-Mail to master email id.

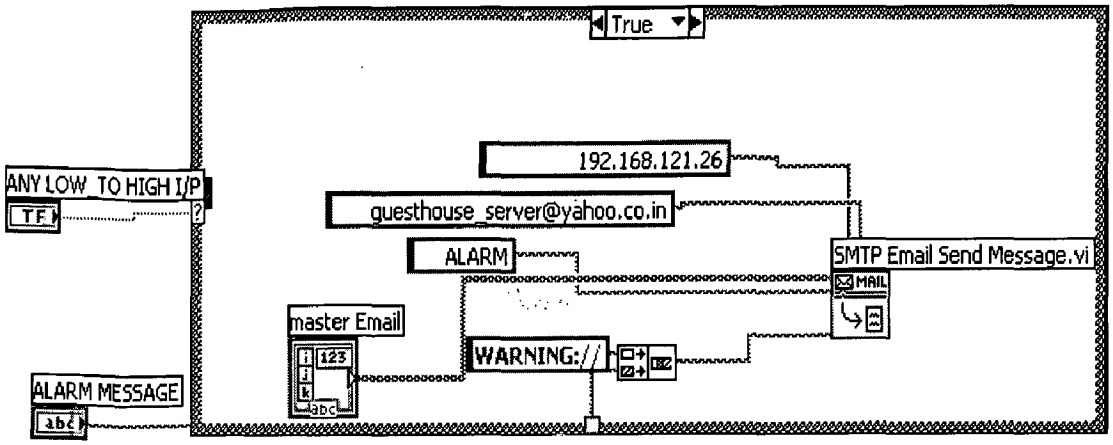


Fig 5.20:Block diagram for send e-mail program

D. Block diagram To send SMS to master mobile

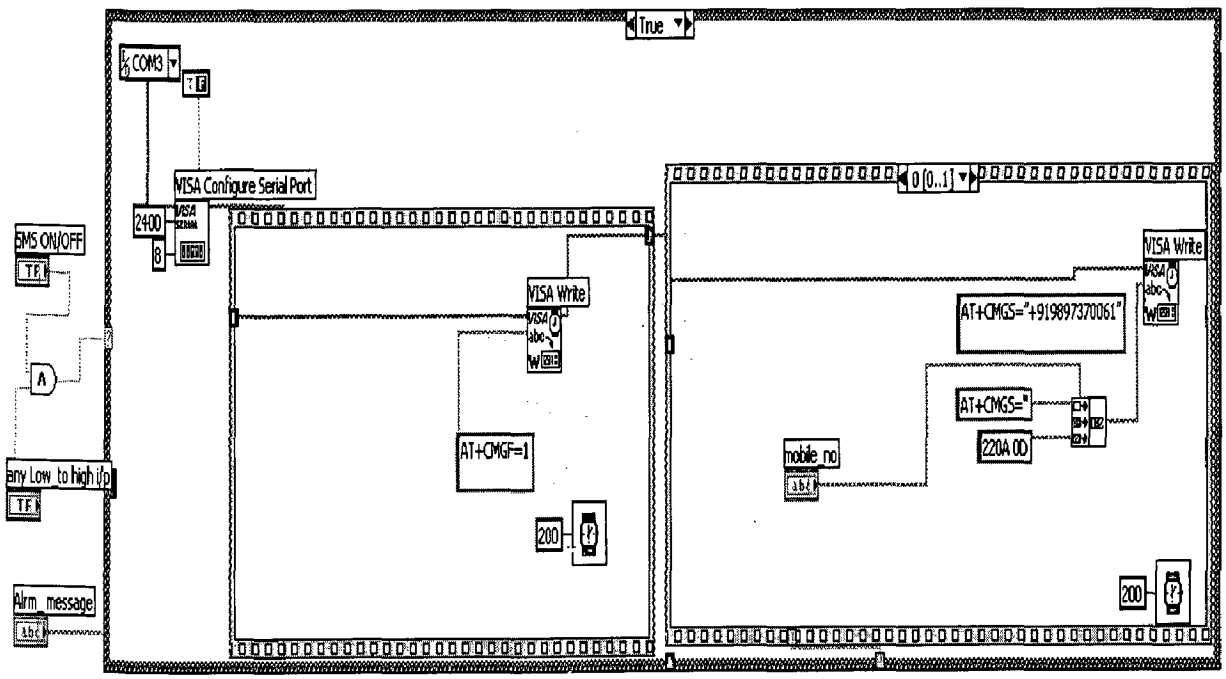


Fig 5.21: Block diagram for send sms program

5.4.4. TO CONTROL OF APPLIANCES IN A ROOM

i. Purpose: This program illustrates how to control each appliance in single room through commands sent by master through computer.

ii. Description : The main blocks used are Data socket open and Data socket Write block as shown in table 5.2.

Fig 5.22 shows Algoithm and fig 5.24 shows block diagram for this program

iii. Algorithm :

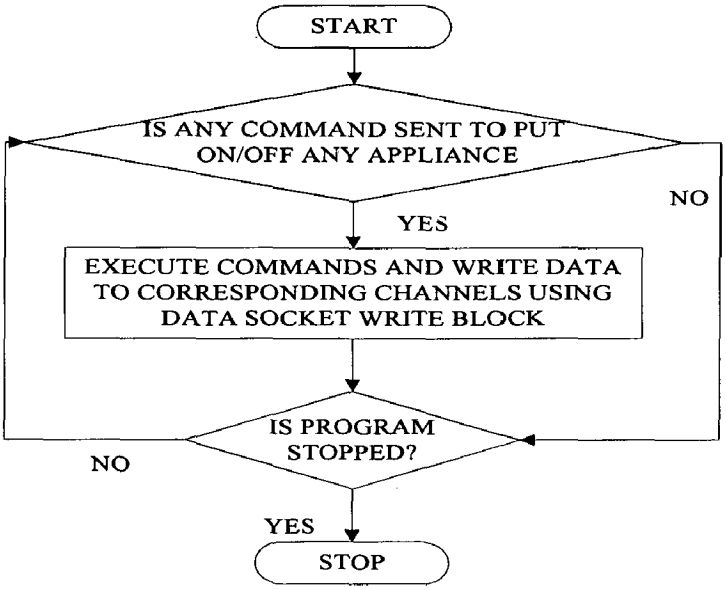


Fig 5.22 Algorithm to control of appliances in a room

iv. Labview program block diagram

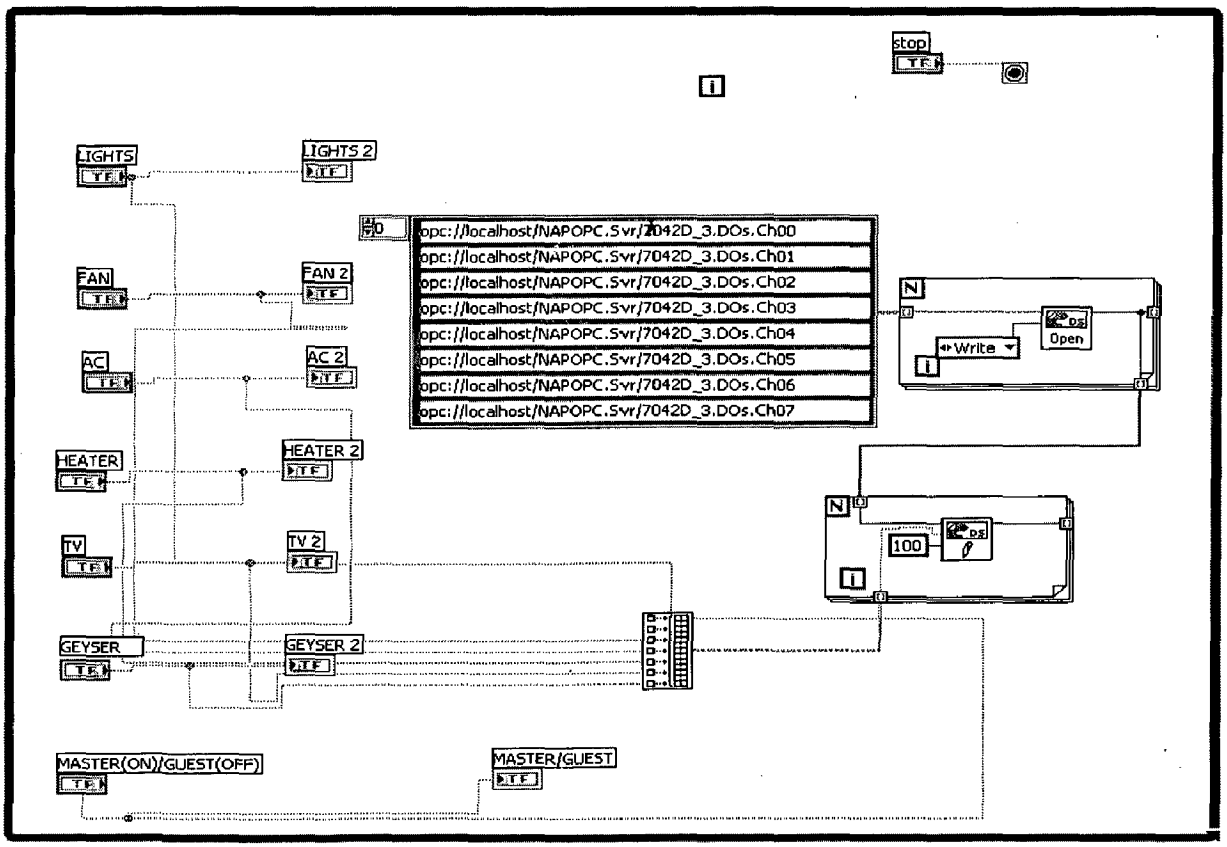


Fig 5.22 Block diagram to control of appliances in a room

5.4.5. TO CONTROL OF APPLIANCES IN A ROOM USING SMS COMMAND

i. Purpose: This program illustrates for controlling of electric appliance in room by sending SMS commands by master through a mobile.

ii. Description : This type of programming is can be written in microcontroller [35].Master

Can send commands via Bluetooth also[36].

a)The main blocks used are Visa configuration ,Visa Read ,and Visa write block as specified in table:

b) Master should send specific SMS to GSM Modem to operate specific function .

SMS : NXY, where N=Room No, X=L(Lights)/ F (Fan)/ A(AC) /H(Heater)/T(TV)/G(Geyser)/E (Everyappliance); Y=N (ON)/ F(OFF).

Eg., To put ON geyser in Room 101, SMS: 101GN.

c) Commands used in send SMS Program :

- AT+CMGF=1: To keep modem in SMS message mode.
- AT+CNMI: To acknowledge to PC if any new SMS comes to Modem.
- AT+CMGR: To read the SMS stored at particular location in Modem Memory.

The fig 5.23 and 5.24 shows the algorithm and block diagram for this program respectively.

iii. Algorithm

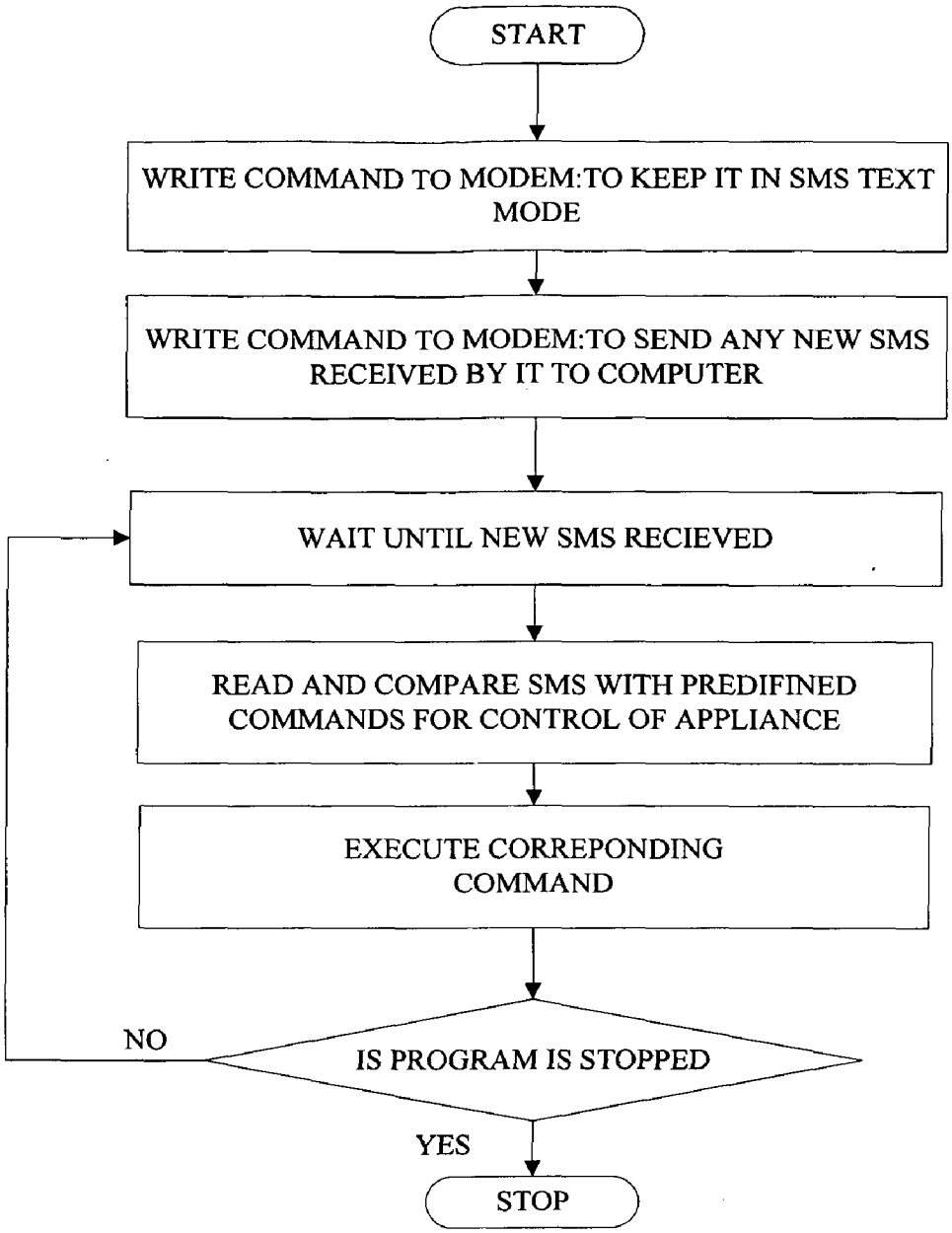


Fig 5.23 Algorithm to control of appliances in a room using sms command

iv. Labview program block diagram

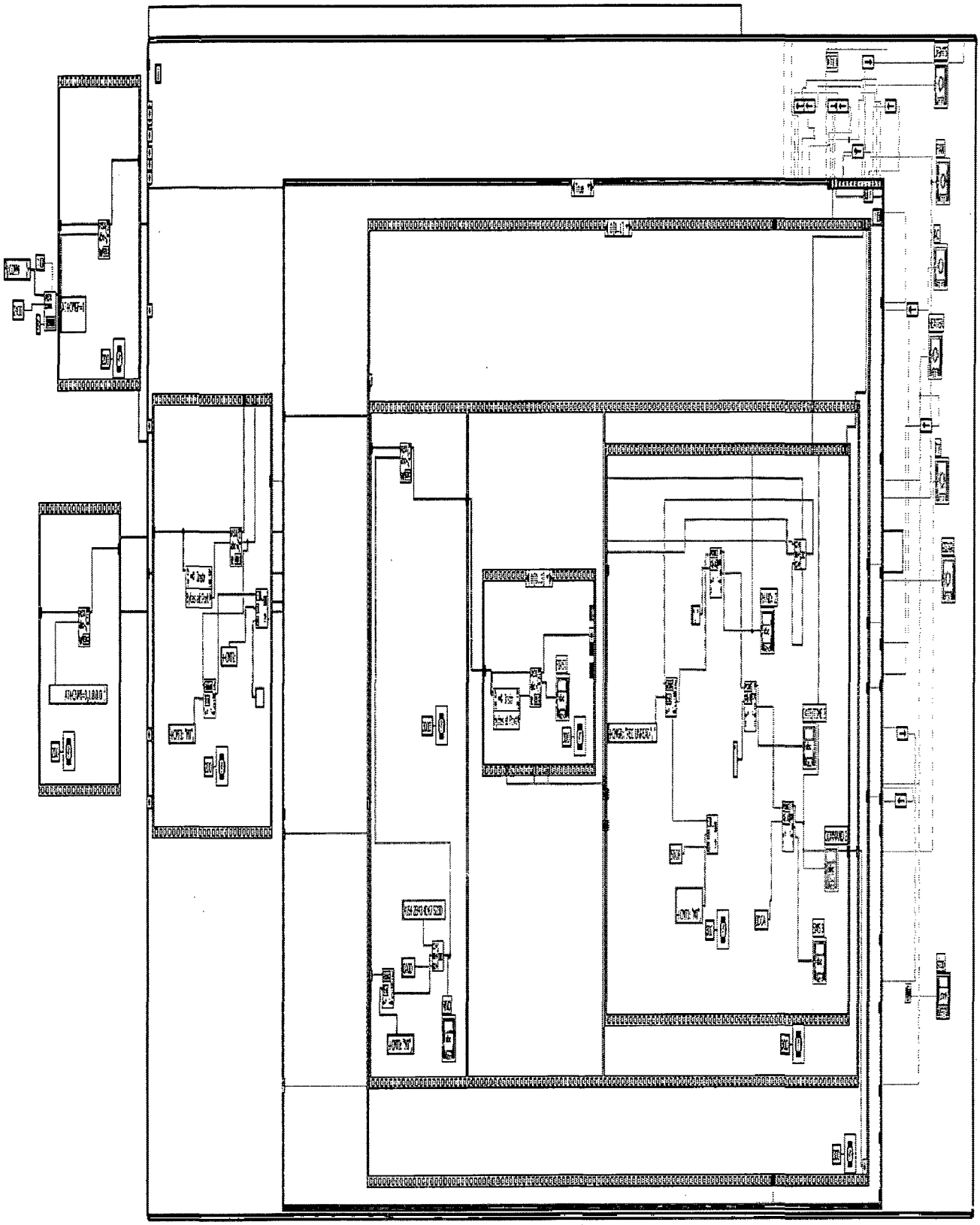


Fig 5.24 Block diagram to control of appliances in a room using sms command

5.4.6. CONTROL OF LAWN LIGHTS USING MASTER OR TIMEBASED CONTROL

i. Purpose: This program illustrates how to control lawn lights according to time based command or master commands.

ii. Description :Here Master should specify the date and time options if lights has to be controlled on time basis. Graphical representation for time based option is shown in fig 5.24,Where D1=Starting Date 1, D2= Ending Date 1, D3= Starting Date 2, D2= Ending Date 2,t1=Starting Time 1, t2= Ending time 1, t3= Starting time 2, t2= Ending time 2.

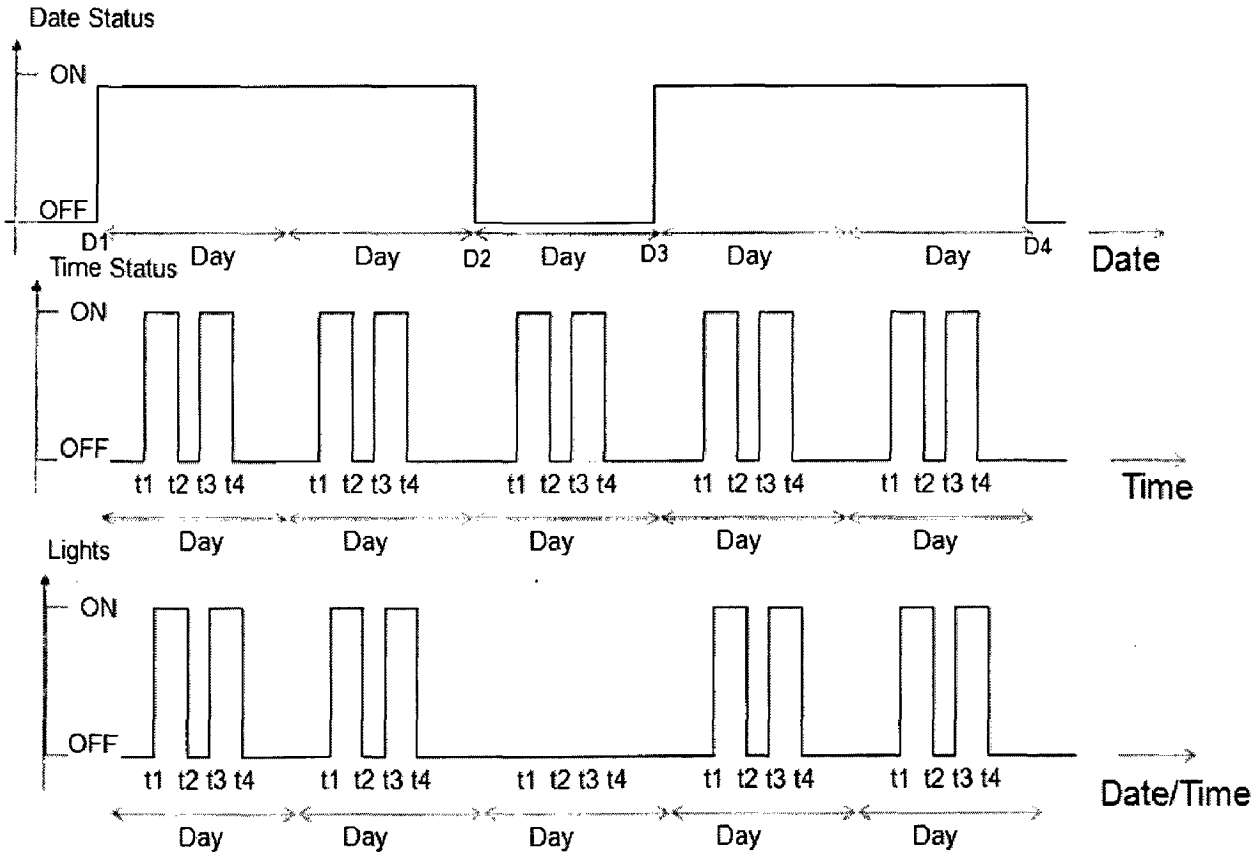


Fig 5.24 : Timebased control of lawn lights

The fig 5.25 and 5.26 shows the algorithm and block diagram for this program respectively.

iii. Algorithm

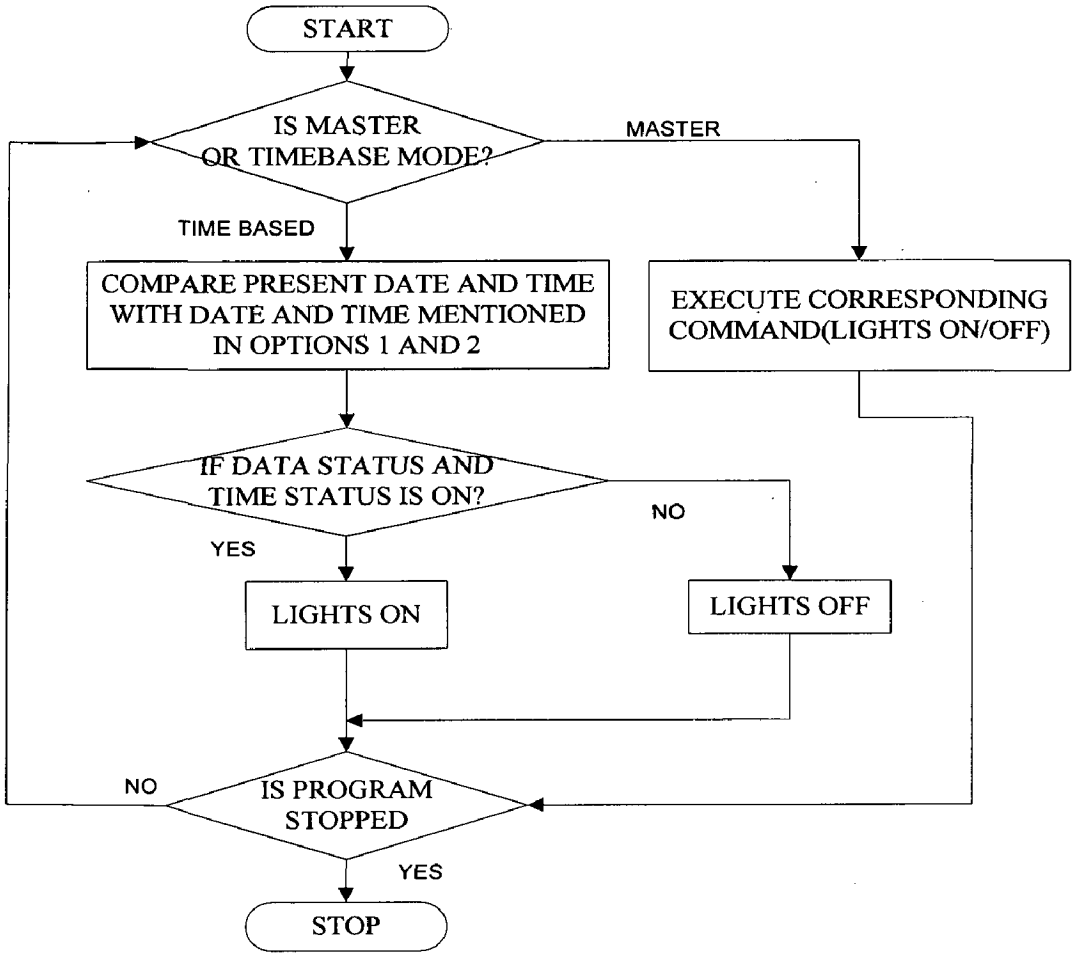


Fig 5.25 :Algorithm for control of lawn lights timebased control

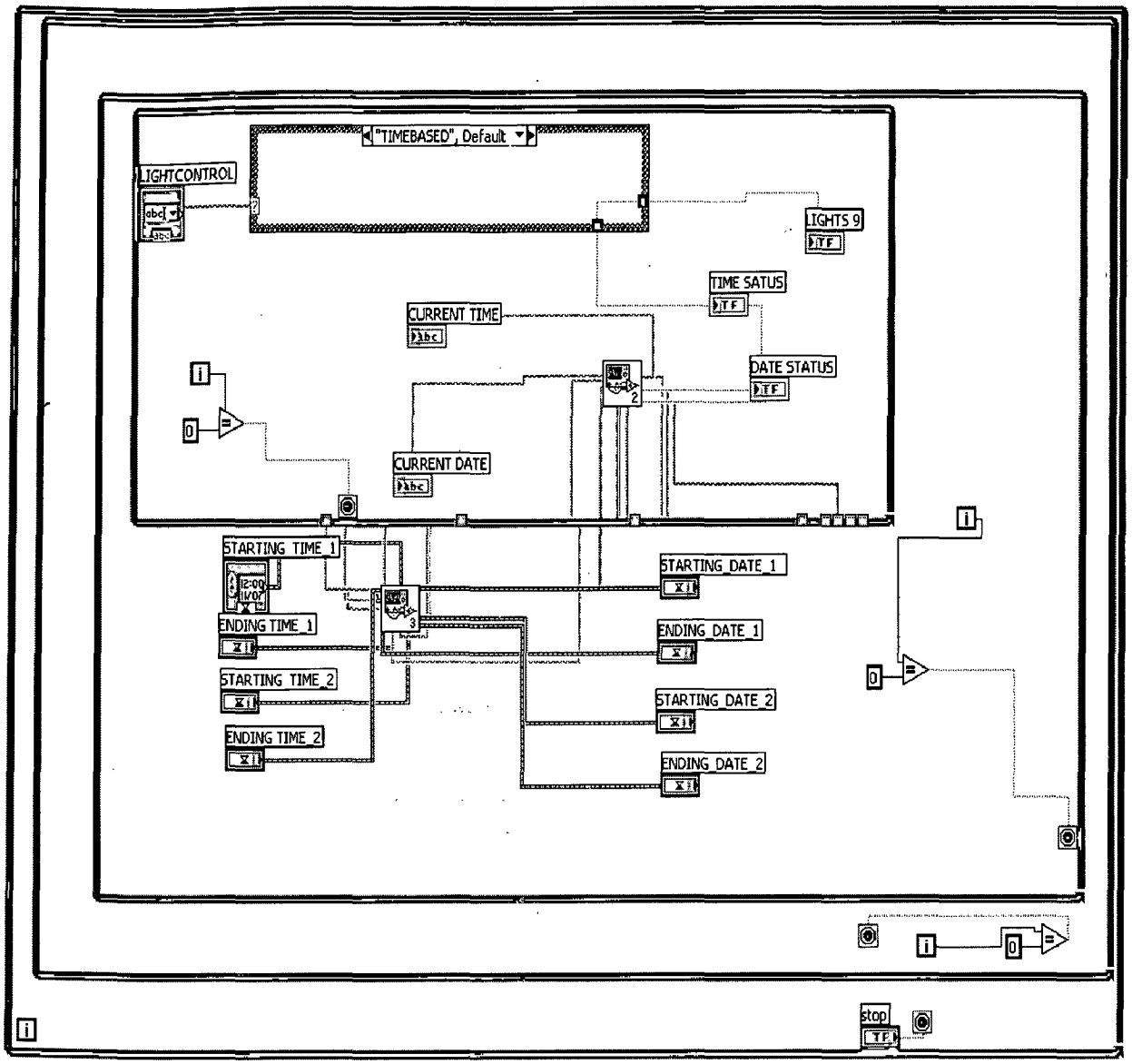


Fig 5.26 :Block diagram for control of lawn lights timebased control

5.4.7 MAIN PROGRAM:

The main program is written with the help of all the programs described previously(5.4.1 to 5.4.6) and block diagram of program is shown in fig 5.27.The main program is written for to monitor two rooms(R-101,R-102,), two corridors(C-1,C-2),to control two rooms, two corridors, Lawn (front,Back),to produce events (alarms ,commands) on excel sheet.This program can be easily extended to all rooms ,corridors and lawns with repetition of subprograms.

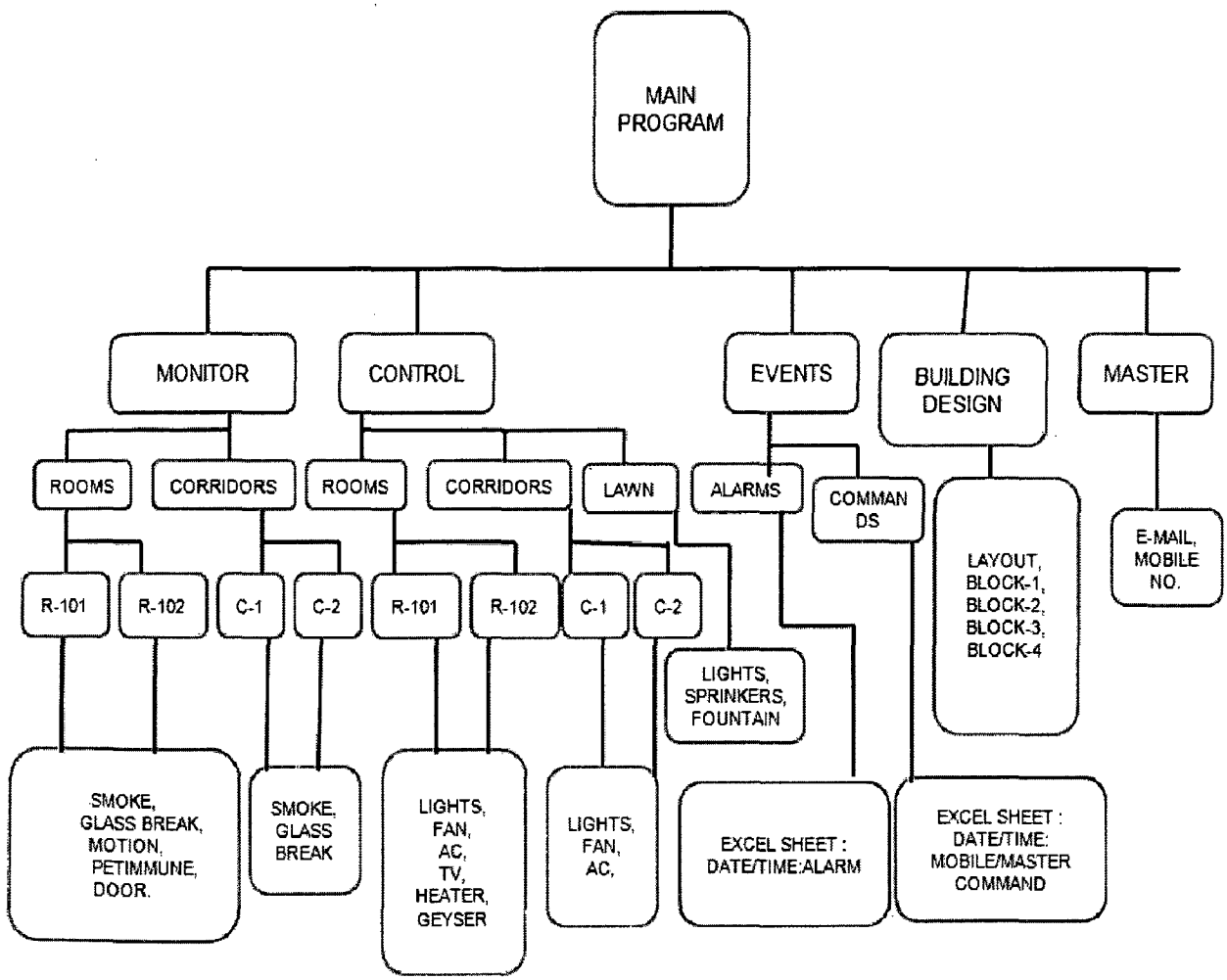


Fig 5.27 : Main program functions

5.5 REMOTE MONITORING AND CONTROL

5.5.1: BASIC CLIENT SERVER MODEL

The basic client –server model with server connected to clients through Ethernet and WIFI is shown in fig 5.28.

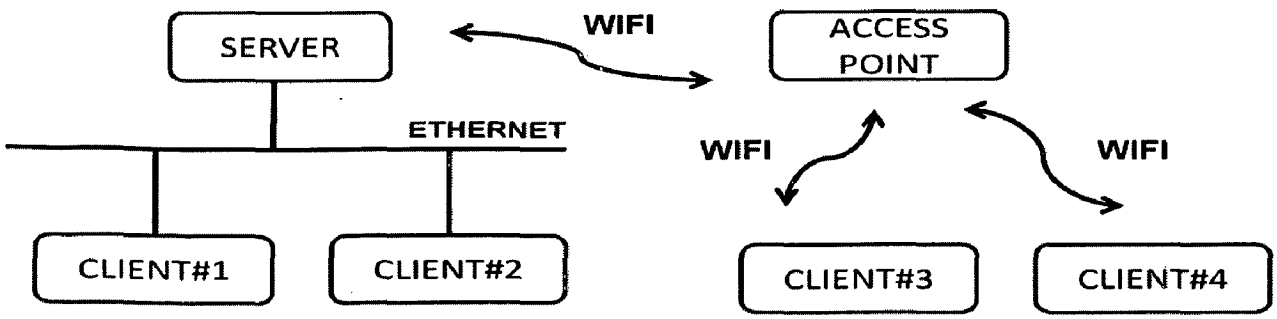


Fig 5.28: Block diagram for basic client server model

5.5.2 CONFIGURATION SETTINGS

We can view and control a VI front panel remotely, either from LabVIEW or from Web browser, by connecting to the LabVIEW built-in Web Server. When we open a front panel remotely from a client, the Web Server sends the front panel to the client, but the block diagram and all the subVIs remain on the server computer. we can interact with the front panel in the same way as if the VI were running on the client, except the block diagram executes on the server.

i. Web server Configuration tool to set URL:

In order to set the front panel address, i.e to configure URL(Uniform Resource Locator) to view and control on remote PC,the Web server Configuration tool is shown in fig 5.29.

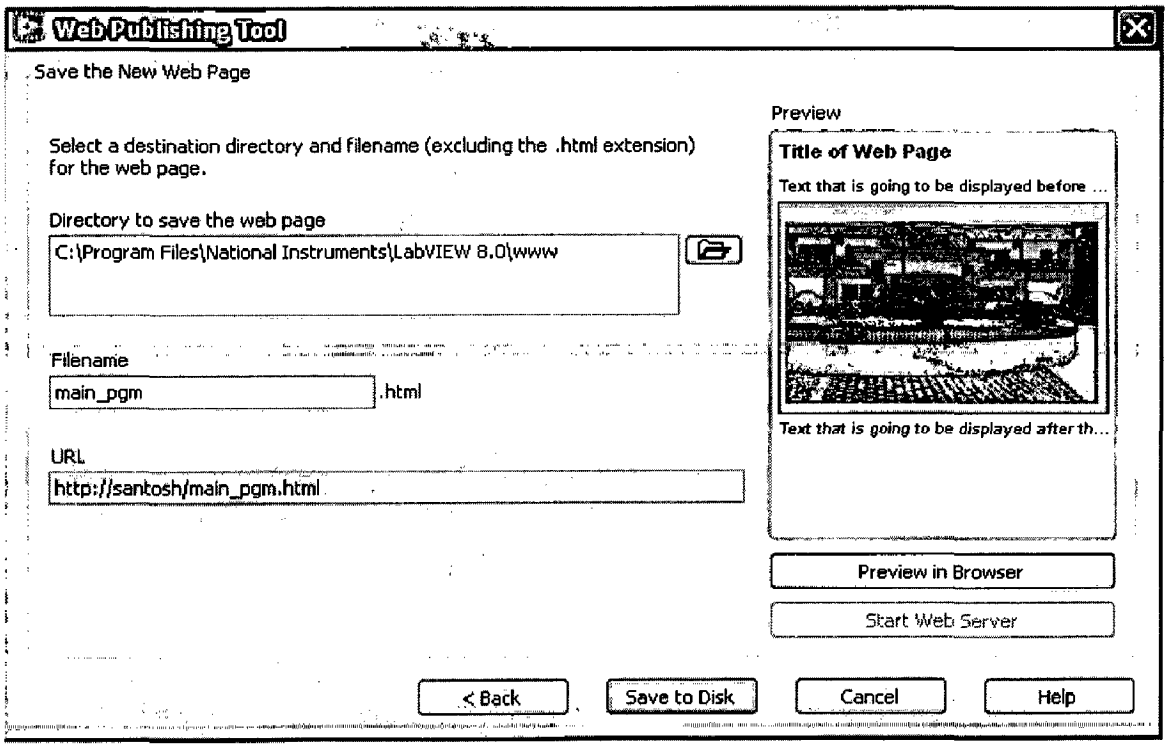


Fig 5.29 Web server configuration tool

ii. Time allocation to client:

To set a time limit on how long a remote client can control a VI, when multiple clients are waiting to control the VI.The window to set time allocation to client is shown in fig 5.30.

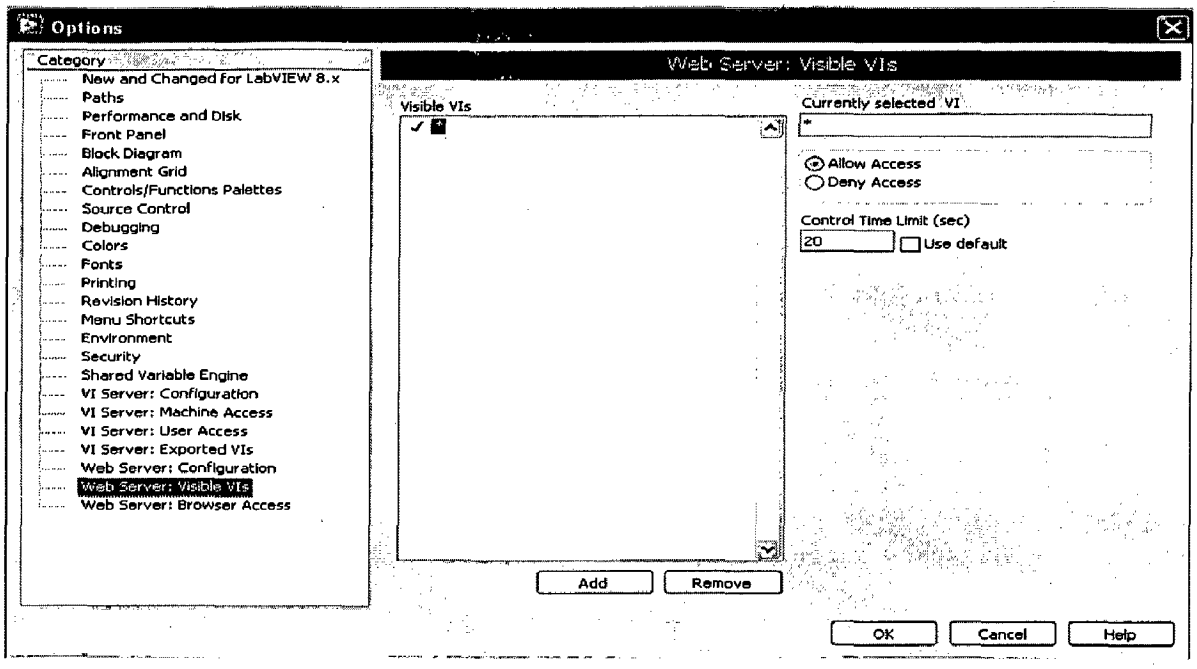


Fig 5.30 Time allocation to client

iii. Important Points Observed

a. All clients and server can monitor any VI front panel.

b. The Web Server allows multiple clients to connect simultaneously to the same front panel, but only one client at a time can control the front panel.

c. Any Client wants to control the Front Panel then It has to send request to server.

d. Any client can control front panel once front panel is under that client control.

e. At any time Server can regain the control to itself from any client.

f. Requirement of Client is Labview run time engine.

5.6 LABORATORY SET UP FOR MAIN PROGRAM : Fig 5.31 shows Laboratory set up for main program as shown in 5.27.The laboratory set up consists of server PC, Digital input module(i-7053D),Digital output Module(i-7042D),Digital I/O Module (i-7044D),RS 232-485 Module(i-7520), Phee net IP Camera,GSM modem, Sensors ,and Digital output indicators (LED's is used).

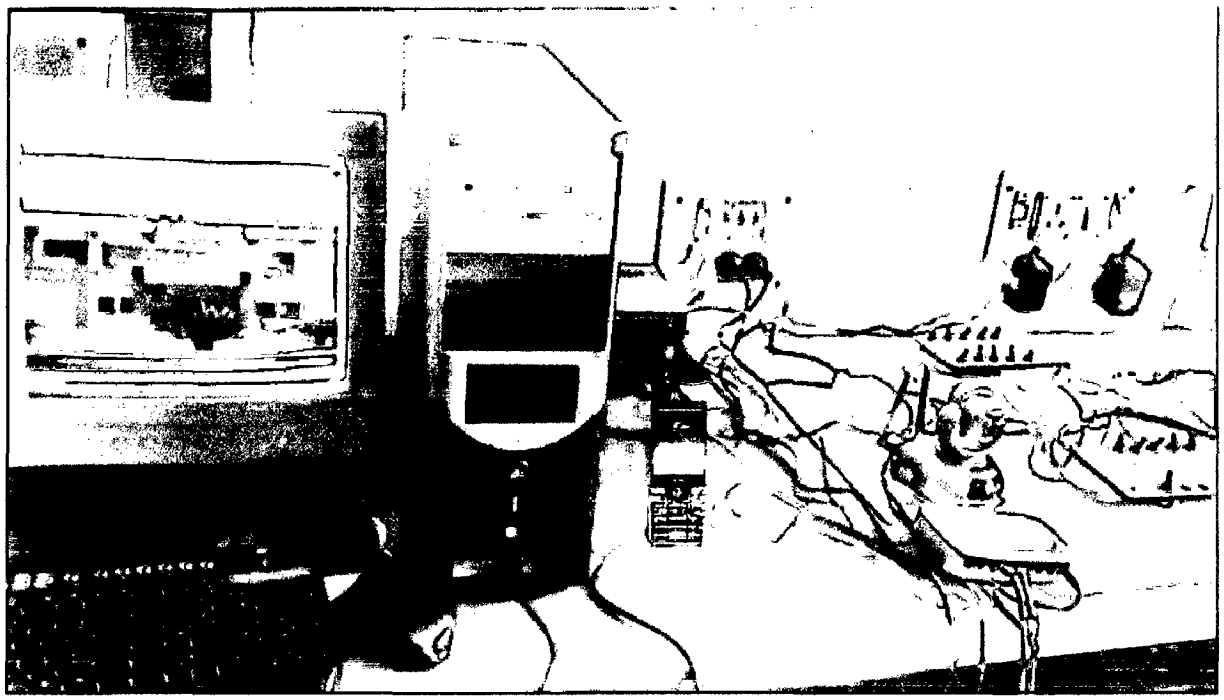


Fig 5.31: Laboratory set up for main program

RESULTS

Following results consists of front panels for programs written in chapter 5.

6.1 FRONT PANELS FOR SUBPROGRAM

a) Fig 6.1 shows Labview front panel for aquire program shown in fig:5.13.The front panel shows whether any sensor is ON/OFF indications.

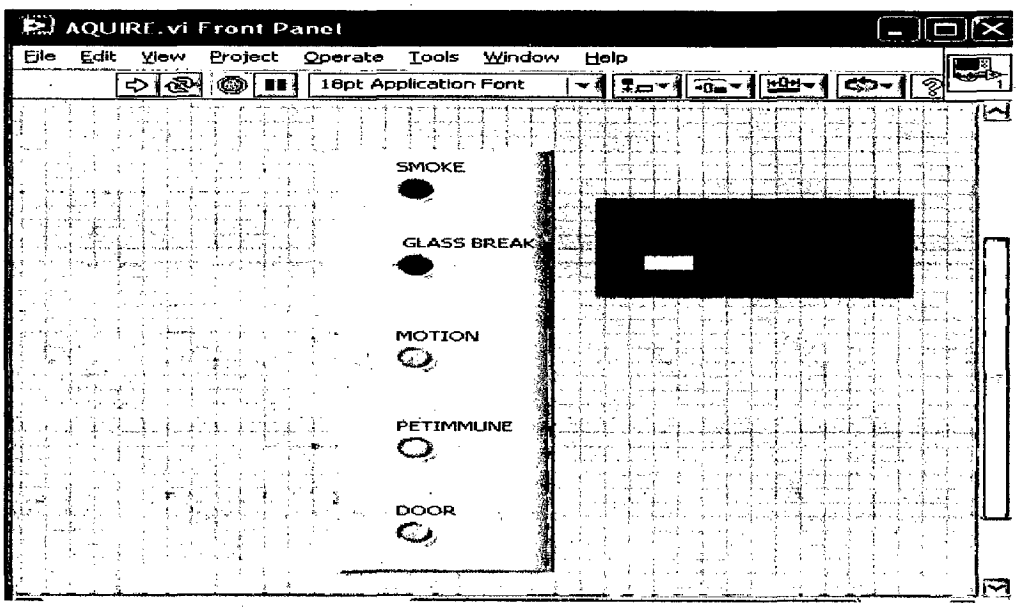


Fig 6.1: Labview front panel for aquire program

b) Fig 6.2 shows Labview front panel for status and excel program shown in fig 5.16.It shows sensor status information .Fig 6.3 shows sensor status information on excel sheet.

i)Front Panel: It shows sensor Status display.

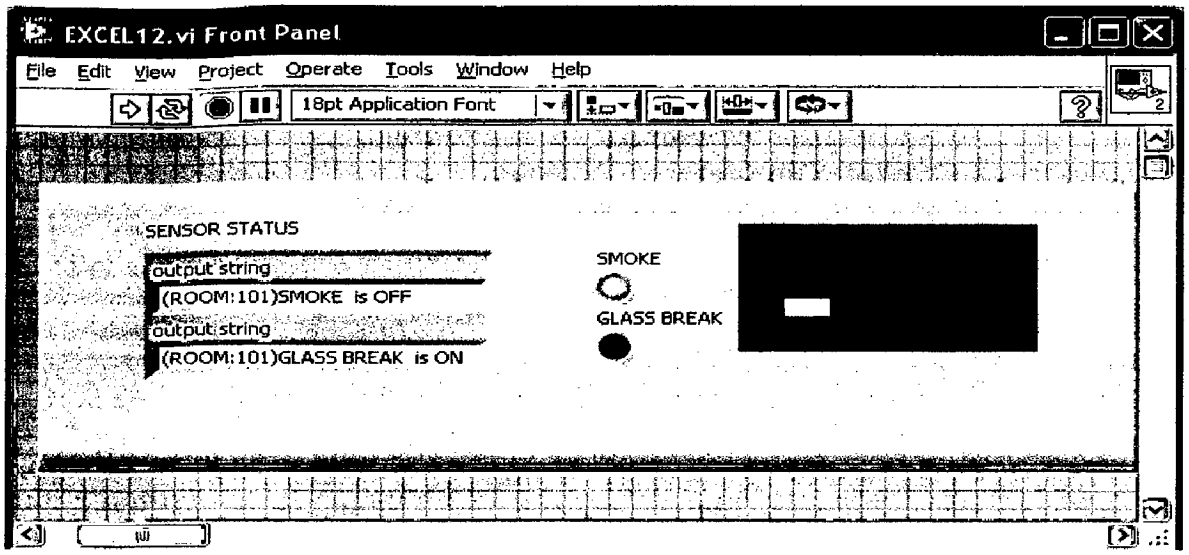


Fig 6.2 : Labview front panel for status program

ii) EXCEL SHEET INFORMATION: Senors status is recorded in excel sheet.

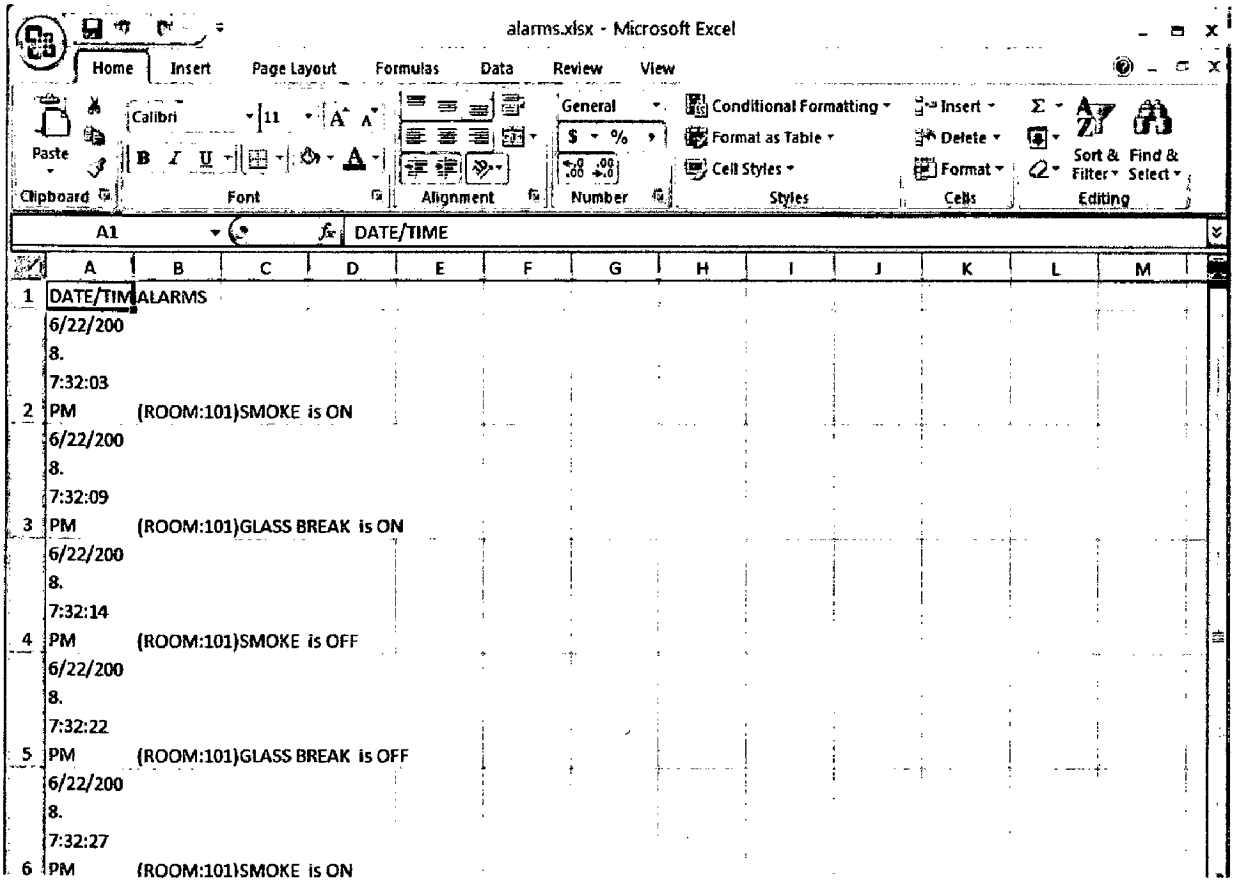


Fig 6.3 : Sensor status information on excel sheet for status program

c) Fig 6.4 shows Labview front panel for room alarm program shown in fig 5.18.It shows whether any sensor status changed from low to high , sends alarm in that room if any event occurs and has alarm control input to put off alarm.

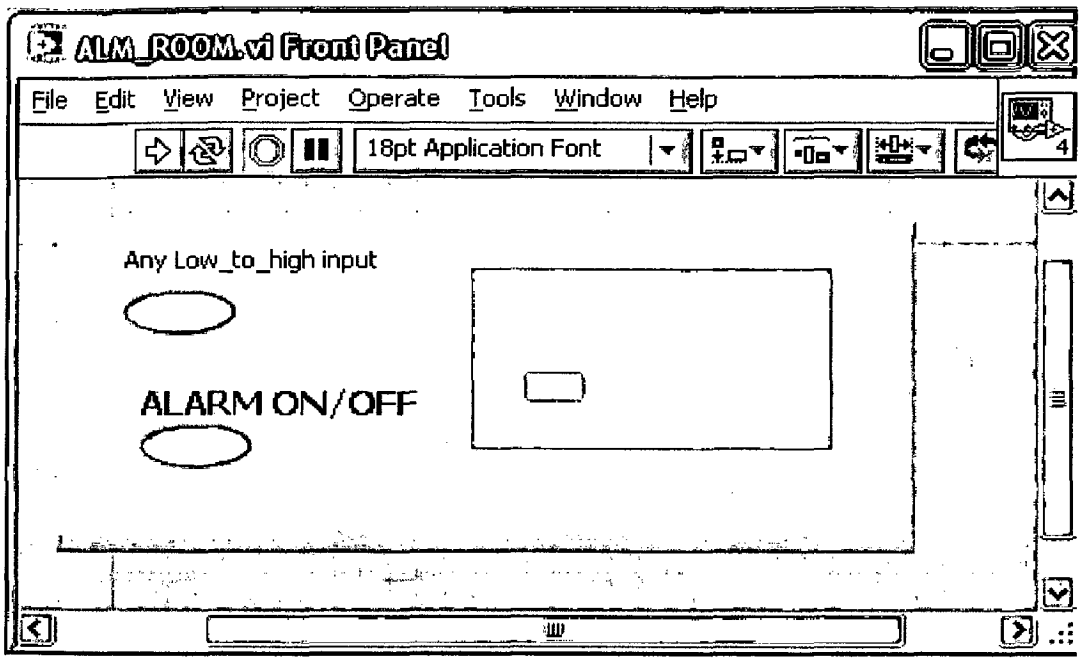


Fig 6.4: Labview front panel for room alarm program

d) Fig 6.5 shows Labview front panel for speaker sound program shown in fig 5.19.Here the sound control is provided to put Off the alarm.

i)Front panel:

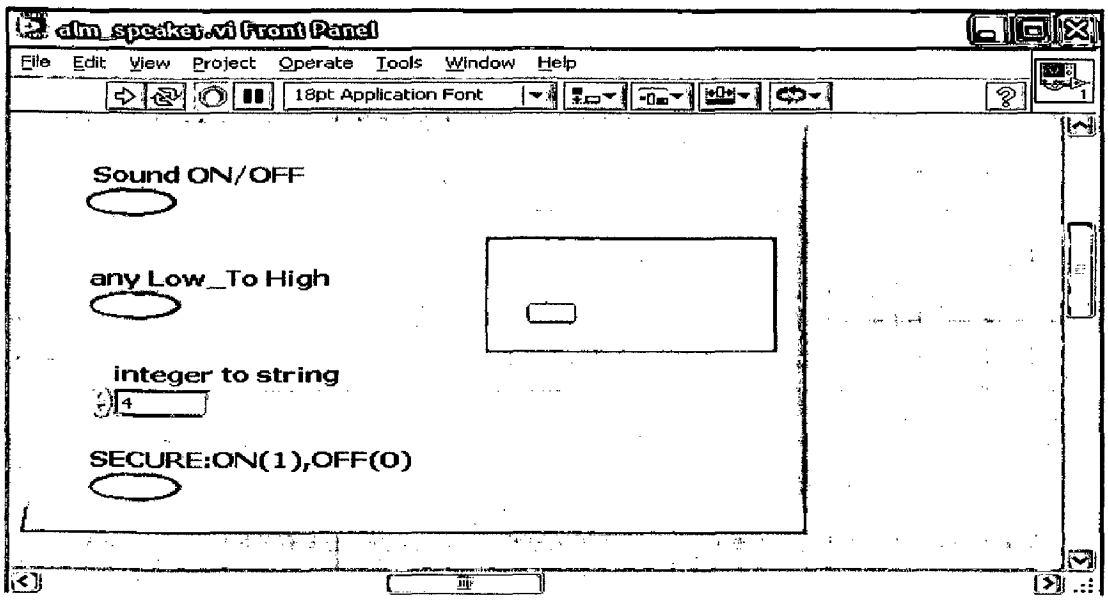


Fig 6.5 Labview front panel for speaker sound program

ii) Plays Sound:

- It plays Pre recorded voice message like reading "SMOKE OCCURRED IN ROOM 101".
- It plays beep sound when more than one event occurs.

e) Fig 6.6 shows Labview front panel to send email program as shown in fig :5.20.This program sends email to master mail id specified in front panel if event occurs.

i) Front panel: To specify master mail id.

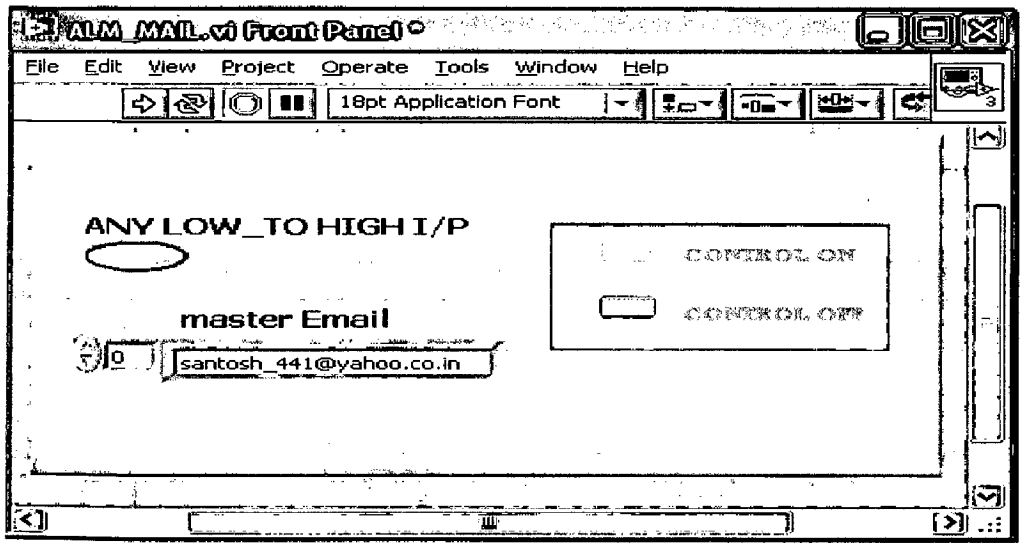


Fig 6.6 shows Labview front panel for send email program

ii) E-Mail message: fig 6.7 shows Received mail to master due to smoke occurrence in room 101.

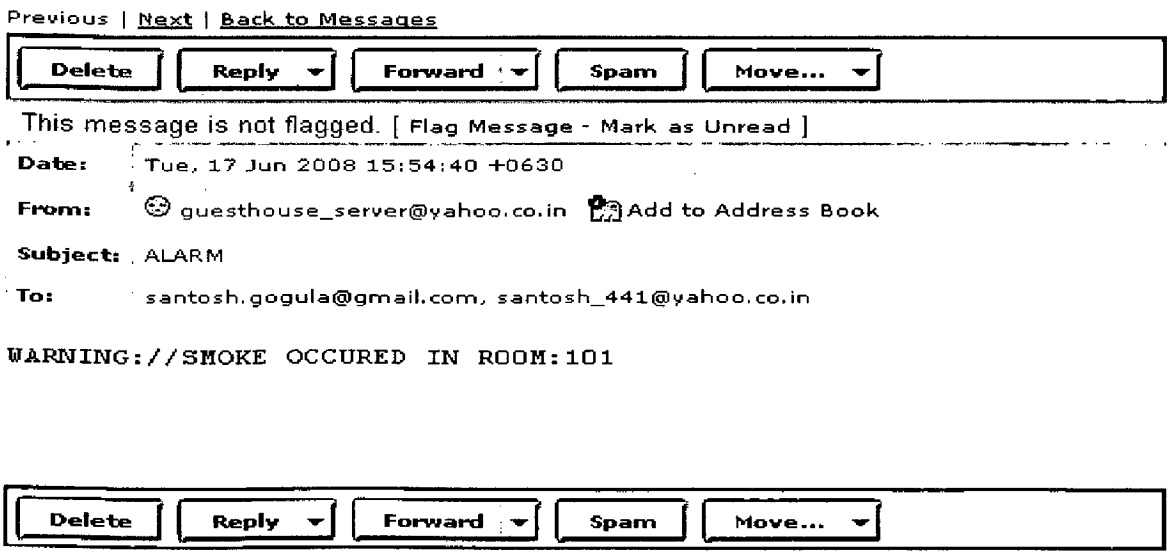


Fig 6.7 : Received mail to master

f) Fig 6.8 shows labview front panel to send sms program shown in fig 5.21.This program sends alarm to master mobile phone whose number is specified in front panel.It also has SMS sending option to keep ON/OFF.

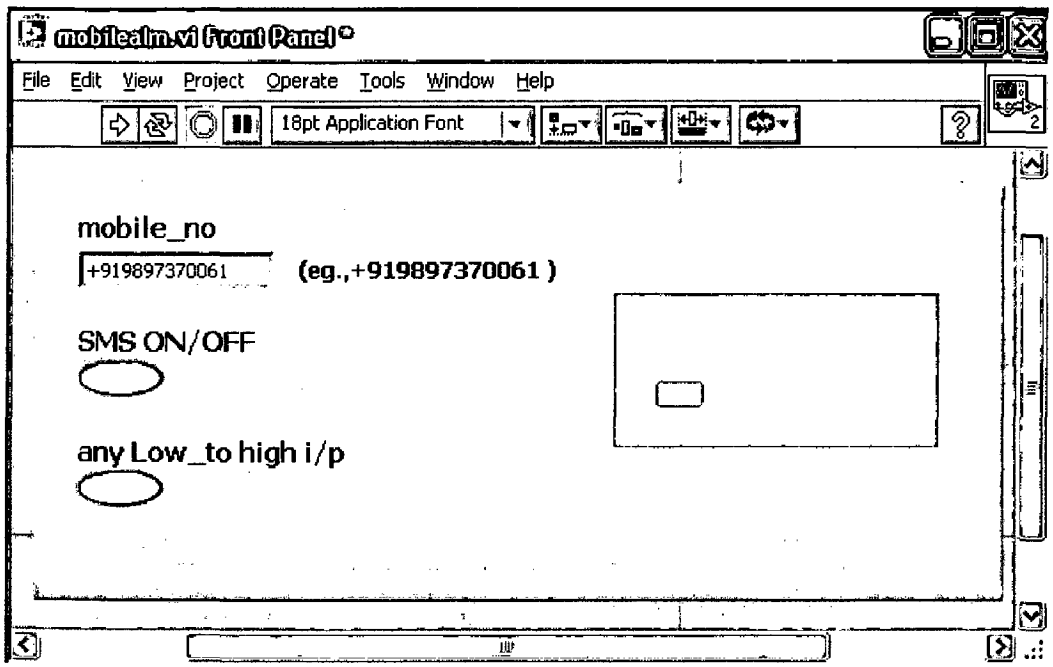


Fig 6.8: labview front panel to send sms for an event occurance

g) Fig 6.9 shows labview front panel to control appliances in single room program shown in fig5.22.Front panel shows control buttons to control any appliance.

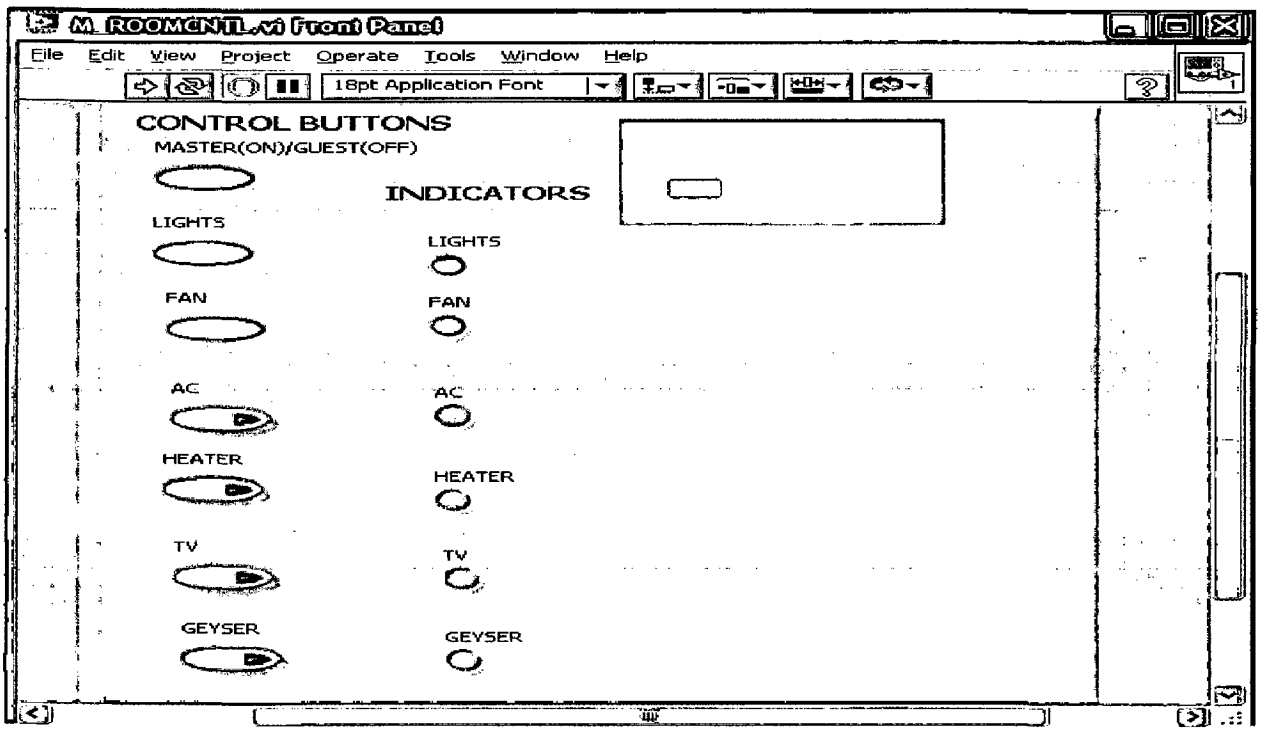


Fig 6.9 Labview front panel to control appliances in single room

h) Fig 6.10 shows Labview front panel to control appliances using sms ,whose program is shown in fig:5.24 .when 101GN as sent as SMS command,then the geysor is ON as shown in panel.

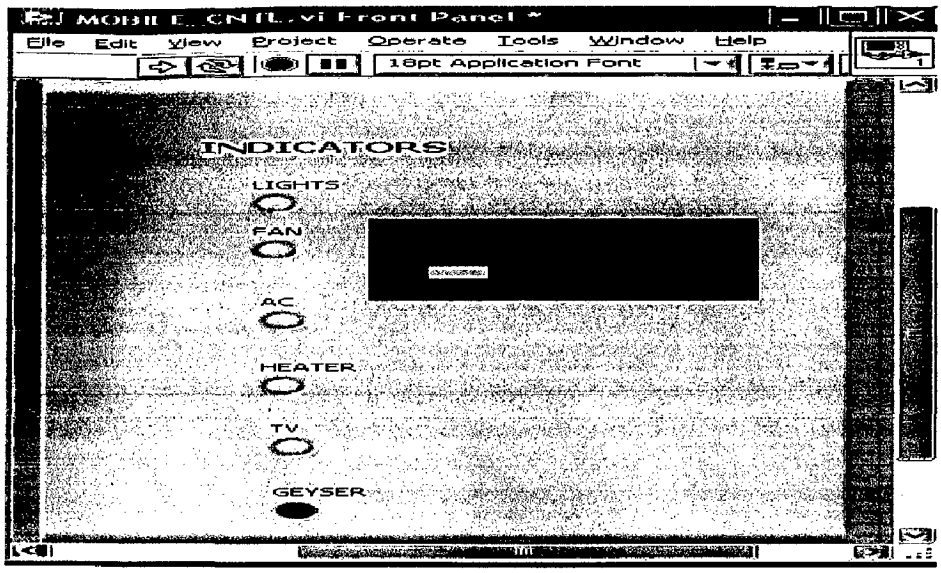


Fig 6.10 Labview front panel to control appliances using sms command

i)Fig 6.11 shows Labview front panel for control of lights in lawn using timebased or master command whose program is shown in fig:5.26.Here the master should specify the time and date details if master selects to control lights using time based option.

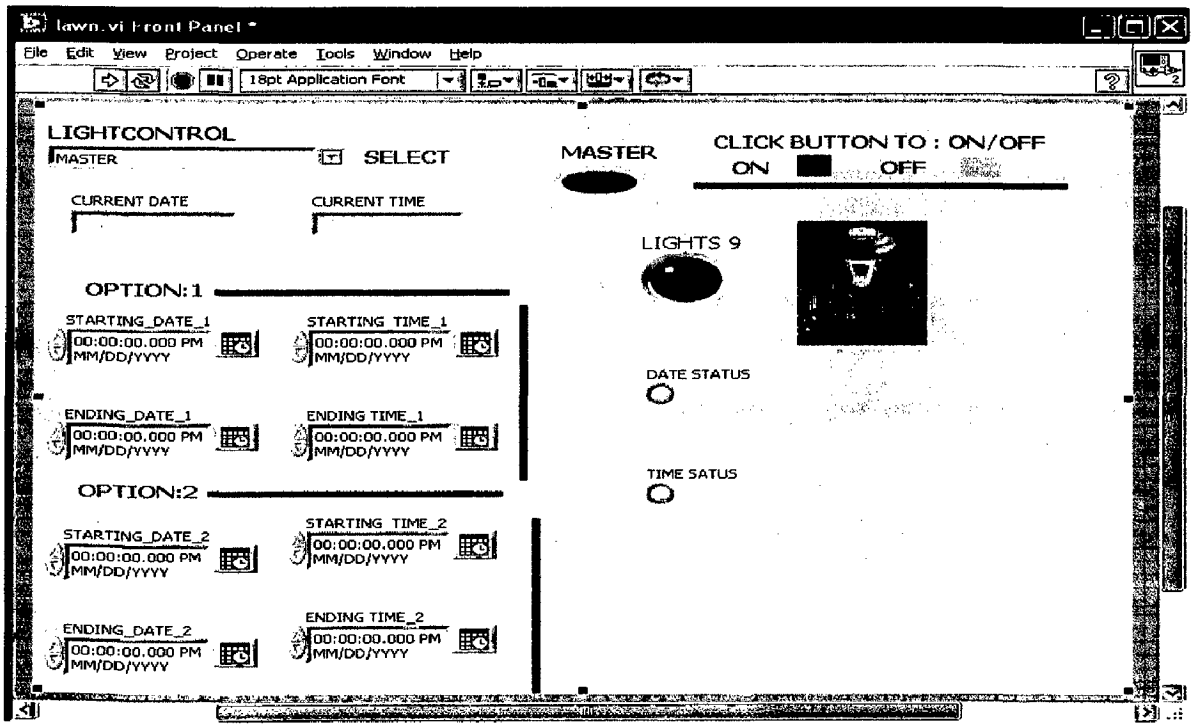


Fig 6.11 Labview front panel for control of lights in lawn using timebased or master command

6.2 LABVIEW FRONT PANELS FOR MAIN PROGRAM:

The labview front panels from fig 6.12 to fig 6.21 shows the various functions described in main program functions shown in figure 5.27.

- Fig 6.12 shows main front panel for main program.
- Fig 6.13 subfront panel allows to monitor the various sensors status information placed in Room 101. Secure control should be ON only if guest was not there so that ,pet immune and door sensor status are also monitored along with smoke and glass sensors status which are always monitored . Alarm control allows to put OFF alarm, which is activated (due to any event) in that room. similarly the monitor of room 102 can also be seen which is not shown here .
- Fig 6.14 subfront panel allows to monitor the various sensors status information placed in corridor 1. Alarm control allows to put OFF alarm, which is activated (due to any event) in that corridor. similarly the monitor of corridor 2 can also be seen which is not shown here .

  Monitoring program is written such that if any event occurs an audio alarm is activated in that area(room/corridor) ,speaker alarm is activated to master,event message is sent to master's e-mail and SMS, specified in master's information sub front panel as in fig 6.21.In master control commands has option to control speaker alarm and send SMS option.
- Fig 6.15 subfront panel shows how to control various appliancesin room-101either by master or mobile commands using master/mobile control input.There also exist remote/local input which should be ON if guest is there to give local control, otherwise it should be OFF to have control to master/Mobile. similarly the control of room 102 can also be done which is not shown here .
- Fig 6.16 subfront panel shows how to control various appliances in corridor-1 by master commands when remote/local input is OFF. If remote/local input is ON allows to control appliances in corridor-1 locally. similarly the control of corridor 2 can also be done.
- Fig 6.17 shows how to control lawn lights in back lawn either through time based or master. If master is selected, lights can be controlled with master input command.if time based is selected, then based on time and date options specified the lights will be controlled.Similarly control procedure is there to control sprinkers,fountain in back lawn,and lights in front lawn which is not shown here.
- Fig 6.18 and 6.19 shows excel sheets data for Date/Time:Alarm in any room(101 or102)and corridor(1 or 2) and Date/Time:Mater/Mobile Commands to any appliance in room or any corridor or any lawn.
- Fig 6.20 shows basic GHB block-1design and similar block designs can be seen which is not shown here.

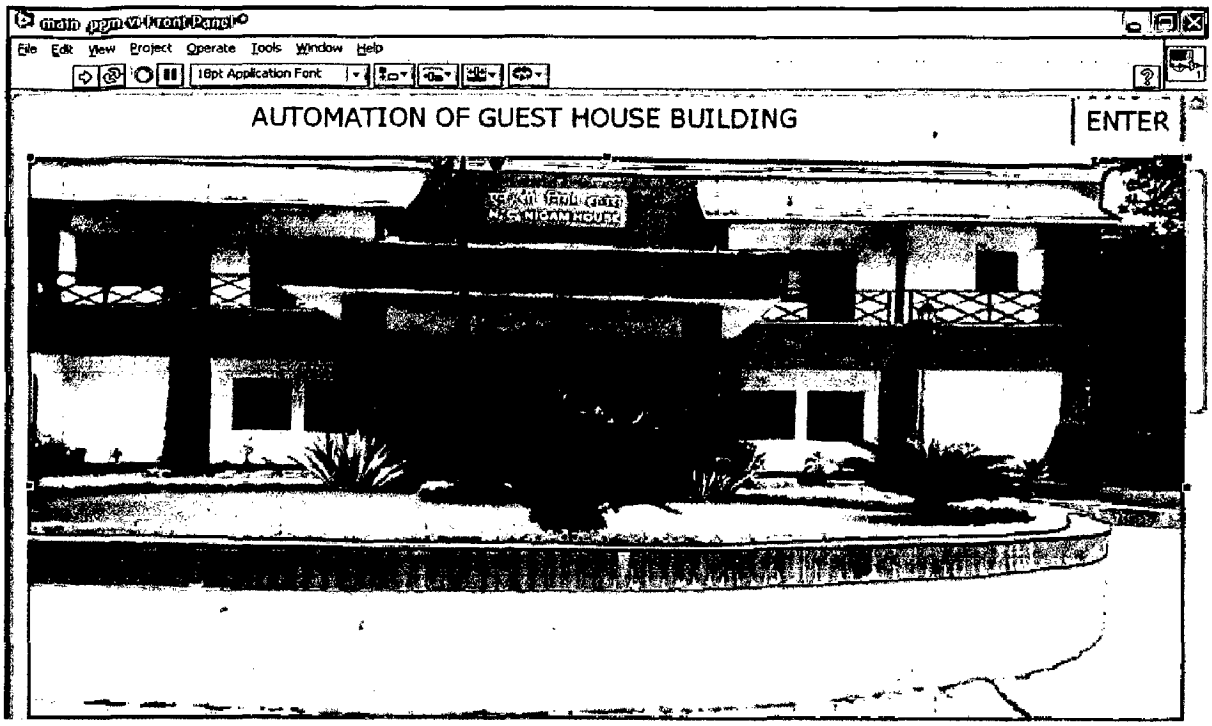


Fig 6.12 Front panel of Main Home Page

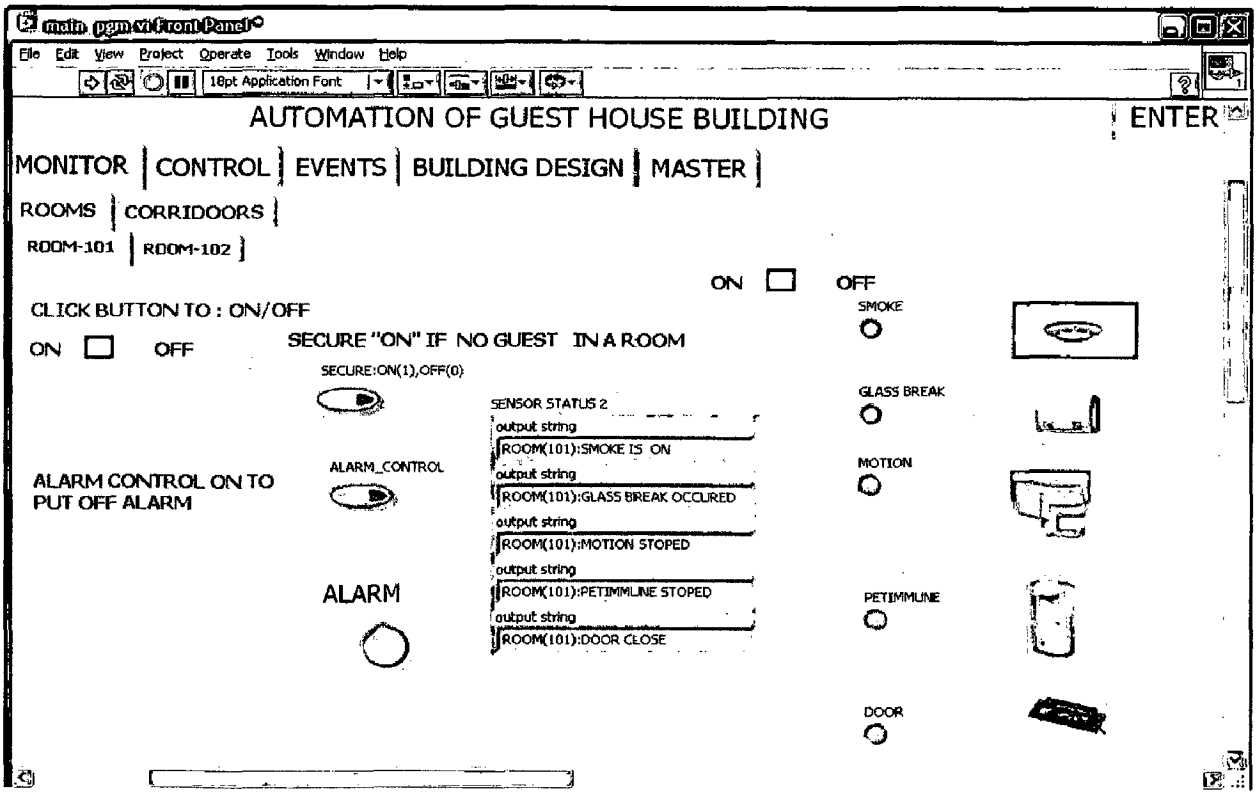


Fig 6.13 Subfront panel To Monitor Room101: (Similar for Room-102)

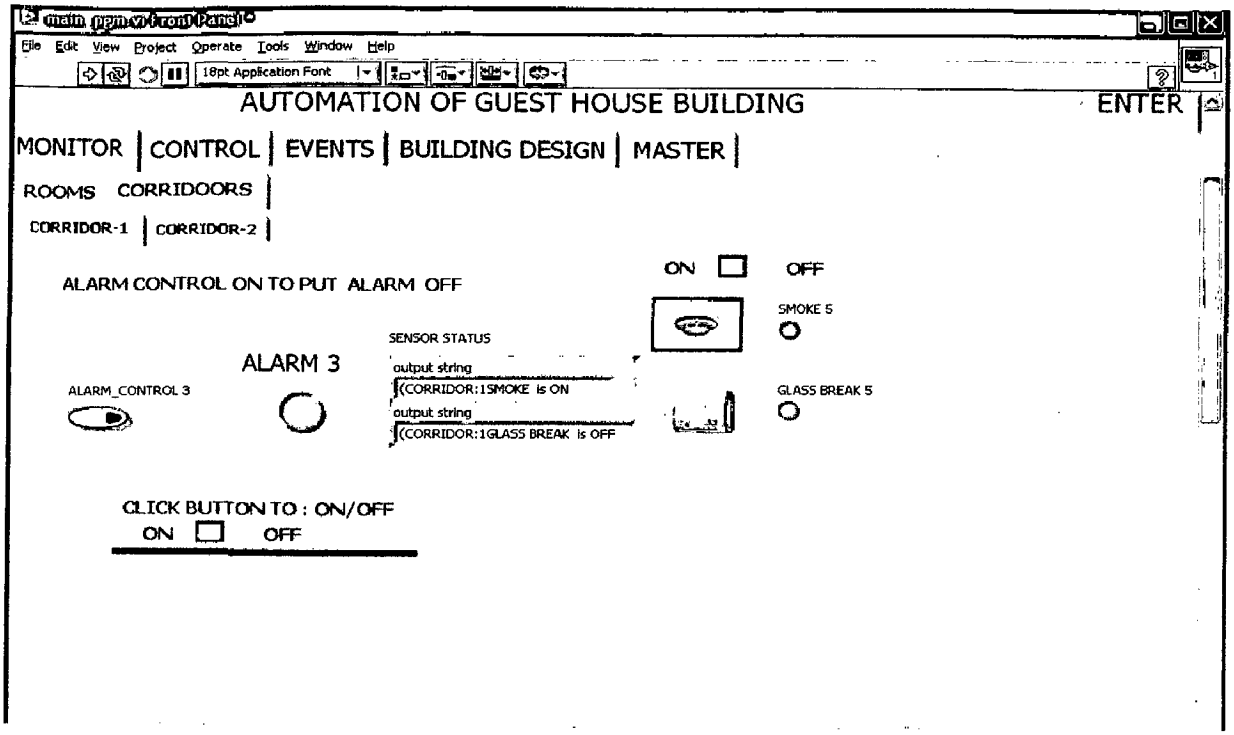


Fig 6.14 Sub front panel to Monitor Corridor 1: (Similar for Corridor-2)

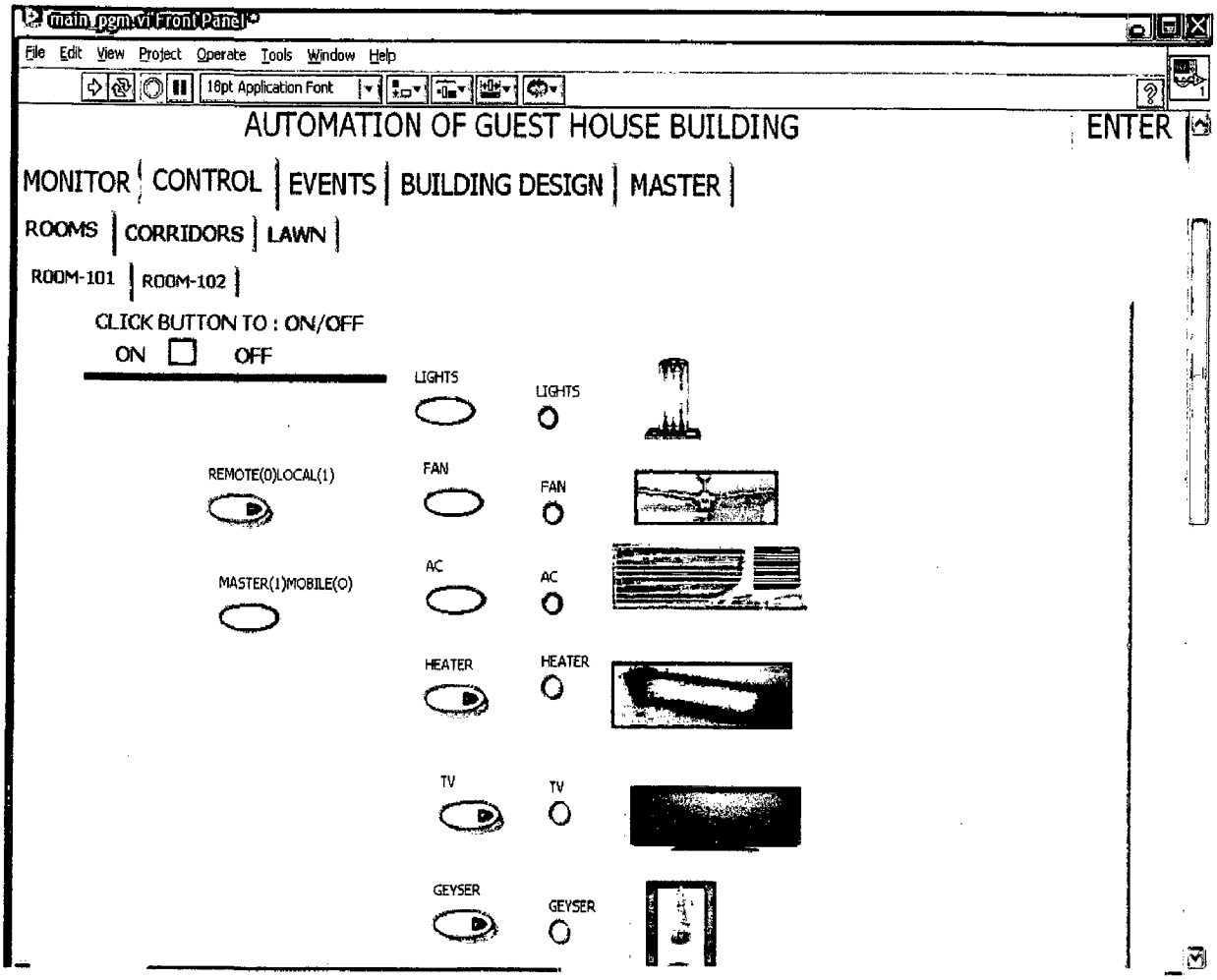


Fig 6.15 Sub front panel to control Room-101: (Similar for Room-102)

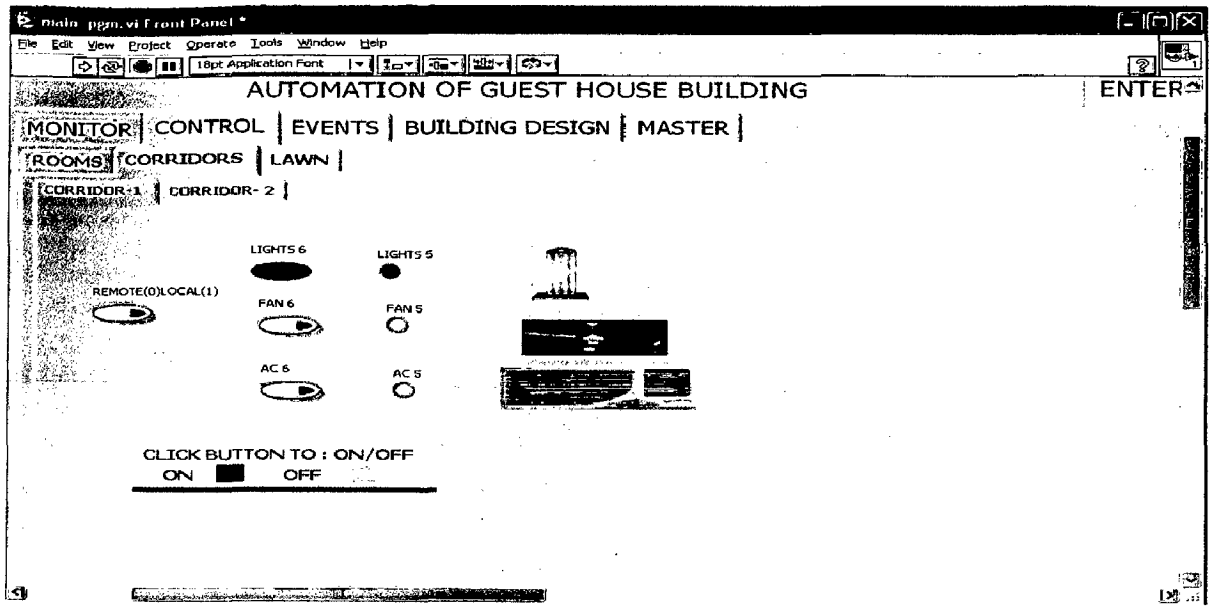


Fig 6.16 Sub front panel to Control Corridor 1: (Similar for Corridor-2).

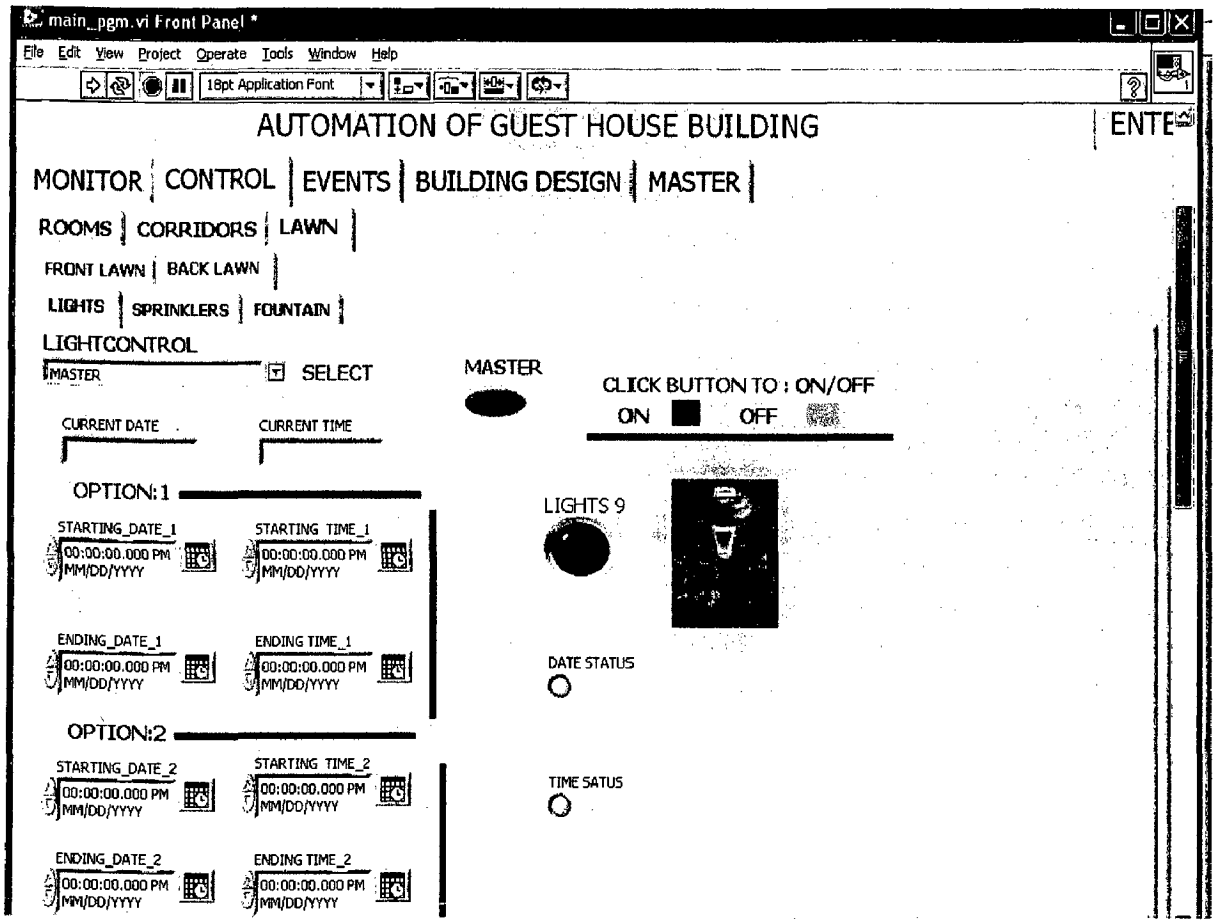
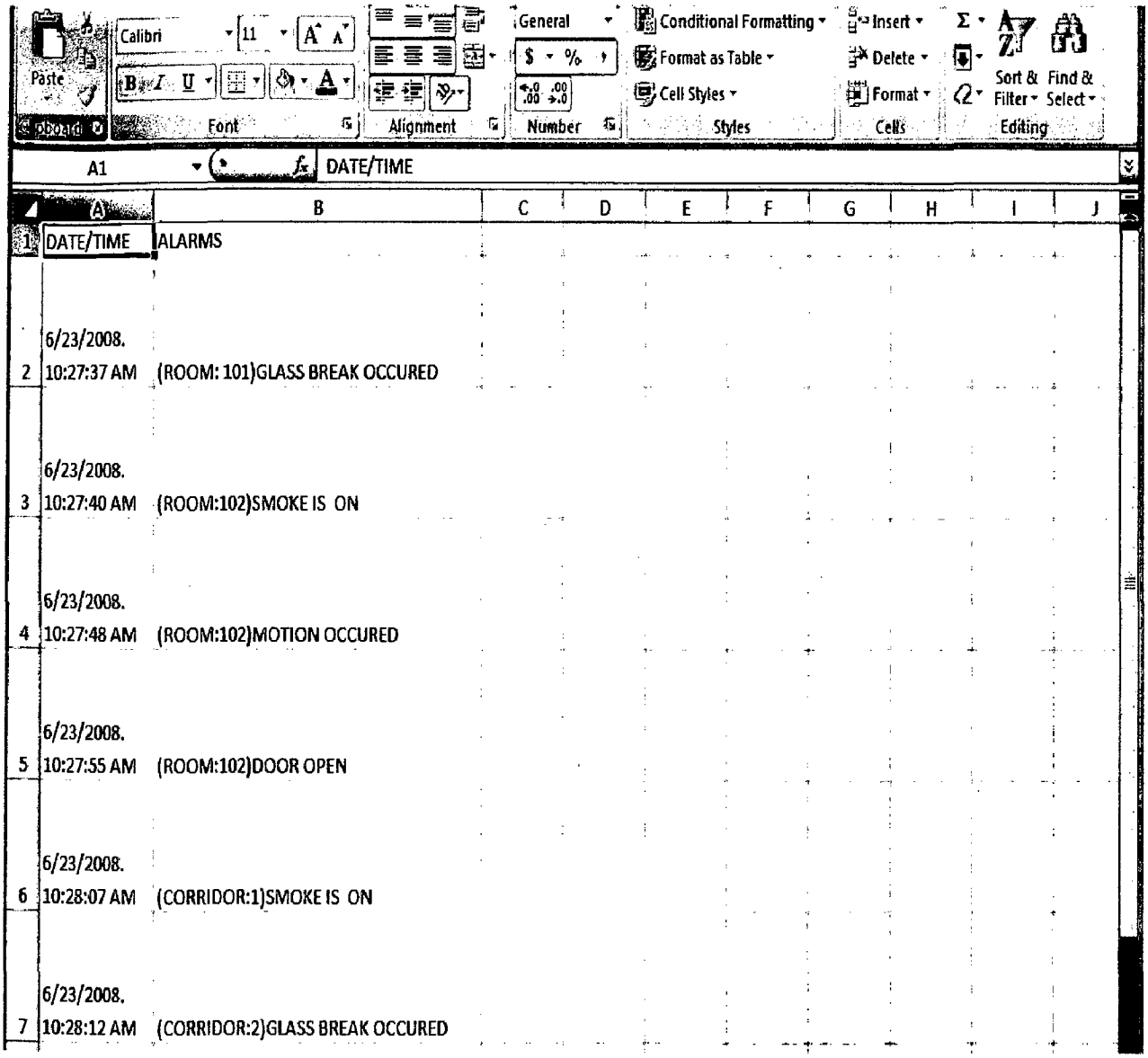


Fig 6.17 Sub panel to Control Lights in Back Lawn,(Similar for Sprinker,Fountain, and Front Lawn).



	A	B
1	DATE/TIME	ALARMS
2	6/23/2008. 10:27:37 AM	(ROOM: 101)GLASS BREAK OCCURED
3	6/23/2008. 10:27:40 AM	(ROOM:102)SMOKE IS ON
4	6/23/2008. 10:27:48 AM	(ROOM:102)MOTION OCCURED
5	6/23/2008. 10:27:55 AM	(ROOM:102)DOOR OPEN
6	6/23/2008. 10:28:07 AM	(CORRIDOR:1)SMOKE IS ON
7	6/23/2008. 10:28:12 AM	(CORRIDOR:2)GLASS BREAK OCCURED

Fig 6.18 To Monitor Alarms in Excel sheet

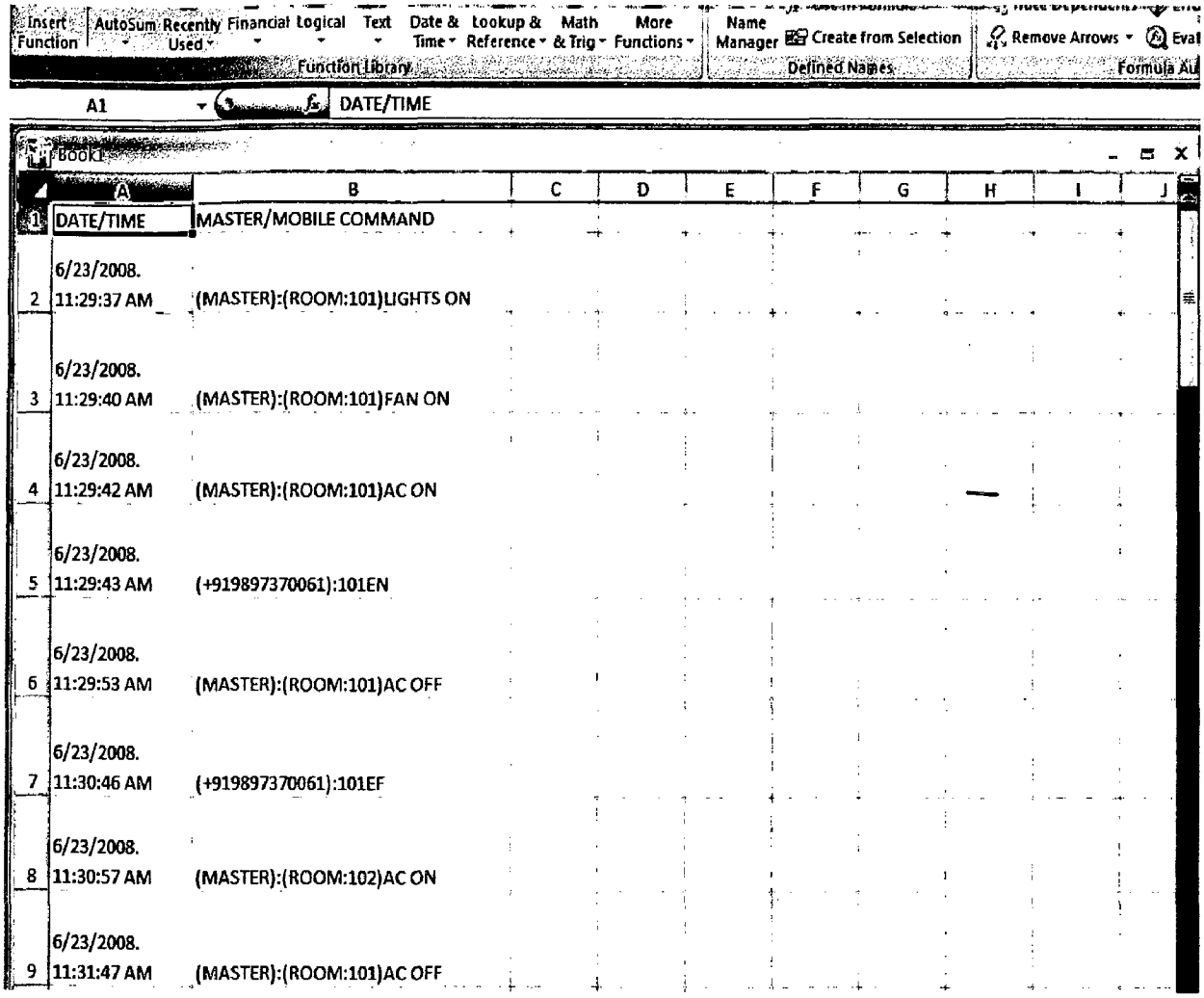


Fig 6.19 To Monitor Commands in Excel sheet

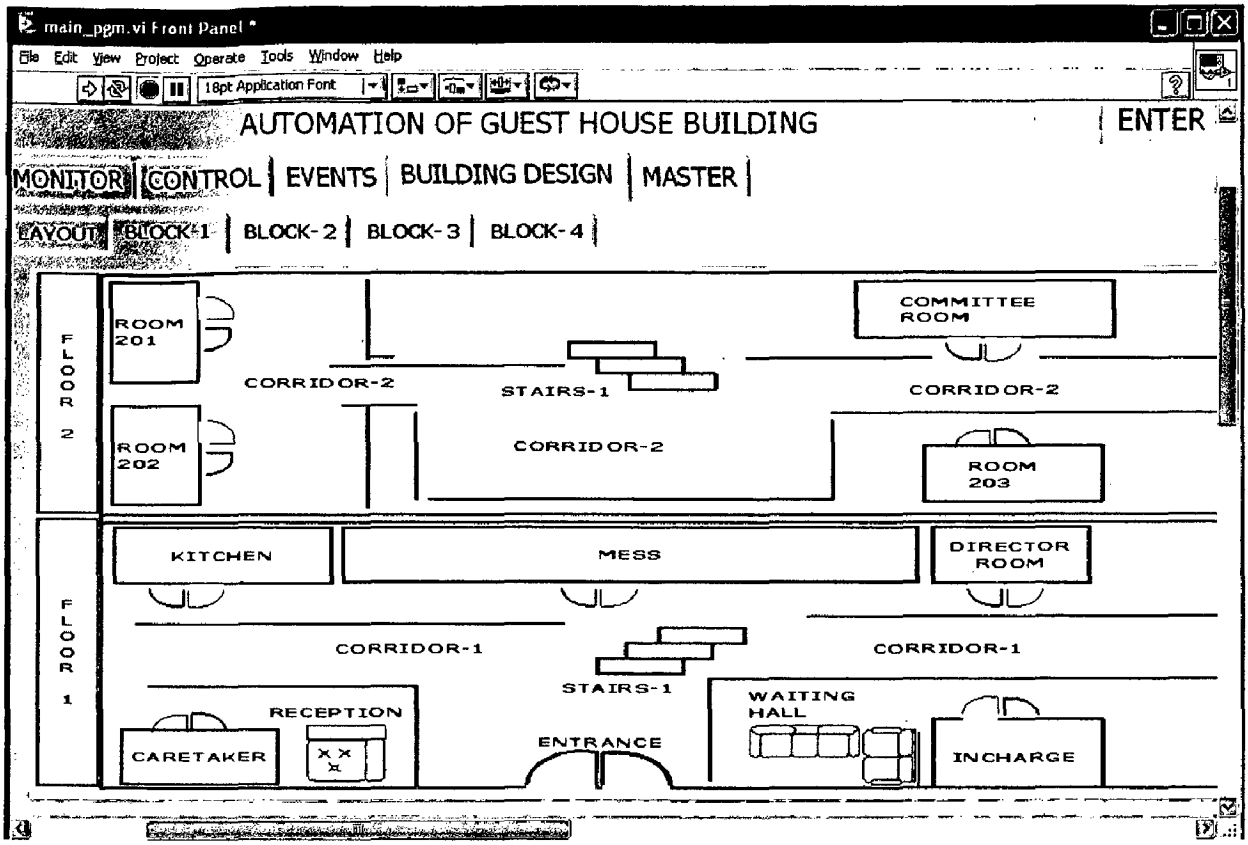


Fig 6.20 Sub front panel displaying Building Design (Block-1) (same as shown in 5.1.2 section)

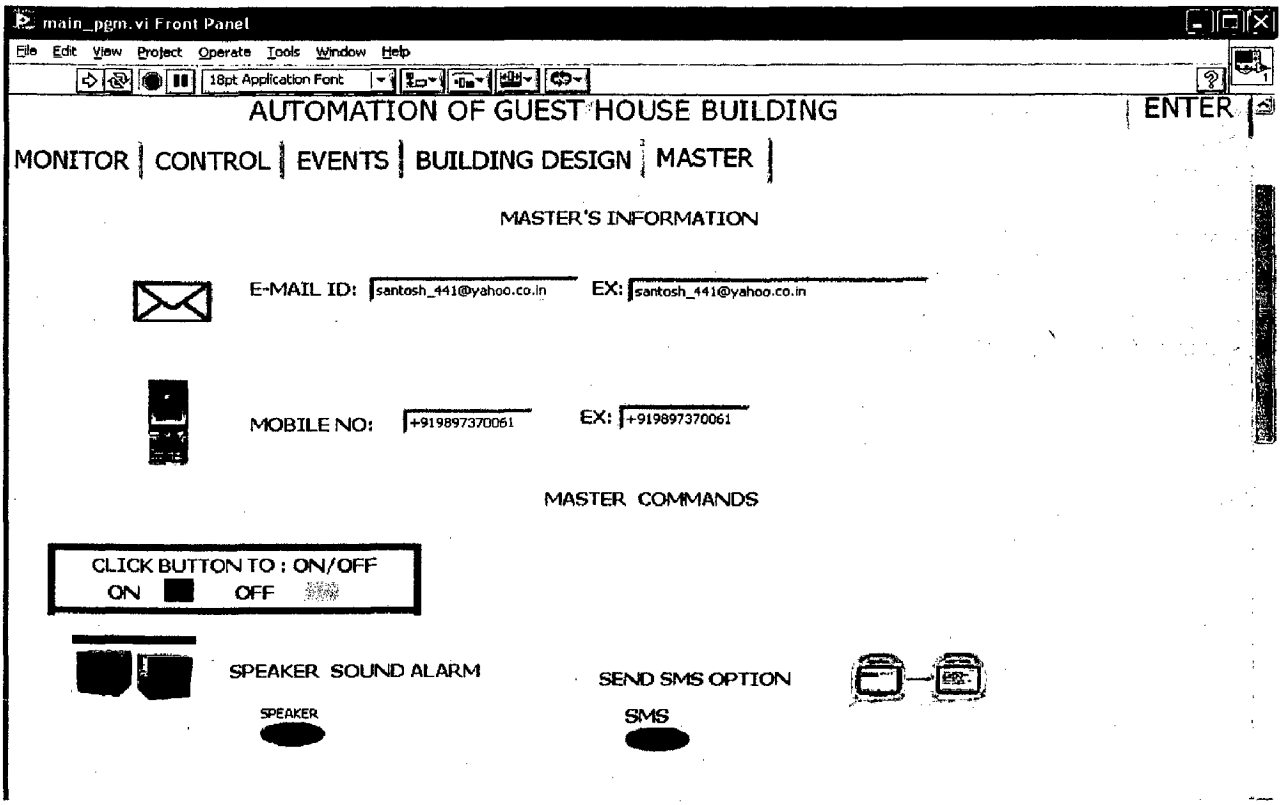


Fig 6.21 Sub front panel to Enter Master Information and Master Commands

6.3) FRONT PANELS FOR REMOTE MONITORING AND CONTROL FOR LABVIEW MAIN PROGRAM:

Fig 6.22 to fig 6.28 shows Front panels for remote monitoring and control of labview main program which is shown in fig 5.27.A network consisting of one Server-"SANTOSH", Client#1="MANOHAR" in Wired Network-Ethernet, Client #2="NARSING" in Wireless Network-WIFI is implemented. Time allocation to clients =1 minute, when multiple clients are waiting.Observe the steps i) to vii) sequentially which shows client server communications.

i) Fig 2.22 shows front panel when Control transferred to MANOHAR. Server displays following:

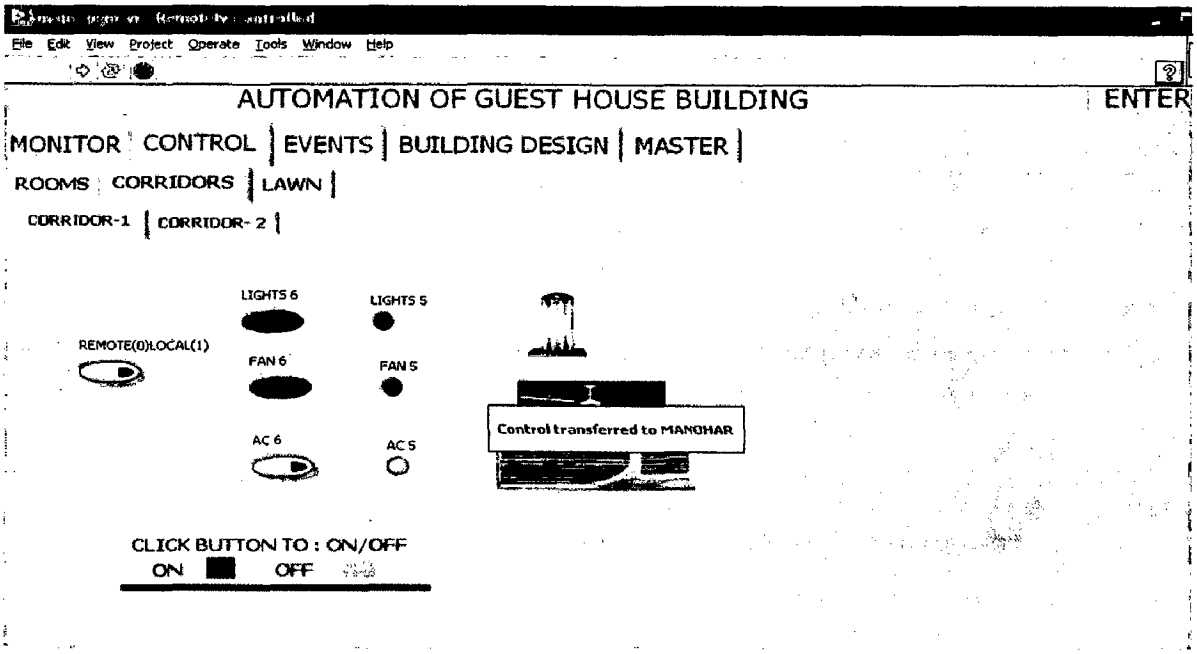


Fig 6.22 : Server Message Front panel when Control transferred to MANOHAR

ii) Fig 6.23 shows when NARASING requested a control then NARASING displays following:

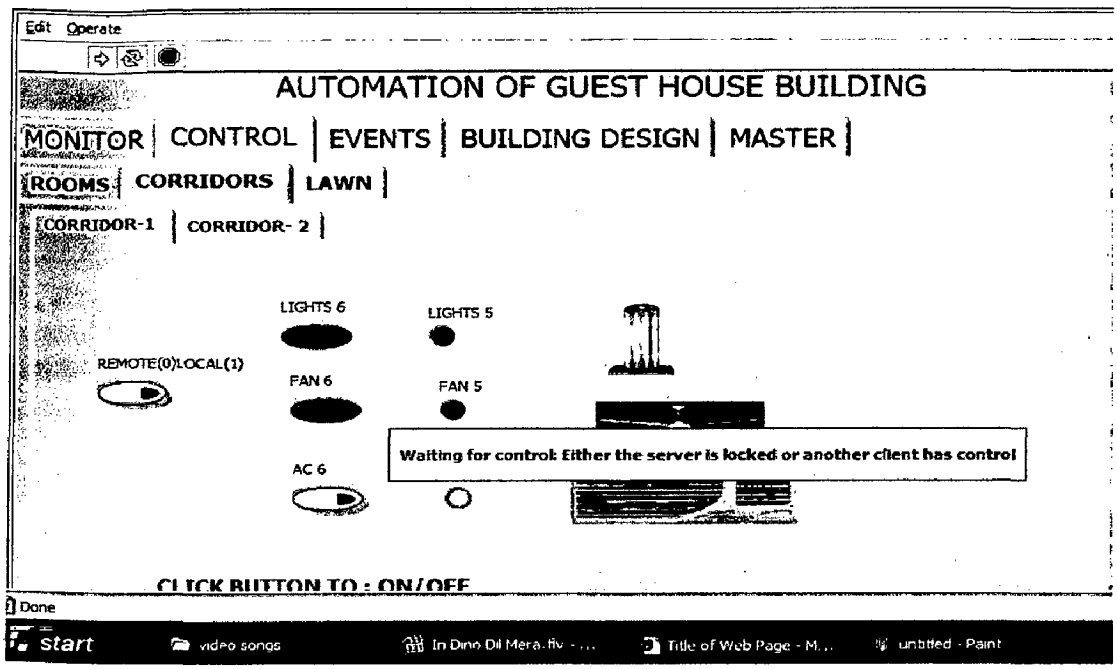


Fig 6.23 NARASING front panel when NARASING requested a control to server.

iii) Fig 6.24 shows MANOHAR Front panel when NARASING requested a control.

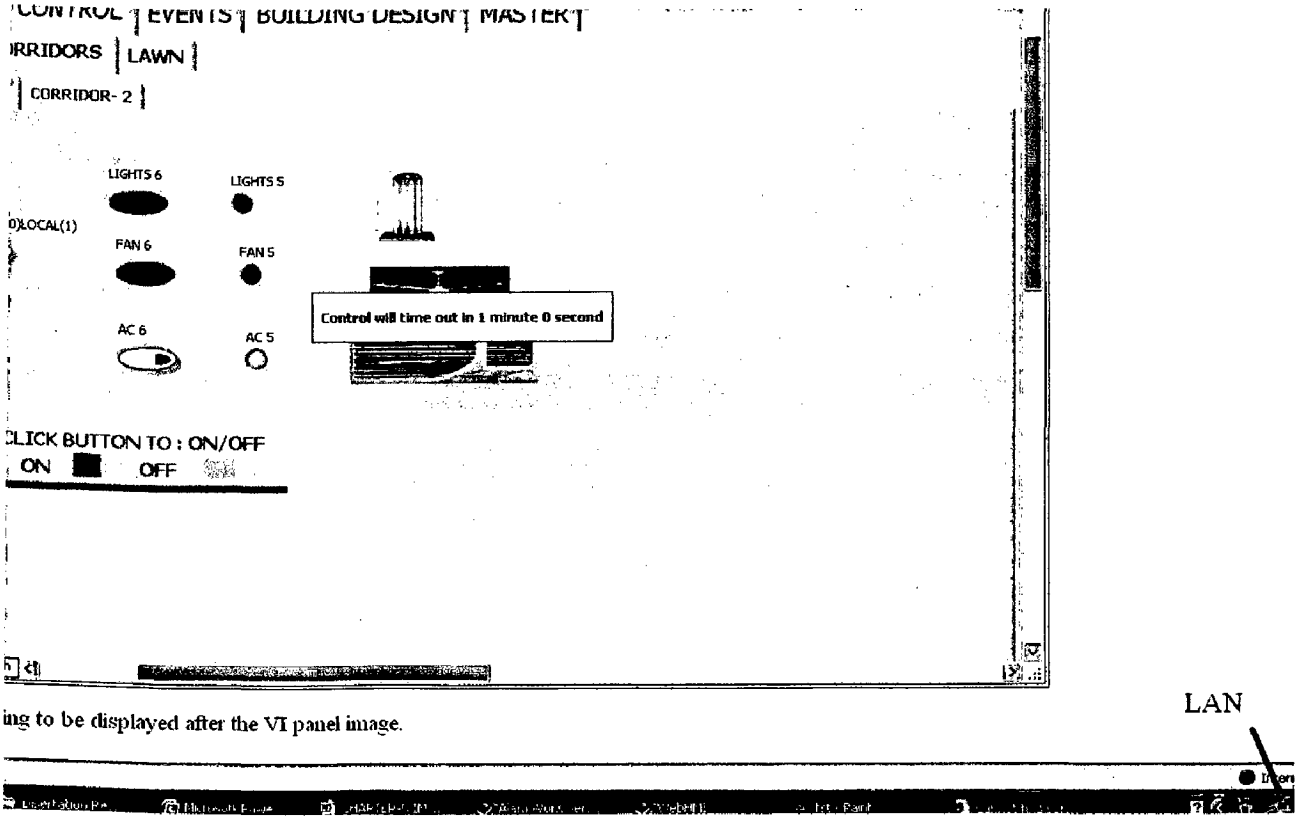


Fig 6.24 MANOHAR Front panel when NARASING requested a control.

iv) Fig 6.25 shows front panel of SERVER after 1 minute from step iii).

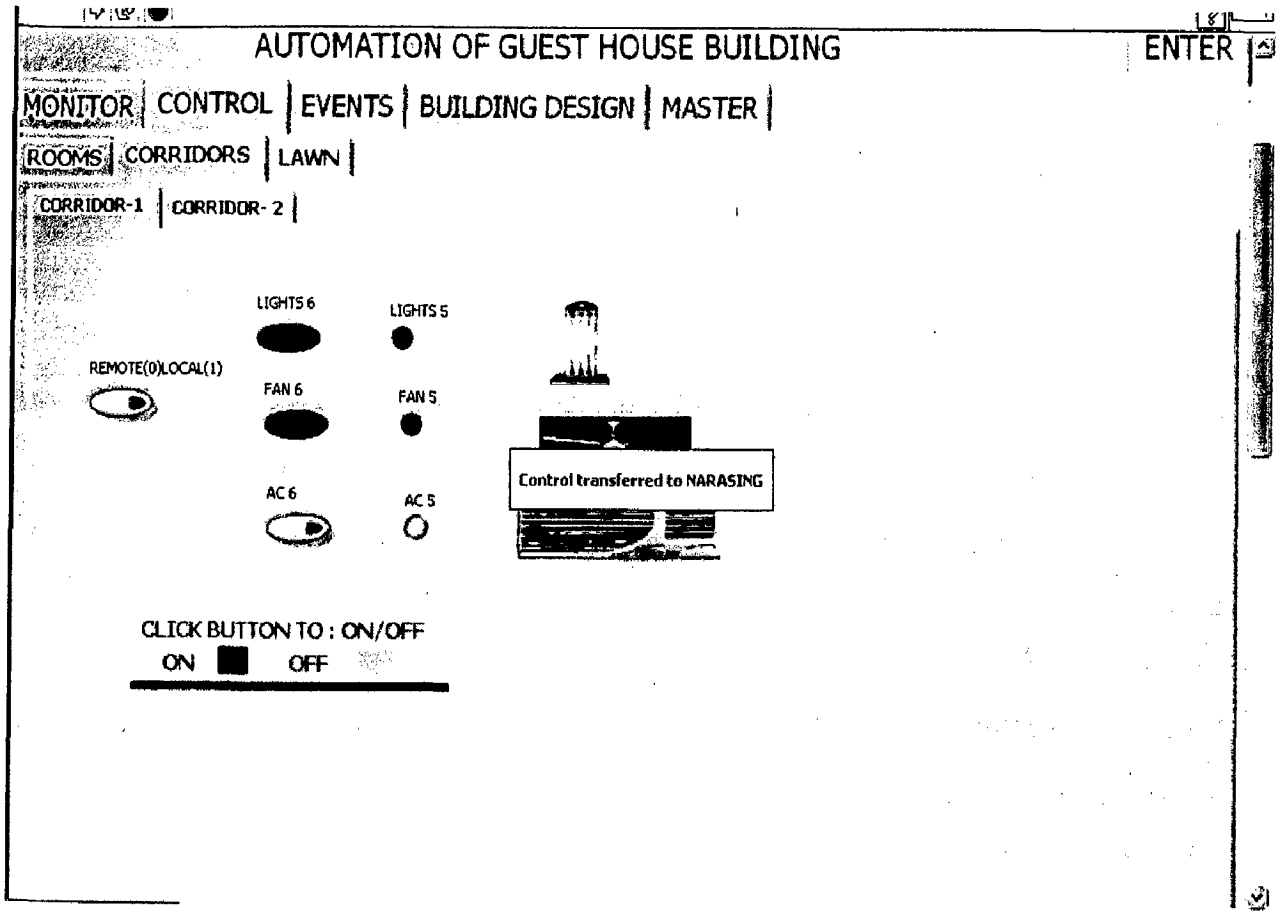


Fig 6.25 Front panel of SERVER after 1 minute from step iii)

v)Fig 6.26 shows NARASING Front panel after 1 minute from step iii)

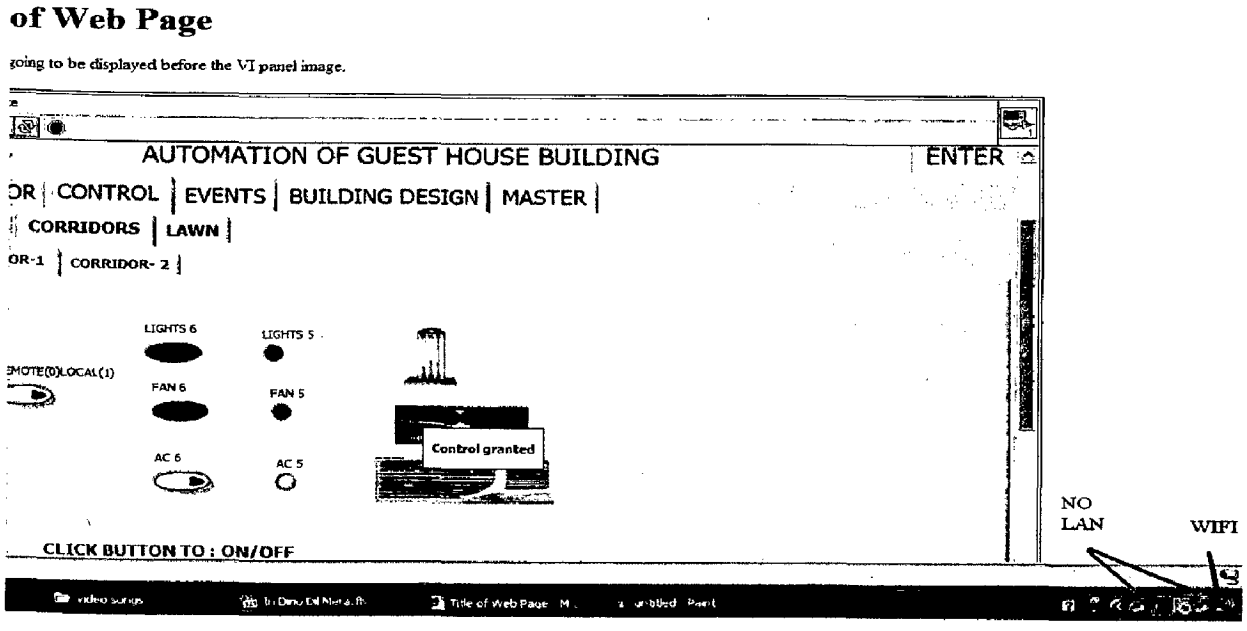


Fig 6.26: NARASING Front panel after 1 minute from step iii)

vi) Fig 6.27 shows SERVER front panel ,when manohar requested control during which control is under NARASING .

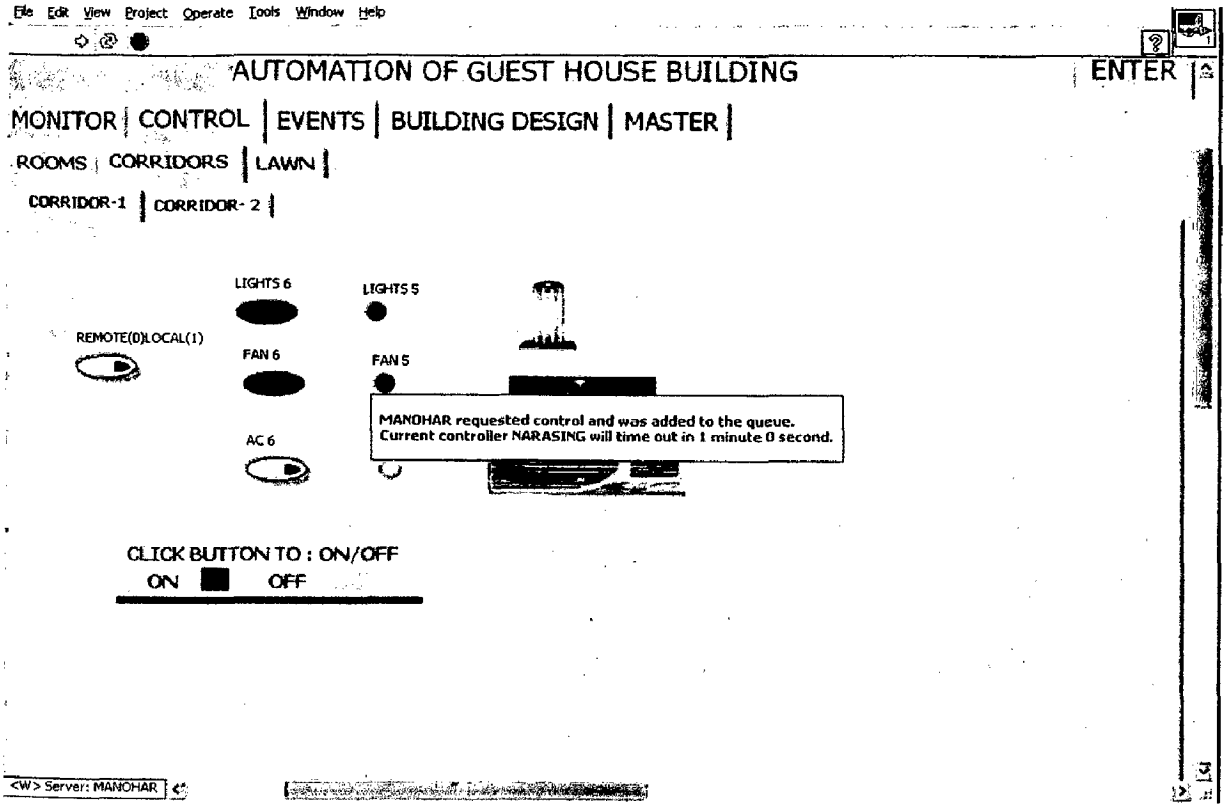


Fig 6.27 :SERVER front panel ,when manohar requested control during which control is under NARASING

vii)Fig 6.28 shows front panel of NARASING ,when SERVER has regained control .

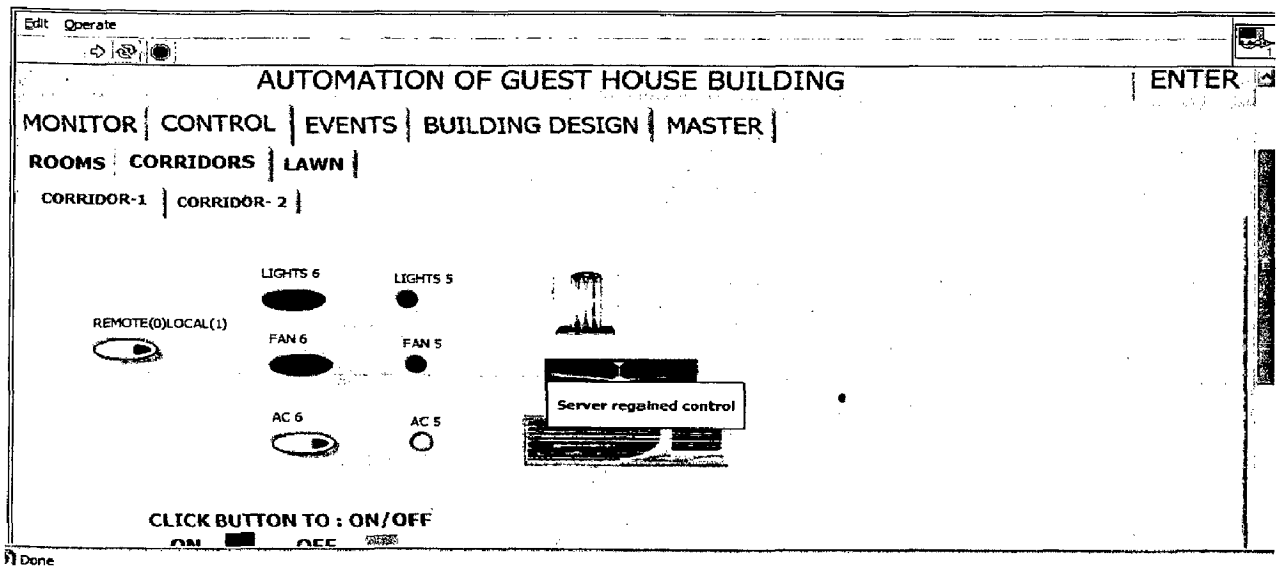


Fig 6.28 Front panel of NARASING ,when SERVER has regained control

CHAPTER-7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

First, the study of BAS subsystems, various wired and wireless sensor network protocols for BAS has done. Second, the IP camera and security control system has been implemented in laboratory. Third, to design of BAS for GHB ,study of architectural design of GHB, designed hierarchal network for GHB with four networks naming modbus, ethernet ,WiFi, mobile. Client –server model is developed by using both Ethernet and wifi. Then a main program is written in labview allows to monitor of sensor status in any room, corridor in server or in any client front panel. If any event occurs it displays event message in front panel, in excel sheet (datalog), server sends alarm in that area, sends voice alarm through speaker , email and SMS to master. The program enables to control any appliance in any room, corridor, lawn either by sending command through local server or from any client or from any mobile phone through SMS.

7.2 FUTURE SCOPE

In Present work the acquisition and control is done with modbus network with RS-232 to RS-485 converter which requires a re-wiring in entire building according to design. Of course the design is suitable for any new construction of building so that a wiring can be preplanned according to requirement.

In future, to avoid large wiring, a distributed IP network is developed with the help of RS-485 to Ethernet gateway or with RS-485 to wifi gateway. Among two gateways The best option is to use RS-485 to wifi gateway so that less wiring required and also can easily installed and connected to client and server in WiFi environment of building.

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APPENDIX-A DIGITAL I/O MODULE SPECIFICATIONS

Modbus compliant digital i/o module specifications table is shown in table A.1:

Model no:i-7050D.

Table A.1: i-7050D specifications:

Digital Input	
Channels	7
Input Type	Sink, non-isolated channel with common ground
Off Voltage Level	+1V max.
On Voltage Level	+4V ~ +30V
Input Impedance	3K9, 0.3W
Counters	channels : 7
	Max. Counters : 16-bit (65535)
	Max. Input Frequency : 100Hz
	Min. Pulse Width : 5ms
Digital Output	
Channels	8
Output Type	NPN, Sink, Open collector
Output Voltage	30V max.
Output Current	30mA max.
Interface	
Interface	RS-485
Format	N, 8, 1
Baud Rate	1200 ~ 115200bps
LED Display	
1 LED as Power/ Communication indicator	
7 LEDs as Digital Input indicators, and 8 LEDs as Digital Output indicators (for i-7050D)	
Power	
Input Voltage Range	10~30VDC
Power Consumption	0.4W (i-7050) / 1.1W (i-7050D)
Environment	
Operating Temperature	-25 to 75°C
Storage Temperature	-40 to 85°C
Humidity	5 to 95%, non-condensing

APPENDIX-B RS-232 TO RS-485 INTERFACE SPECIFICATIONS

RS-232 TO RS-485 interface specifications are given in table B.1
Model no: i-7520

TABLE B.1: RS-232 to RS-485 interface specifications

Parameter	Detail
Input	RS-232 protocol
Output	RS-485 protocol (two wire, D+, D-)
Speed	auto switching baud rate, 300~115200 bps Internal "Self Tuner".
No. of Modules	Maximum of 256 modules. in a single RS-485 network without using a repeater. Maximum of 2048 modules. in a single RS-485 network when using a repeater
Isolation voltage	3000Vdc on the RS-232 side
Repeater request	4,000 feet or over 256 modules

APPENDIX-C IP CAMERA SPECIFICATIONS

The table C.1 shows IP camera(Model no: MCAS-300PTW) specifications.

Table C.1 IP camera specifications

Audio Specification	
Voice	24kbps ,8kbps(option) Build-in microphone External microphone connector Audio / Video output connector
Video Specification	
Resolution	640 x 480 pixel
Sensor	1/4" color CCD sensor
Electronics Shutter	1/60 ~ 1/100,000 sec
Image(Video Setting)	
Image Compression	MPEG4
Frame Rate	30fps@CIF, 10fps@VGA
Compression Rate Selection	Medium/Standard/good/detailed/excellent
Frame Rate Setting	30/25/20/15/10/5/3/2/1
Video Resolution	NTSC: Up to 30 Frames at 640 x 480 PAL: Up to 25 Frames at 640 x 480
Wireless Specification:	
Standard	IEEE 802.11g
Frequency	2.400~2.4835GHz
System Hardware	
Pan / Tilt	Pan: range ± 135°, 10°~50°/sec Tilt: range +90°~-45°, 7°~25,°/sec Auto pan mode Auto patrol mode
LAN Port	One RJ-45 port to connect to 10/100Mbps Ethernet, auto-sensing
Generic I/O Port	1 sensor input(max. 12VDC 50mA) 1 relay output(max. 24VDC 1A, 125VAC 0.5A)
Power Supply	12VDC,1.5A external power supply
Management	
Communication Protocol	TCP/IP, HTTP,SMTP, FTP, Telnet, NTP, DNS, DHCP, DDNS, UPnP
Operating Environment	
Temperature	Operation:0 °C ~ 40 °C Storage:-20 °C ~ 70 °C

APPENDIX D DEFAULT ZONE TYPES

The default zone data types of security panel (Model:NX 8v2) is shown in table D.1

TABLE D.1: Default zone data types of security panel.

DATA	DESCRIPTION OF DEFAULT ZONE TYPES
1	DAY ZONE - Instant when system is armed trouble zone when system is disarmed.
2	24-HOUR AUDIBLE - Creates an instant yelping siren alarm regardless of the armed state of the control panel.
3	ENTRY/EXIT DELAY 1- A trip will start entry delay 1. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed
4	FOLLOWER WITH AUTO- BYPASS DISABLED - This zone will be instant when the system is armed and no entry orexit delays are being timed. It is delayed during entry and exit delay 1 times. This zone will not automatically bypass even if enabled in Segment 1 of Location 23.
5	INTERIOR FOLLOWER WITH AUTO- BYPASS ENABLED - This zone will be instant when the system is armed and noentry or exit delay is being timed. It is delayed during entry and exit delay 1 times. This zone will automatically bypass ifenabled in Segment 1 of Location 23.
6	INSTANT - This zone creates an instant alarm whenever it is tripped and the Armed LED is on.
7	24-HOUR SILENT - Creates an instant silent alarm regardless of the armed state of the control panel. It will not display on the keypad
8	FIRE - This zone will light the Fire LED and sound the temporal siren each time the zone is shorted. It will also rapidly flash the Fire LED indicating a trouble if the zone is open.
9	ENTRY/EXIT DELAY 2- A trip will start entry delay 2. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed.
10	24-HOUR SILENT SUPERVISED- Creates an instant silent alarm regardless of the armed state of the control panel. It will display on the keypad.
11	KEYSWITCH ZONE - This zone type will arm and disarm the partition or partitions of the control panel that it resides in each time the zone is shorted. Keyswitch arming will report as user #99.
12	INTERIOR FOLLOWER WITH "CROSS ZONE" ENABLED -This zone will be instant when the system is armed and noentry or exit delay is being timed. It is delayed during entry and exit delay times. If a "Cross Zone" is not being timed it will start a "Cross Zone" timer. If a "Cross Zone" is being timed it will create an instant alarm. This zone will automatically bypass when enabled in Segment 1 of Location 23.
13	INSTANT ENTRY GUARD - This zone creates an instant alarm whenever it is tripped and the Stay LED is off. It will start an entry delay time 2 if it is tripped and the system is armed and the Stay LED is on.
14	ENTRY/EXIT DELAY 1 WITH GROUP BYPASS ENABLED -A trip will start entry delay 1. This zone will bypass when the "Group Bypass" command is entered at the keypad. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed.
15	INTERIOR FOLLOWER WITH GROUP BYPASS ENABLED - This zone will be instant when the system is armed and noentry or exit delays are being timed. It is delayed during entry/exit delay times. This zone will bypass when the "GroupBypass" command is entered at the keypad. This zone will automatically bypass if enabled in Segment 1 of Location 23.
16	INSTANT WITH GROUP BYPASS ENABLED - This zone creates an instant alarm whenever it is tripped and the Armed LED is on. This zone will bypass when the "Group Bypass" command is entered at the keypad.
17	ENTRY/EXIT DELAY 1 WITH TAMPER ENABLED- A trip will start entry delay 1. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed. This zone type can be used to enable tamper on awireless transmitter.

18	INTERIOR FOLLOWER WITH TAMPER AND AUTO-BYPASS ENABLED -This zone will be instant when the system is armed and no entry or exit delay is being timed. It is delayed during entry and exit delay times. This zone wil automatically bypass if enabled in Segment 1 of Location 23. This zone type can be used to enable tamper on a wireless transmitter.
19	INSTANT WITH TAMPER ENABLED -This zone creates an instant alarm whenever it is tripped and the Armed LED is on. This zone type can be used to enable tamper on a wireless transmitter.
20	ENTRY/EXIT DELAY 2 WITH TAMPER ENABLED-A trip will start entry delay 2. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed. This zone type can be used to enable tamper on a wireless transmitter.
21	GAS DETECTION- Creates an instant alarm regardless of the armed state of the control panel. It will display on the keypad and activate the keypad sounder.
22	LOW TEMP DETECTION- Creates an instant silent alarm regardless of the armed state of the control panel. It will display on the keypad and activate the keypad sounder.
23	HIGH TEMP DETECTION- Creates an instant silent alarm regardless of the armed state of the control panel. It display on the keypad and activate the keypad sounder.
24	MANUAL FIRE - This zone will illuminate the Fire LED and sound the temporal siren each time the zone is shorted. It will also rapidly flash the Fire LED indicating a trouble if the zone is open.
25	CHIME ONLY - Creates no alarm regardless of the armed state of the control panel. It will chime anytime it is faulted and will display on the keypad. Local only.
26	INTERIOR FOLLOWER DELAY 2 - This zone will be instant when the system is armed and no entry or exit delay is being timed. It is delayed during entry and exit delay 2 times. This zone will automatically bypass if enabled in Segment 1of Location 23.
27	INTERIOR FOLLOWER FORCE ARMABLE - This zone will be instant when the system is armed and no entry or exit delay is being timed. It is delayed during entry and exit delay 1 times. This zone will automatically bypass if enabled in Segment 1 of Location 23.
28	ENTRY/EXIT FORCE ARMABLE DELAY 2 - A trip will start entry delay 2. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed.
29	INTERIOR FOLLOWER WITH ACTIVITY SUPERVISION ENABLED - This zone will be instant when the system is armed and no entry or exit delay is being timed. It is delayed during entry and exit delay times. It will send a report if the zone activity time is reached without a change of state. Refer to Location 40 / Segment 11.
30	ENTRY/EXIT WITH ACTIVITY SUPERVISION ENABLED-A trip will start entry delay 1. It will send a report if the zone activity time is reached without a change of state. Refer to Location 40 / Segment 11. The lack of a trip during exit delay will enable the Automatic Bypass or Instant mode if so programmed.

APPENDIX E AUXILIARY OUTPUT EVENT SELECTION

For security panel(Model NX 8v2) ,Auxiliary output event selection data is shown in table E.1.

Table E.1: Auxiliary output event selection

DATA	EVENT	DATA	EVENT	DATA	EVENT
0 √	Burglary Alarm	19	Exit	38	Download In Process
1 √	Fire Alarm	20	Entry or Exit	39	Smoke Power
2 √	24 Hour Alarm	21	Armed State	40	Short Circuit (Over-current)
3 √	Trouble Alarm	22	Disarmed State	41	Box Tamper
4 √	Tamper Alarm	23	Ready	42	Siren Tamper
5	Yelping Siren (Burglary)	24	Not Ready	43	Any Open
6	Temporal Siren (Fire)	25	Fire	44	Any Short
7	Any Siren	26	Fire Trouble	45	Any Fault (Open/ Short on Non-Fire Zone)
8	Any Bypass	27	Chime	46 √	Any Alarm
9	AC Fail	28 √	Expander Trouble	47	Beeping Keypad
10	Low Battery	29	Dynamic Battery Test Time	48 √	Code Entry (See note below)
11 √	Duress	30	Open Period	49 ◆ √	Key FOB Function 1
12 √	Aux 1 Keypad Zone	31	Closed Period	50 ◆ √	Key FOB Function 2
13 √	Aux 2 Keypad Zone	32	Listen-In	51	Always ON
14 √	Panic Keypad Zone	33	Line Seizure	52	Alarm Flash
15	Keypad Tamper	34	Ground Start	53	Armed Away
16 √	Autotest	35	Fail To Communicate	54	Armed Stay
17	Alarm Memory	36	Telephone Line Fault	55	Aux Comm Fail
18	Entry	37	Program Mode	56	(CP-01) Progress Annunciation

◆ In above table Events 49 & 50 require one or more of the following to operate: NX-408E, NX-416E, NX-448E wireless receivers, or NX-1700E card reader along with NX8v2.

√ If set to follow condition, these events will be 1 second.