BUILDING MANAGEMENT AND CONTROLLING SYSTEM FOR RESIDENTIAL APPLICATION

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Abstract

In the world of today, a major change in technology can be seen as an advantage, a number of different fields from industrial & communication to household application can be automatically controlled. Despite the popularity of the subject, one surprising aspect of building management (BA) is the scarcity of authoritative literature references regarding the topic. Building management and control system consists of a system installed in buildings that controls and monitors building services responsible for heating, cooling, ventilation, air conditioning, lighting, shading, life safety, alarm security systems, and many more. It aims at automating tasks in technologically-enabled environments, coordinating a number of electrical and mechanical devices interconnected in a distributed manner by means of underlying control networks.

INTRODUCTION

In this era, where energy management is the concern of everyone, the buildings are being constructed in a manner to provide maximum comfort and ease to the people with minimum energy utilization. This whole thing is only possible with the help of controlling devices that are to be installed in a building during construction. This controlling can be of any type, from simple switching on and off of the lights, to water motor control and many more. Therefore main idea of designing this system is to automate these operations of the plant in most resourceful manner besides controlling; security factor has also been kept in concern with password protection. Fire alarms systems, main gate security and main gate barrier automation has been kept at priority in this system. The working of BMS is totally based on the input in a form of information by the devices such as sensors; once the information is collected it can be processed with the help of controller that will further instruct the system to perform a specific task.

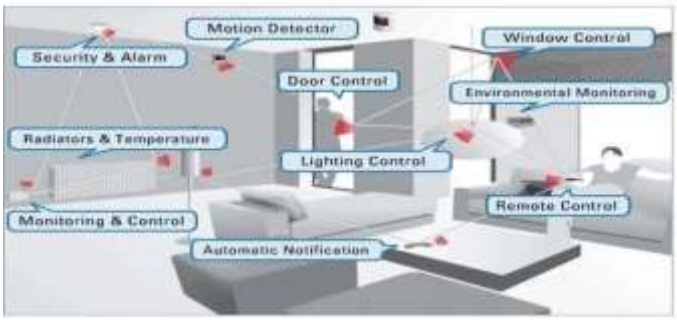


Figure 1: Building management system model

Building Management System is based on the controlling of temperature, humidity and carbon dioxide inside the building, the priority is given to maintain a specific temperature in a building by controlling the heating and cooling, which is done by operations of fan and ventilation. Beside this minimization of carbon dioxide followed by increase in oxygen has also been kept as an important feature.

This building management system is mainly designed to manage and supervise the following activities:

1. Lighting Control (lamp)
2. Air Conditioning System (fan)
3. Security System Monitoring (HMI)
4. Home Monitor (HMI)
5. Water Consumption.(Using water sensor)
6. Door Opening & Closing (Using Stepper Motor)

The Building structure is equipped with electronic circuits, power supplies, controller, sensors, and DC motors.

I. BLOCK DIAGRAM

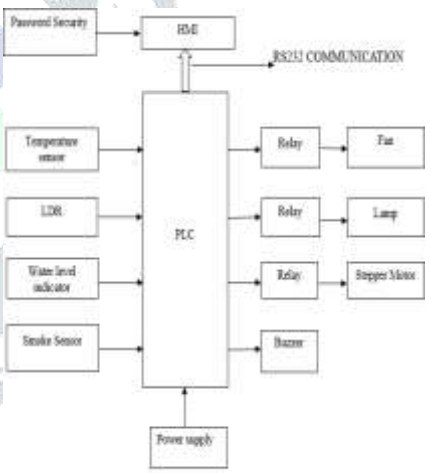


Figure 2.1: Block Diagram of BMS

A PLC is used to obtain values of physical conditions through sensors connected to it.

II. METHODOLOGY

PLC is used to obtain values of physical conditions through sensors connected to it. These integrated sensors such as the

1. Temperature sensor read to temperature values,
2. The gas sensor detects smoke and cooking gas to avoid fire outbreak
3. The automatic switching on and off of the light is controlled by the Light Dependent Resistor (LDR) which determines the day light intensity.
4. Password security in which authorized persons are allowed to register onto the system first. After authorized

registration the system allows to start monitoring. Whenever the system monitors for the password, the system scans and compared the information against the stored ones. If a match with the stored one is found, the system turn on the motor to open the door, else the system does not open the door.

If any leakage in the LPG cylinder or smoke smoke detected the PLC will automatically give alarm sound. GSM Module is used to alert the residential persons with unsecured operations.

IV. HARDWARE DESCRIPTION

A. PLC (Programmable Logic Controller)

A programmable Logic Controller (PLC) is a Solid state/computerised industrial controller that performs discrete or sequential logic in a factory environment. It was originally developed to replace mechanical relay, timers and counters. PLC's are used successfully to execute complicated control operations in a plant. A sequence of instructions is programmed by the user to the PLC memory and when the programme is executed, the controller operates a system to the correct operating specifications.

"PLC is a Special Purpose Computer which has no display, no keyboard, no printer, no hard drive and hides in the Control panel out on the factory floor, but it is still a Computer".

"Digital electronic device that uses a programmable memory to store instructions and to implement specific functions such as logic, Sequence, timing, Counting and arithmetic operations to control machines and processes".

Figure 3: PLC

Materials Details

FATEK PLC B1-20MR2-D24

- Voltage specification
  Power Input: DC +24V
- PLC Input: Configurable npn or pnp
- PLC Output: npn

Features

- Core Technology of Advanced SoC
- Compact and Rugged
- High Quality and High Reliability
- Competitive Low Price
- Easy to use, consistent instruction

Description

- 12 points 24VDC digital input (4 points 50KHz
- 2 points total 5KHz), 8 points relay output (2 points 50KHz)
- Built-in 1-2 communication ports
- Left side is expandable 0-2 modules
- Right side is expandable up to 80 I/O points.

Pin Diagram

- B1/B1z Main Units
  24 I/O points main unit (14 IN, 10 OUT)

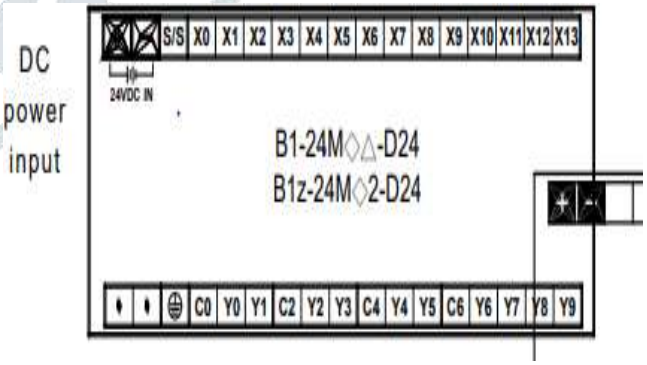


Figure 4: Pin Diagram

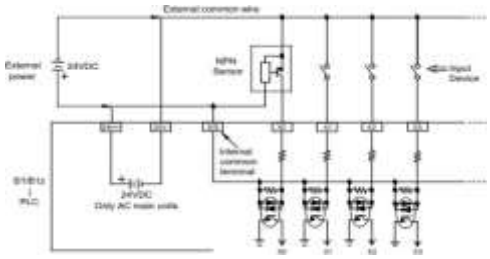


Figure 5: Wiring of 24VDC single-end SOURCE input

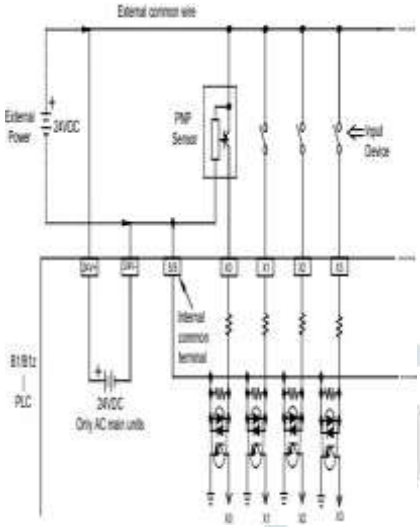


Figure 6: Wiring of relay single-end outpu

4.2 ANALOG INPUT MODULE

B1-L4AD

Figure 7: Analog Input Module

B1-L4AD is one of the analog input module of FATEK B1 series PLC,it provides 4
channels of 12-bit (coded in14 bits) analog inputs.

Specifications of B1-L4AD :

Total Channels : 4 Channel
Resolution : 12 bits
Coding Format : 14 bits (0 ～ 16383)
Signal Resolution : 2.44mV(Voltage),
4.88uA(Current)
Register Occupied : 4 Register (D4072~D4075)
Conversion Time : Updated each scan
Accuracy : ±1 %
Max. Absolute Input Rating : ±15V(Voltage), 30mA(Current)
Input Impedance : 100KΩ(Voltage), 125Ω(Current)
Output Range : 0 ～ 10V(Voltage)
0 ～ +20mA(Current)
Indicator(s) : No
Internal Power Consumption : 5V, 25mA(Max. Load)
Operating Temperature : 0 ～ 60 ℃
Storage Temperature : -20 ～ 80 ℃

Pin Diagram B1-L4AD :

Figure 8: Pin Diagram B1-L4AD

Wiring Diagram of B1-L4AD

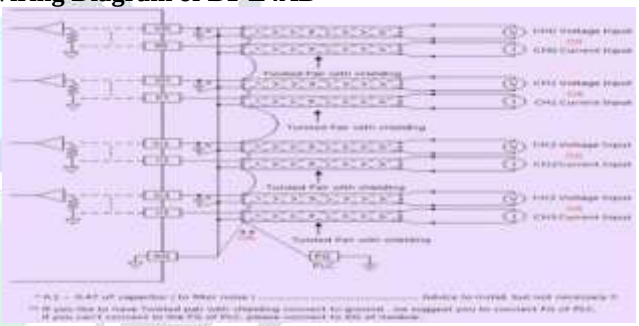


Figure 9: Wiring Diagram of B1-L4AD

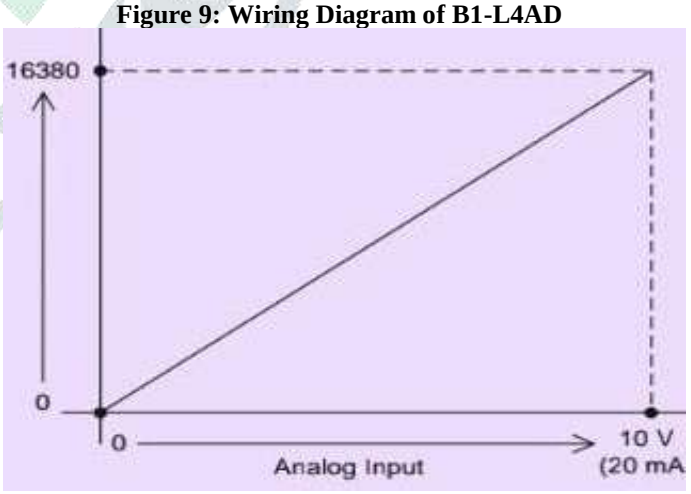


Figure 10: Characteristics Chart of B1-L4AD

B. PLC INPUTS

a. (HMI) Human Machine Interface

KINCO – HMI, Model No- MT4230T, 4.3 INCH TOUCH DISPLAY

HMI is short for Human Machine Interface. We use HMIs in industry to control and monitor machines. A very common HMI that you all encounter on a regular basis would be an ATM machine. The screen and pushbuttons allow you to operate the machine to dispense a certain amount of money, or to deposit money. One of those devices is our "Human Machine Interface" or HMI. An HMI can be mounted locally onto a panel door or in a remote panel located closer to the machinery. The HMI can be a very dynamic tool in assisting the operator in controlling and monitoring the machinery. The PLC will pass signals over the network to the HMI for monitoring and the HMI can send signals to the PLC for controlling the machinery. Operator or maintenance personnel can operate and monitor the machine from the HMI. They may include information like temperature, pressure, process steps, and material counts. They can also show very precise levels in tanks and exact positioning of machines. Where machine information used to be viewed on multiple indicators can now be viewed on one screen. The possibilities are only limited to the software and hardware used. For maintenance personnel, many HMIs can also connect to PLC logic and display it on the screen for troubleshooting purposes. This can save valuable time compared to connecting a computer or laptop every time. Another benefit of having a modern HMI is the fact that plants and other industrial sites can monitor and control multiple machines or other equipment. A small manufacturing facility could even monitor the entire plant on one centrally located HMI.

Performance Specifications:

- 65,536 True Color TFT LCD
- 32-bit, 800 MHz RISC CPU
- 128 MB FLASH +64 MB SDRAM
- 512 KB Recipe Memory, Record Data Easily
- Real-Time Clock, 2 Year Reserve Time when Powered Off
- 2 COM Ports, Supports simulations Communications; RS232/RS485

Electrical Specifications:

- Rated Power 2.4
-]Rated Voltage 24VDC

Figure 11: Kinco MT4230T

The MT4000 provides faster processing speeds. Each HMI supports simultaneous communications via its multiple serial ports, so that you may connect to numerous controllers. With the simple, convenient and powerful HMIware configuration software, the user can master their design method and create first-class programs efficiently.

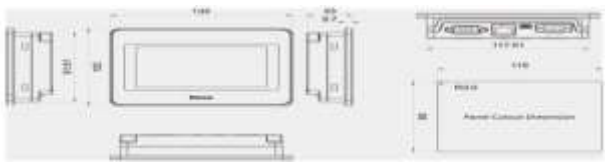


Figure 12: Dimensions of Kinco MT42

Password Security Available: For home monitoring.

Communication between PLC & HMI:

- RS232 is a form of serial data transmission. Or simply put, it is a form of communication. Most people simply called it a serial connection.
- At one time, it was the most used form of data transmission. You will probably recognize the standard 9 pin DB9 cable. Simply put, RS232 transmits signals using a positive voltage for a binary 0 and a negative voltage for a binary 1
- PLCs use RS232 to talk to other modules or even other PLCs. These modules can be anything that also uses RS232 such as, operator interface or HMI, computers, motor controllers or drives, a robot, or some kind of vision system.
- One important thing to remember if you find yourself using RS232 devices is that there are actually two different types.
- DTE stands for Data Terminal Equipment. A common example of this is a computer. DCE stands for Data Communications Equipment. An example of DCE is a modem.

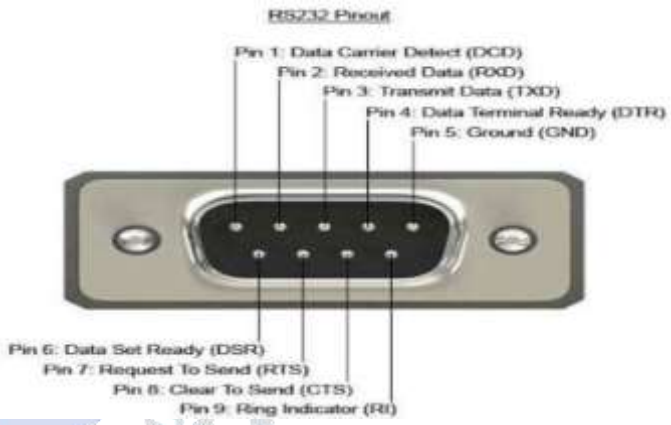


Figure 13: Pin Details of Communication between PLC and HM

b. SENSORS

A sensor is a device that detects and responds to some type of input from the physical environment. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

Some of the sensors we have used for the PLC inputs are

- Temperature sensor
- LDR sensor
- Smoke sensor
- Water level indicator sensor

1) Temperature sensor:

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes.There are different types of temperature sensors such as RTDs, thermistors, thermocouple sensors and semi conductor type sensors etc.,.

We have used PT100 temperature sensor. It is a RTD sensor.It is just like a variable resistor, whose resistance varies with respect to the environment temperature. There are many types of PT100 sensors, the one we use here is a two wire one.

Features

- Platinum Resistant Thermometer (PRT)
- Temperature Range: -200°C to 850°C
- Resistance Range: 1.849K to 39.026K

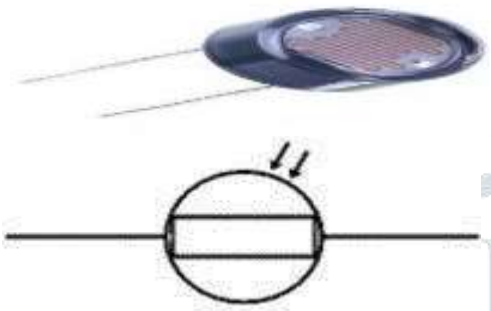
- Accuracy: ±0.1°C
- Nominal Resistance: 100Ω at 0°C

- **Figure 14: Temperature Sensor (PT100)**

2) LDR sensor (Light Dependent Resistor)

- An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

- **Figure 15: LDR Sensor**



- The above shows the typical LDR sensor and it's circuit symbol. LDR has a resistance that falls with an increase in the light intensity falling upon the device .

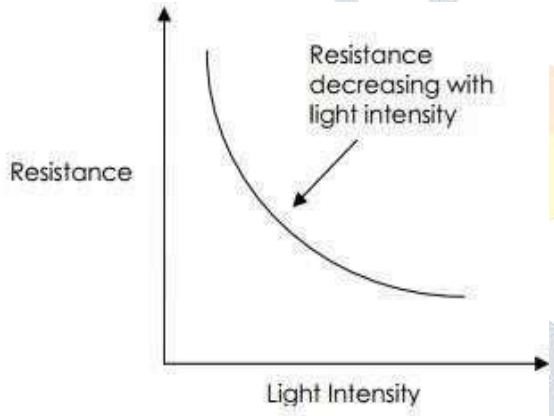


Figure 16: Characteristic graph of light intensity and resistance

- Above shows the Variation in resistance with changing light intensity.The resistance of an LDR may typically have the following resistances:
- Daylight= 5000Ω
- Dark= 20000000Ω
- LDR sensor may be used as lightening switch,camera shutter control etc.,

3) Water level indicator

A water level indicator is a system that relays information back to a control panel to indicate

4) Smoke sensor

Figure 17: Smoke Sensor

A smoke detector is a device that senses smoke, typically as an indicator of fire. Smoke detectors in large commercial, industrial, and residential buildings are usually powered by a central fire alarm system, which is powered by the building power with a battery backup. Domestic smoke detectors range from individual battery-powered units, to several interlinked mains-powered units with battery backup; with these interlinked units, if any unit detects smoke, all trigger even if household power has gone out.

C. PLC Outputs

a. Relay

Figure 18: Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations there of. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

b. Fan

Figure 19: Fan

A fan is a powered machine used to create flow within a fluid, typically a gas such as air. A fan consists of a rotating arrangement of vanes or blades which act on the air.Here 230v AC fan we are using.

c. Lamp

Figure 20: Lamp

A fluorescent lamp, or fluorescent tube, is a low-pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light. An electric current in the gas excites mercury vapor, which produces short-wave ultraviolet light that then causes a phosphor coating on the inside of the lamp to glow. A fluorescent lamp converts electrical energy into useful light much more efficiently than incandescent lamps. The typical luminous efficacy of fluorescent lighting systems is 50–100 lumens per watt, several times the efficacy of incandescent bulbs with comparable light output.

d. Stepper Motor

Figure 21: Stepper Motor

A stepper motor, also known as step motor or stepping motor, is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

The stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. Advantages of step motors are low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment.

e. Buzzer

Figure 22: Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

D. Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load.

1. AC Power Supply
2. DC Power Supply

a. AC Power Supply: In electricity, alternating current (AC) occurs when charge carriers in a conductor or semiconductor periodically reverse their direction of movement. The voltage of an AC power source can be easily changed by means of a power transformer and it is 230V.

b. DC Power Supply: A DC power supply is one that supplies a constant DC voltage to its load. Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains. A DC power supply takes energy from a power input and gives it to a power output. Input can come from batteries, generators, fuel cells, solar power converters, or alternators. The DC power source harnesses the energy and gives it to an electrical load. Here we are using SMPS, SMPS stands for switch-mode power supply. Its job is to convert wall-voltage AC power to lower voltage DC power. A feedback circuit adjusts the switching rate to maintain the desired DC voltage at the output based on the present load.

V. SOFTWARE DESCRIPTION

E. Fatek PLC

Winpro Ladder Software for Simulation

Ladder logic program is exactly similar to electrical Ladder diagram. It is readily understood and maintained by skilled workers familiar with relay Logic. It provides a graphic display of program execution by showing power flow through a ladder diagram, thereby making it easier to debug

Features

- Can simulate the FATEK PLC ladder program execution without PLC connection.
- With providing single/multiple/continuous scan mode, the execution result at each scan end can be easily checked.
- With providing program address breakpoint and data breakpoint, it is convenient to check any intermediate execution result and to identify any data changed.
- Provides communication interface allows external program or device (For example, graphic panel or HMI) to modify or monitor the variable value during the simulation.
- With run time editing feature, during the simulation process the program can be modified without stop the execution.

F. Kinco HMI

Kinco HMIware 2.5 Version

Kinco HMIware Configuration Software is a human-machine interface(HMI)
configuration software developed by Kinco Electric (Shanghai) Ltd. It is special for MT4000/5000 series HMI. Kinco HMIware provides a powerful integrated development environment for users. Products are widely applied in various kinds of fields such as medical, chemical industry, electric power, printing, textile, food, national defense and engineering machinery, intelligent household, high speed railway.

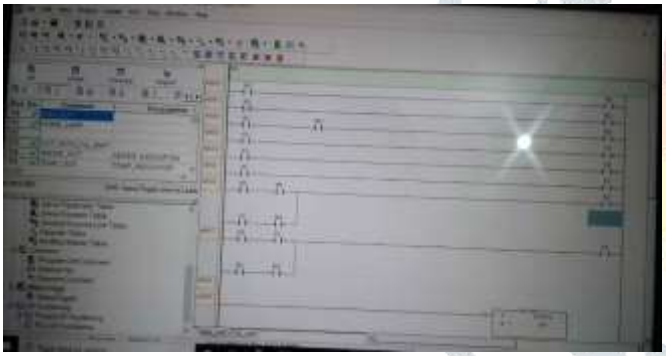


Figure 23: Ladder logic programme

Figure 24: Display screen

Figure 25: Display screen

Figure 26: Display screen

VI. WORKING OF THE HARDWARE MODEL

Plc is used for sending control sending to HMI. The HMI is used for displaying, monitoring and controlling actions. They are programmed according to the required control actions in their respective software's.

In order to operate the system the user should first log in to the system using security password. After that the door gets open and the remaining sensors starts operating. We have explained the sensors operation below.

LDR Sensor: It is light dependent sensor, if the intensity of incoming light is equal to the intensity of LDR sensor, the sensor remains as usual. If the intensity is lower then the sensor sends this control signal to the PLC -HMI system and the lamp glows.

Smoke sensor: If there is gas or smoke sensed by the sensor, it sends signal to HMI there by giving control signal to the alarm circuit and thus it warns the owner by siren. thereby protecting the system from danger or fire.

Temperature sensor: It is a dependent sensor. If there is more temperature, it sends signals to HMI and makes the fan to run and also it is used to indicate the temperature in the room with the help of temperature indicator.

Water level sensor: This sensor regularly senses water in the tank in which it is placed and indicates the water level through level indicator, hence if the water content is low or

high it alerts the people to know the water availability.

Figure 27: Layout

Figure 28: Outer cover of the model

Figure 29: Hardware Model

Figure 30: Hardware Model

Figure 31: Sectional view of Model

VII. ADVANTAGES AND APPLICATIONS

G. ADVANTAGES

1. Building automation – This project can be used to control various Home Appliances
2. We can control device from a long distance, thus it gives ease of access.
3. Password security for door access.
4. No need to carry separate remote or any other controlling unit.

H. APPLICATIONS

1. Home automation
2. Industrial Security.
3. Industrial automation

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VIII.EXPECTED OUTCOME

- Its mandatory for the system to have an authentication process to enter the building, to avoid any kind of unauthorized access, they need to validate password.
- Produce an implemented system that controls and monitors the house gadgets in different conditions.
- Produce a smart building system that efficiently reduces energy wastages.
- Security alerts will be sent via SMS during emergency.

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