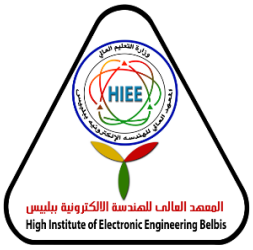
Ministry of Higher Education,
High Institute of Electronic Engineering,
Ministerial Resolution 5053 - 12/10/2009,
K 10, Bilbies – 10th of Ramadan



Ministry of Higher Education,
High Institute of Electronic Engineering,
Department of Computers and Systems Engineering.

Graduation Project

SMART Home

Supervised By

Prof. Dr. / Essam Nabil

Department of Computers and Systems Engineering,

High Institute of Electronic Engineering.

Supervisors **Head of the Department** **Dean**

2021 / 2022

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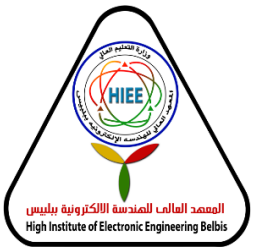

Department of Computers and Systems Engineering.

SMART Home

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2021 / 2022

إهـــــــــداء

﴿بِسْمِ اللهِ الرَّحْمنِ الرَّحِيمِ﴾

﴿وَقُلِ اعْمَلُواْ فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ﴾

إلهي لايطيب الليل إلا بشكرك ولايطيب النهار إلى بطاعتك .. ولاتطيب اللحظات إلا بذكرك .. ولا تطيب الآخرة إلا بعفوك .. ولا تطيب الجنة إلا برؤيتك

الله جل جلاله

إلى من بلغ الرسالة وأدى الأمانة .. ونصح الأمة .. إلى نبي الرحمة ونور العالمين..

سيدنا محمد صلى الله عليه وسلم

إلى من كلله الله بالهيبة والوقار .. إلى من علمني العطاء بدون انتظار .. إلى من أحمل أسمه بكل افتخار .. أرجو من الله أن يمد في عمرك لترى ثماراً قد حان قطافها بعد طول انتظار وستبقى كلماتك نجوم أهتدي بها بالليل وبالنهار.

والدي العزيز

إلى ملاكي في الحياة .. إلى الشمعة المتقدة لتنير ظلمة حياتي إلى بسمة الحياة وسر الوجود

إلى من كان دعائها سر نجاحي وحنانها بلسم جراحي إلى أغلى الحبايب

أمي الحبيبة

إلى من أرى التفاؤل بعينهم .. والسعادة في ضحكتهم إلى رياحين حياتى

إخوتى.

إلى إخوة لم تلدهن أمي .. إلى من تحلو بالإخاء وتميزوا بالوفاء والعطاء إلى ينابيع الصدق الصافي إلى من معهم سعدت ، وبرفقتهم في دروب الحياة الحلوة والحزينة سرت إلى من كانوا معي على طريق النجاح والخير

إلى من عرفت كيف أجدهم وعلموني أن لا أضيعهم

أصدقائى

إلى كل من أشعل شمعة في دروب عملنا وإلى من وقف ليعطى من حصيلة فكره لينير دربنا

إلى من نقول له بشراك قول رسول الله صلى الله عليه وسلم":إن الحوت في البحر ، والطير في السماء ، ليصلون على معلم الناس الخير"

أساتذتى الكرام


وَقُلِ اعْمَلُوا
فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ

ABSRACT

Installing a smart home technology system provides homeowners with convenience and secure. Rather than controlling appliances, opening doors, lighting, and other features using different devices, they can control them all using one device usually a smartphone or tablet. Since they're connected to a portable device, users can get notifications and updates on issues in their homes. For instance, smart doorbells allow homeowners to see and communicate with people who come to their doors even when they're not at home. Users can set and control the internal temperature, lighting, and appliances as well.

Project Systems:

1. **Automatic Night Lighting system**
2. **Solar system power**
3. **Firefighting system**
4. **Smart Garage door**
5. **Weather Monitoring system**
6. **Rain Detector System**
7. **Smart Security system**
8. **printed circuit board (PCB)**
9. **Mobile Application**

Project objectives.

The main objective of this project is:

- Smart home allows homeowners to control appliances, opening and closing doors, lights, and other devices remotely using a smartphone or tablet through an internet connection.
- Smart homes can be set up through wireless or hardwired systems.
- Smart home technology provides homeowners with convenience and cost savings.

- Security risks and bugs continue to plague makers and users of smart home technology.

Contents

Chapter One

Introduction To SMART Home

Introduction

A smart home is a house that has devices, which are connected to the internet, to enable remote management and monitoring of appliances and systems such as lighting, heating, etc. Often referred to as home automation, smart homes provide home owners with a sense of security, comfort, energy-efficiency and convenience at the same time, by providing them access to control the smart devices installed in their home, through a smart home app or other networked devices. Usually, smart home automation systems, which are a part of Internet of Things (IoT), share consumer usage data among themselves, to operate together and automate actions based on the preferences of the home owner. Its refers to a convenient home setup where appliances and devices can be automatically controlled remotely from anywhere with an internet connection using a mobile or other networked device. Devices in a smart home are interconnected through the internet, allowing the user to control functions such as security access to the home, temperature, lighting, and a home theater remotely.

1.2 literature Review of Smart Homes

Various definitions have been used to define smart homes (Table 1). Among the different approaches, the definitions by Aldrich [44] and Lutolf [45] covered the nature of smart homes in a pervasive way. Aldrich [44] defined a smart home as “a residence equipped with computing and information technology, which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond”.

Their definition embraced the technological component of the phenomenon, the services and functions it provides and the types of user needs that smart homes aim to meet. A similar approach was followed by Lutolf's [45] definition, which described smart homes as "the integration of different services within a home by employing a common communication system. It assures an economic, secure and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility". [11]

Although the two definitions share similar principles, they differ in the services that the technology provides and the types of user needs it aims to satisfy. More broadly, the majority of scholars refer to technological attributes when defining smart homes. Balta-Ozkan's [46] definition states that the "smart home is a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed or controlled, and provide services that respond to the needs of its inhabitants". De Silva et al. [15] followed a similar approach without specifying the technological elements of smart homes. The authors stated that it is "a home-like environment that possesses ambient intelligence and automatic control, which allows it to respond to the behavior of residents and provide them with various facilities". The definitions by Balta-Ozkan [46] and De Silva et al. [15] share the idea of the capability to respond to residents' needs through automated technology. The technological perspective was also supported by Diegel et al. [47], who described it as a system, enhanced with four levels of smartness, namely smart appliances, smart control, smart management and smart sensors. Integration and collaboration of these four levels of smartness creates a living environment in the house.

The service/context-led definition is another approach to defining the smart home. From the perspectives of Kofler et al. [48] and Scott [49] the main service a smart home provides is the management of energy consumption. The vision of Kofler et al. [48] is that an intelligent house is equipped with multiple devices that cooperate with each other as a homogeneous system to monitor electronic appliances, promote efficient energy management and sustainability. Scott [49] clarified that the service is enabled by the integration of technological features, such as smart heating and smart meters. This group of definitions places more emphasis on sustainability and energy consumption and promotes the potential of smart home services to improve users' comfort. Focusing on a different context, Chan et al. [1] emphasized healthcare needs from the perspective of ageing users. This definition states that a "smart home is a house, which promises to provide cost effective home care for the ageing population and vulnerable users". There are a number of other conceptual explanations that support the concept of smart home technology to meet the needs of ageing people, enhance the quality of life and promote independent living for residents [18, 50-52]. Remotely controllable assistive technology made it possible to propose services that would meet the demands of an elderly population [18] .

There is significant overlap among the above-mentioned definitions, which share three characteristics in common: technology, services and the ability to satisfy users' needs. The core of the smart home is the technology, which consists of hardware and software components, including sensors and home appliances. Being represented as objects or electronic devices, sensors are capable of detecting changes in human behavior and other stimuli from the environment [4, 53].

Sensors are integrated into home appliances through wireless and wired systems that make it possible to monitor and track residents when they are watching TV, cooking, sleeping, cleaning and doing a range of other activities [53]. The system represents configurations of appliances and sensors that produce a variability of functions and services, tailored to residents' needs [9]. Put differently, the architecture of 12
technology determines the services and the benefits the smart home aims to provide [1]. When it comes to lifestyle support, a smart home represents a house with sensors and domestic devices, linked through a communication network. It empowers users to remotely control household appliances and decrease the burden of everyday household activities [9, 12]. Connected devices provide an opportunity for smart home residents to effectively manage their energy usage, while enhancing their convenience and comfort in their daily routine [49]. Fully-automated devices have the potential to improve the quality of life and encourage the independent living of residents, especially for an ageing population through constant health management, and they even provide virtual medical assistance in cases of need [53]. The smart home represents smart devices and sensors that are integrated into an intelligent system, offering management, monitoring, support and responsive services and embracing a range of economic, social, health-related, emotional, sustainability and security benefits

Table 1: Definitions and characteristics of Smart Homes

Definition based on theme	Technology			Services				Users' Needs						
Authors	Sensors	Devices	Integrated systems	Control/monitor	Energy management	Support and assist	Anticipate and respond	Cost-efficiency	Comfort	Emotional	Security	healthcare	Quality of life	Sustainability
Aldrich [44]			x		x		x		x	x	x		x	
Lutolf [45]			x		x			x	x		x		x	
De Silva *et al.* [15]			x	x									x	
Reinisch and Kofler [48]			x	x	x			x	x			x	x	x
Scott [49]		x	x		x			x	x				x	x
Balta-Ozkan [2]	x	x	x	x									x	
Chan *et al.* [1]						x		x				x	x	
Diegel *et al.* [47]	x	x		x	x								x	
Alam *et al.* [18]		x				x						x	x	

Chapter Tow

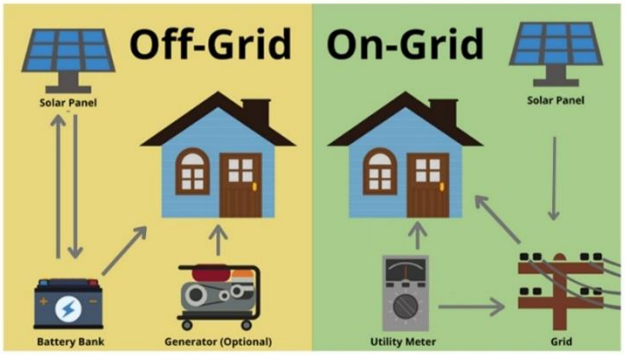
Solar Power System

Introduction

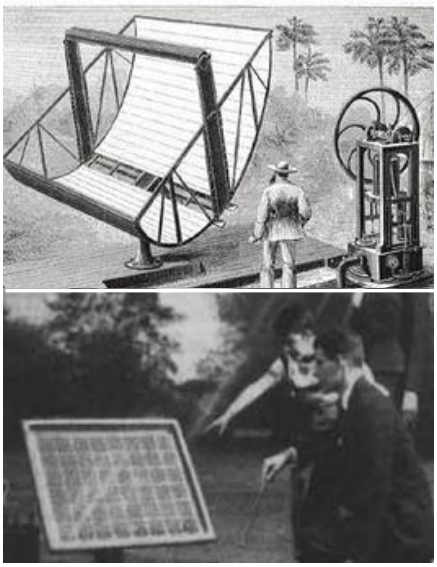
The sun throws out a vast amount of energy " 885 million terawatt hours every year " in the form of photons. These are fast-moving waves that bring energy to earth as heat, light, and radiation. If the energy is converted into electricity directly using devices based on semiconductor materials, we call it photo voltaic (PV). The term photovoltaic consists of the Greek word φως (phos), which means light, and -volt, which refers to electricity and is a reverence to the Italian physicist Alessandro Volta (1745-1827) who invented the battery The solar cell is the elementary building block of photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice.

number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a ‘photovoltaic module’. Modules are designed to supply electricity at a certain voltage. The current produced is directly dependent on the intensity of light reaching the module. Several modules can be wired together to form an array. Photovoltaic modules and arrays produce direct-current electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

There are two main types of photovoltaic system. Grid connected systems (on-grid systems) are connected to the grid and inject the electricity into the grid. For this reason, the direct current produced by the solar modules is converted into a grid-compatible alternating current. However, solar power plants can also be operated without the grid and are then called autonomous systems (off-grid systems).



2.2 History Of Solar Power :



Solar energy is one of the oldest energy used in the entire world and today forms a large part of the most widespread and clean renewable energy sources.

We understand from that, Solar technology isn't new. Its history spans from the 7th Century B.C. to today.

We started out concentrating the sun's heat with glass and mirrors to light fires. Today, we have everything from solar-powered buildings to solar powered vehicles.

The milestones in the historical development of solar technology from the 7th Century B.C. to the 1200s A.D :

- 7th Century B.C : Magnifying glass used to concentrate sun's rays to make fire and to burn ants.
- 3rd Century B.C : Greeks and Romans use burning mirrors to light torches for religious purposes.
- 2nd Century B.C : The Greek scientist, Archimedes, used the reflective properties of bronze shields to focus sunlight and to set fire to wooden ships from the Roman Empire which were besieging Syracuse.
- 20 A.D : Chinese document use of burning mirrors to light torches for religious purposes.
- 1st to 4th Century A.D : The famous Roman bathhouses in the first to fourth centuries A.D. had large south facing windows to let in the sun's warmth.
- 6th Century A.D : Sunrooms on houses and public buildings were so common that the Justinian Code initiated "sun rights" to ensure individual access to the sun.
- 1200s A.D : Ancestors of Pueblo people called Anasazi in North America live in south-facing cliff dwellings that capture the winter sun.

2.3 Component

2.3.1 Solar Panels

"A panel designed to absorb the sun ' s rays as a source of energy for generating electricity or heating."

Types of Solar Panels :

1. Monocrystalline
    - Pure silicon
    - 24.4% Efficiency
    - Moderate cost
    - Longest lifespan
    -

2. Polycrystalline
    - Silicon crystals melted together
    - 19.9% Efficiency
    - Least expensive cost
    - Moderate lifespan

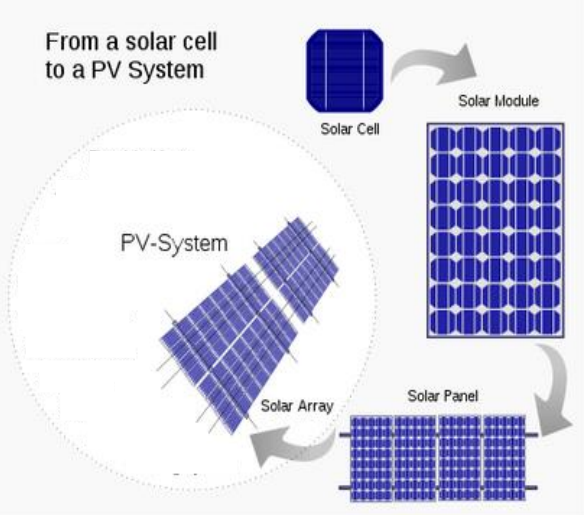
3. Thin-Film
    - A variety of materials
    - 18.9% Efficiency
    - Most expensive cost
    - Shortest lifespan

“In this project we used poly crystalline”

Physical Specification :

2w 12v Solar Panel
Size: 136mm x 110mm
Operating temp : -20 ~ +60 C
Back cover: PCB
Weight : 60g

Here is an image which will help you better understand some basic terminology.



- Solar Cell: Semiconductor device that converts sunlight into direct current (DC) electricity
- Module: PV modules consist of PV cell circuits sealed in an environmentally protective laminate and are the fundamental building block of PV systems
- Solar Panel: Includes one or more PV modules assembled as a pre-wired, field-installable unit
- Array: A PV array is the complete power-generating unit, consisting of any number of PV modules and panels

All solar photovoltaic (PV) panels use crystalline silicon wafers as the main component material. Silicon is used to create semiconductors for about 95% of all solar panels on the market today, with the other 5% using experimental and in-development technologies like organic photovoltaic cells.

We note that silicon is the predominant material used in the construction of solar panels, and this raises the questions about "Why was silicon used as a semiconductor material for the photovoltaic unit?" Silicon is characterized by having many ideal properties that made it the ideal candidate as a semiconductor material, and its advantages are :

- Available in abundance and
- at reasonable prices Chemically and electronically speaking, silicone is quite easy to optimize for the photovoltaic

- effect that efficiently converts sunlight into electricity
- Having a long lifespan, making the investment in solar panels even more fruitful.

What toxic materials are in solar panels?

Some of the metal and chemical materials in a solar panel can be toxic and hazardous if exposed to people, including panels that may have cadmium telluride, arsenic, hexavalent chromium coatings, copper or selenium. In typical operation, though, these materials are securely contained and don't pose any direct risk.

2.3.2 Charge Controller

Is fundamentally a voltage or current controller to charge the battery and keep electric cells from overcharging.

Specifications :

- Rated Charge Current: 10A
- Rated Discharge Current: 10A
- Rated Charge Power for 12V : 120W
- Rated Charge Power for 24V : 240W
- System Voltage : 12V/24V Auto

2.3.3 Battery

We used Sealed Lead Acid Battery.

Description:

- Rechargeable battery 12V 7A hour.
- Dimensions 150x65x95mm.
- Brand : Ultracell

2.4 How to Calculate your Energy Load ?

Multiply the power used by each appliance times the hours per day that you use it – this gives you the total number of kWh per day for that appliance. Add up all the appliances and you will have the total number of kWh that you need per day.

Appliance	no of units	power consumption of each unit (W)	power (Wh)	Maximum Power consumption (kWh/day)	Average power consumption (kWh/day)
Refrigerator	50	80	4000	96	96
TV	50	70	3500	84	18.55
Fluorescent light bulb	250	22	5500	132	40.7
Fan	100	50	5000	120	54.166
CD/DVD player	50	50	2500	60	4.34

2.5 HOW IT WORKS

Each PV cell is made up of two layers of semi conducting material, most commonly silicon. One layer has a positive charge and the other a negative charge. The charges are added to each layer by adding another material. To create the negative charge in one layer, phosphorous is commonly added which results in more electrons. To create the positive charge in the other layer, boron is commonly added which results in less electrons. The layering of positive and negative charges creates an electric field at the junction of the layers.

When sunlight hits the PV Cell it is absorbed by the semiconductor material. The absorption of sunlight pushes an electron free of the electric field. Metal cond0uctive plates on both cell layers and a wire connecting them form a circuit which allows the ‘freed’ electrons (e-) to flow as DC electrical current. The electrical current can be used to power things on site, stored or connected to the grid (load).

The electrical current produced is dependent on how much sunlight is absorbed. As silicon is shiny and reflects sunlight, an antireflective coating is generally applied to reduce reflection losses. The electrical current together with the cell's voltage (produced by the electric field) defines the power (wattage) that a solar cell can produce.

2.6 Solar Power Applications :

There are many applications that include solar energy in its installation because of its advantages in several factors, the most prominent of these applications are the following :

- Solar electricity
- Solar water heating
- Solar heating for building
- Solar ventilation
- Solar lighting
- Portable solar
- Solar transportation
- Solar distillation
- Solar pumping
- Solar drying of agricultural and animal producing
- Solar furnaces
- Solar cooking
- Solar greenhouse

2.7 Advantages & Disadvantages

Advantages :

- Renewable and Pollution Free
- More Solar Energy in Summer
- Diverse Application
- Less to No Maintenance for Years
- Can be Stored in Battery Reduce Electricity Bill Safe option
- Easy instalment Improved efficiencies

Disadvantages :

- Needs Lots of Space
- Less Solar Energy in Winter
- DC Equipment are Expensive
- No Solar Power at Night and Cloudy Days
- Expensive Battery High Initial Cost

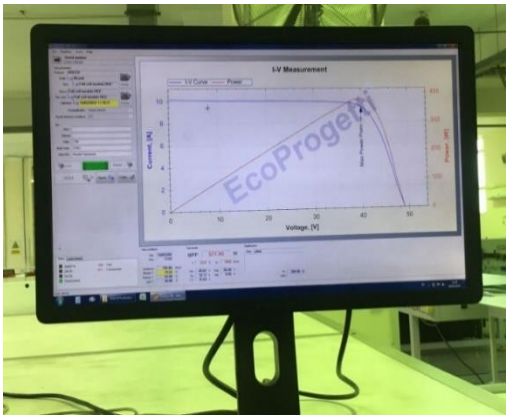
To gain the greatest benefit and a large amount of information to work on the project, we visited the Arab Organization for Industrialization, and these are

some pictures from the visit :

Solar panel production steps

vacuum pump and laminator

Glass Washing



I-V Measurement

Solar Panel

Chapter Three

Automatic Night Lighting System

Introduction

The simplest and often, most effective way to save energy on lighting is by turning lights off. In commercial environments it can be difficult for workers to remember to turn off unneeded lighting. Automatic lighting controls offer an inexpensive, effective way to minimize lighting costs, by turning unneeded lights off, or in some cases, dimming lights.

- It is a simple and powerful concept, which uses MOSFT as a switch to switch ON and OFF the street light system automatically.
- It automatically switches ON lights when the sunlight goes below the visible region of our eyes. (in evening after Sunset).
- It automatically switches OFF lights when Sunlight fall on sensor called LDR (Light Dependent Resistor) in morning. LDR can sense the light just like our eyes .

3.2 Objectives :

- By using this Automatic system for street light controlling, we can reduce energy consumption because the manually operated street lights are not switched off properly even the sunlight comes and also not switched on earlier before sunset.
- In sunny and rainy days, ON and OFF time differ noticeably which is one of the major disadvantage of using timer circuits or manual operation for switching the street light system.

3.3 Components :

- LDR
- IRF740 MOSFET
- 30K Ohm & 20 Ohm Resistors
- Regulator 5v
- 12v LEDS
- Small LEDS

1- LDR :

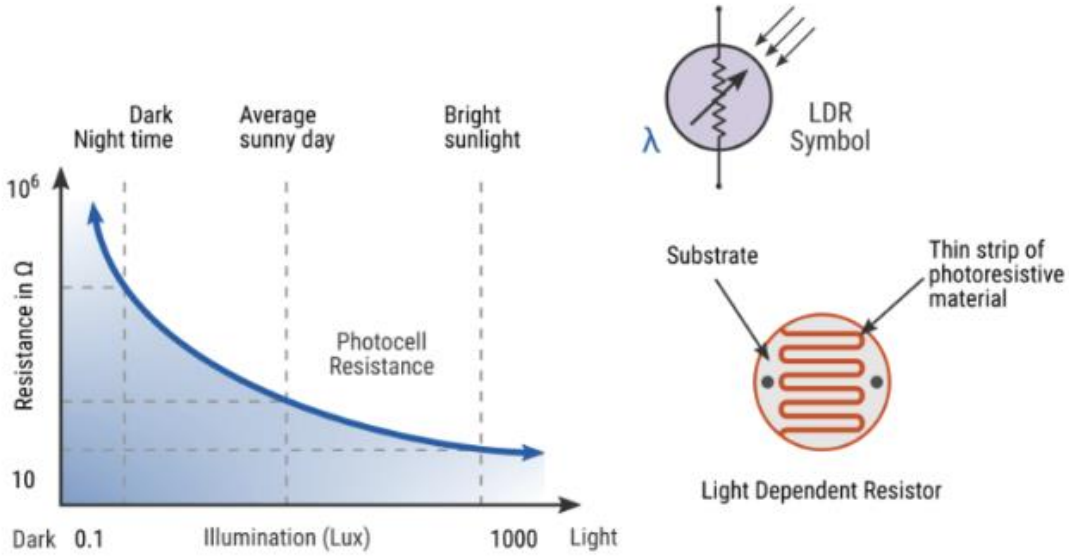
Photo resistor or light dependent resistor is an electronic component that is sensitive to light. When light falls upon it , then the resistance changes.

Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases. The Photo resistor is made of semiconductor materials with high resistance and sensitivity to light, and covered with insulating ceramic material to withstand high temperature, as it contains cadmium sulfide (positive and negative side).

LDR is built with a zigzag track of photo-sensitive material (photo resistor), When the light falls on the photo resistor, the resistance of the photo resistor decreases , While in the dark, the sensor can have resistance as high as a

thousand or mega ohms. In the light, its resistance drops to a few hundred ohms.

The below diagram shows the LDR resistance vs illumination characteristic curve.



2- IRF 740 MOSFET

The IRF740 is an N-Channel Power MOSFET which can switch loads up to 400V.

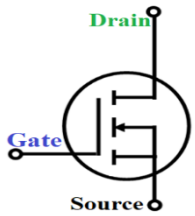
The main principle of the MOSFET device is to be able to control the voltage and current flow between the source and drain terminals.

It works almost like a switch and the functionality of the device is based on the MOS capacitor. The MOS capacitor is the main part of MOSFET which is the semiconductor surface below the oxide layers between the source and drain terminal.

The MOSFET will operate as a three-terminal device:

- Drain
- Source
- Gate

Symbol Of MOSFET:



Description	Pin Name	Pin Number
Current flows out through Source (maximum 10A)	Source	1
Controls the biasing of the MOSFET (Threshold voltage 10V)	Gate	2
Current flows in through Drain	Drain	3

3- Resistor (30k Ohm) :

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

It works to limit the passage of electric current and at the same time it reduces the voltage levels within the electrical circuit.

Resistors maybe fixed resistance or variable

Resistance, In our circuit we use 30k ohm fixed resistance.

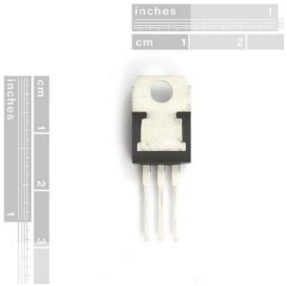
4- Regulator 5v :

This is the basic L7805 voltage regulator, a three-terminal positive regulator with a 5V fixed output voltage.

This fixed regulator provides a local regulation, internal current limiting, thermal shut-down control, and safe area protection for your project.

Each one of these voltage regulators can output a max current of 1.5A .

Features :

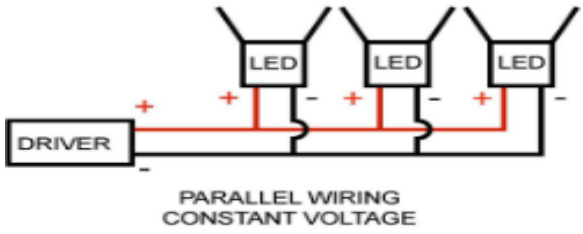


- Output Voltage: 5V
- Output Current: 1.5A
- Thermal Overload Protection
- Short Circuit Protection
- Output Transition SOA Protection

5- 12v LEDS :

- We use 8 LEDS 12v with white Light.
- It Was connected In parallel

Connected in parallel overview



Objectives of connected in parallel:

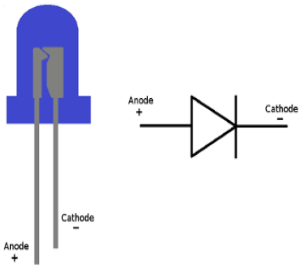
- In parallel combination each appliance gets the full voltage.
- If one appliance is broke down , others are not affected.
- The parallel circuit divides the current through the appliances,
- Each appliance gets proper current depending on its resistance.

6- Small LEDS :

An LED is a two-lead semiconductor light source, which emits lights when activated.

Features and Technical Specifications:

- Superior weather resistance
- 5mm Round Standard Directivity
- UV Resistant Eproxy
- Forward Current (IF): 30mA
- Forward Voltage (VF): 1.8V to 2.4V
- Reverse Voltage: 5V
- Operating Temperature: -30℃ to +85℃
- Storage Temperature: -40℃ to +100℃
- Luminous Intensity: 20mcd



LEDS Configuration Pin out :

• **Anode**	• **Positive terminal of LED**
• **Cathode**	• **Negative terminal of LED**

3.4 Working Principle :

LDR is photoconductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the LDR, then the electrons in the valence band of the material are eager to the conduction band.

When light falls on the LDR then the resistance decreases, and increases in the dark. When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease. These

photons in the incident light must have energy greater than the band gap of the semiconductor material. This makes the electrons to jump from the valence band to conduction.

the MOSFET device is to be able to control the voltage and current flow between the source and drain terminals.

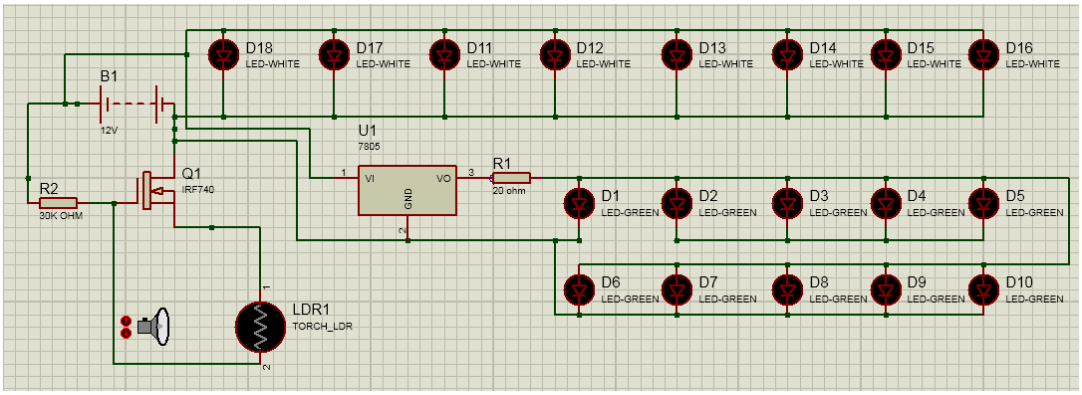
3.5 How it Work :

The MOSFET in our circuit works As A switch that Can control LEDS And change its condition ON or OFF Depends on the information that came from LDR which sense the light And when it happened the resistance value will be Decreases, In this time the MOSFET Start its main work and switch lights ON And when the Resistance of LDR Became Increase the MOSFET Turn Lights OFF.

3.6 How To Connect :

- First Put MOSFET on board, It have 3 legs:
  1. Drain connected to GND
  2. Source Connected to LDR & GND
  3. Gate connected to other Leg Of LDR & 30K OHM & VCC 12v
- Then We Connected 12v LEDS TO GND & VCC
- After That We Connected Regulator and it have 3 legs:
  1. Input connected to 12v VCC
  2. Ground Connected to GND
  3. Output Connected to 20 ohm Resistance
- Finally We connected small LEDS With Regulator, Negative legs on LEGS Connected to GND Positive Leg of Each LED Connected to 20ohm Resistance

3.7 Circuit Design



We Use 10 LEDS With Green Light.

Chapter Four

Microcontroller Applications

Chapter Contents

ESP32
Microcontroller

4.1.1 Microcontroller ESP-32 :

Esp32 DevKit v1 is one of the development board created to evaluate the ESP-WROOM-32 module. It is based on the ESP32 microcontroller that boasts WIFI , Bluetooth, Ethernet and Low Power support all in a single chip.

ESP32 is already integrated antenna and RF balun , power amplifier, low-noise amplifiers, filters, and power management module. The entire solution takes up the least amount of printed circuit board area This board is used with 2.4 GHz dual-mode Wi-Fi and Bluetooth chips by TSMC 40nm low power technology, power and RF properties best, which is safe, reliable, and scalable to a variety of applications.

4.1.2 Features of the ESP32 :

Processors:

- CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS .
- Clock speed : 240 Mhz

Memory:

- Internal memory

  ROM : 448 KB for booting and core functions .

  SRAM : 520 KB for data and instructions .

  SRAM in RTC : 16 KB for co-processor accessing during deep-sleep mode .
- External Memory

  ESP32 can address up to 16 MB external flash and 8 MB external SRAM .

Security:

- IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3 (depending on version)[5] and WAPI .
- Encryption is intended for encrypting the contents of the ESP32's off-chip flash memory .
- As a result , physical readout of flash will not be sufficient to cover most flash content .

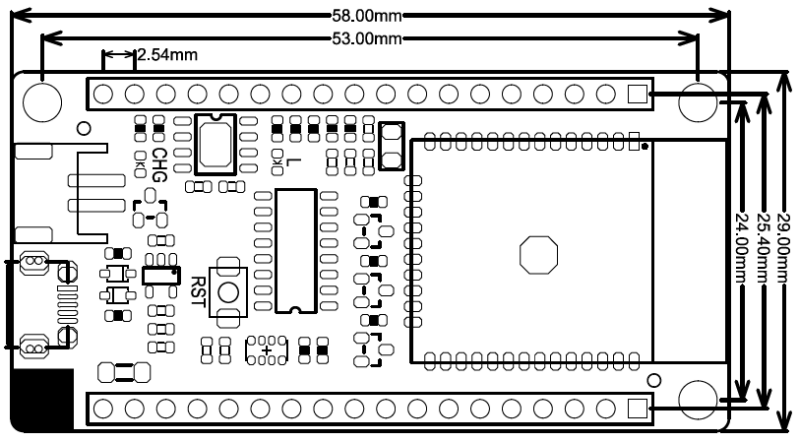
Power management:

- Internal low-dropout regulator .
- Individual power domain for RTC .
- 5 μA deep sleep current .
- Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt .

Wireless connectivity :

- WIFI : 150.0 Mbps data rate with HT40 .
- Bluetooth : BLE (Bluetooth Low Energy) and Bluetooth Classic .

4.1.3 Dimensions :



4.1.4 Power :

1. **USB :**

   The easiest way to power your ESP32 dev kit is to use the USB port. The dev kit includes a micro USB port through which you can both supply power to the board, and implement serial communication with the host computer for uploading a sketch.

Warning

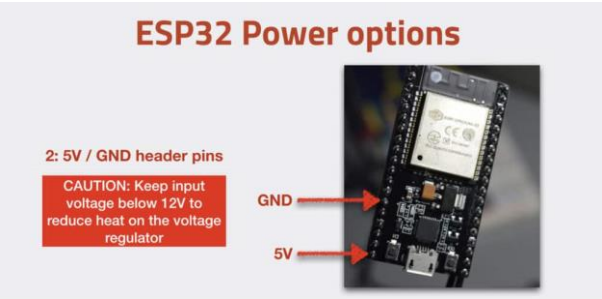
The power supply must be provided using **one and only one of the options above,**otherwise the board and/or the power supply source can be damaged .

   Just plug one end of the cable into your computer's USB port or to a USB compatible power, the other end to the USB port of the ESP32 dev kit, and you're good to go

2. **Unregulated power to GND and 5V pins :**

   The second option is to connect an external unregulated power supply to the 5V pin and ground pins. Anything between around 5 and 12 Volts should work.

   But it is best to keep the input voltage to around 6 or 7 Volts to avoid losing too much power as heat on the voltage regulator (we used 5v in our project).



4.1.5 Which pins should we use ?

The following table shows what pins are best to use as inputs, outputs and which ones you need to be cautious.

The pins highlighted in green are OK to use. The ones highlighted in yellow are OK to use, but you need to pay attention because they may have an unexpected behavior mainly at boot. The pins highlighted in red are not recommended to use as inputs or outputs.

GPIO	State	Notes
GPIO12	caution	strapping pin
GPIO13	OK	
GPIO14	OK	
GPIO15	caution	strapping pin
GPIO16	OK	
GPIO17	OK	
GPIO18	OK	
GPIO19	OK	
GPIO21	OK	
GPIO22	OK	
GPIO23	OK	

GPIO	State	Notes
GPIO25	OK	
GPIO26	OK	
GPIO27	OK	
GPIO32	OK	
GPIO33	OK	
GPIO34	OK	**input only**
GPIO35	OK	**input only**
GPIO36	OK	**input only**
GPIO39	OK	**input only**

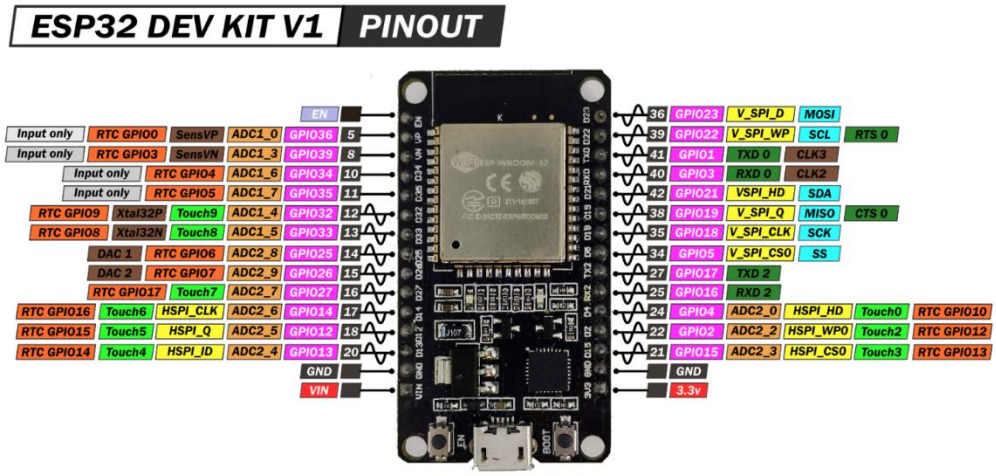
GPIO	State	Notes
GPIO0	X	strapping pin (Boot pin)
GPIO1	TX pin	Most dev. boards use TX and RX for flashing and debugging.
GPIO2	X	strapping pin
GPIO3	RX pin	Most dev. boards use TX and RX for flashing and debugging.
GPIO4	OK	
GPIO5	caution	strapping pin

GPIO	State	Notes
GPIO6	X	connected to the integrated SPI flash
GPIO7	X	connected to the integrated SPI flash
GPIO8	X	connected to the integrated SPI flash
GPIO9	X	connected to the integrated SPI flash
GPIO10	X	connected to the integrated SPI flash
GPIO11	X	connected to the integrated SPI flash

4.1.6 The ESP32 peripherals include :

- 18 Analog-to-Digital Converter (ADC) channels
- 3 SPI interfaces
- 3 UART interfaces
- 2 I2C interfaces
- 16 PWM output channels
- 2 Digital-to-Analog Converters (DAC)
- 2 I2S interfaces
- 10 Capacitive sensing GPIOs

4.1.7 Pin details and its functions :



1. Input only pins

GPIOs 34 to 39 are GPIs – input only pins. These pins don't have internal pull-up or pull-down resistors. They can't be used as outputs, so use these pins only as inputs:

- GPIO 34
- GPIO 35
- GPIO 36
- GPIO 39

2. SPI flash integrated on the ESP-WROOM-32

GPIO 6 to GPIO 11 are exposed in some ESP32 development boards. However, these pins are connected to the integrated SPI flash on the ESP-WROOM-32 chip and are not recommended for other uses. So, don't use these pins in your projects:

- GPIO 6 (SCK/CLK)
- GPIO 7 (SDO/SD0)
- GPIO 8 (SDI/SD1)
- GPIO 9 (SHD/SD2)
- GPIO 10 (SWP/SD3)
- GPIO 11 (CSC/CMD

3. Capacitive touch GPIOs

The ESP32 has 10 internal capacitive touch sensors. These can sense variations in anything that holds an electrical charge, like the human skin. So they can detect variations induced when touching the GPIOs with a finger. These pins can be easily integrated into capacitive pads and replace mechanical buttons. The capacitive touch pins can also be used to wake up the ESP32 from deep sleep.

Those internal touch sensors are connected to these GPIOs:

- T0 (GPIO 4)
- T2 (GPIO 2)
- T3 (GPIO 15)
- T4 (GPIO 13)
- T5 (GPIO 12)
- T6 (GPIO 14)
- T7 (GPIO 27)
- T8 (GPIO 33)
- T9 (GPIO 32

4. Analog to Digital Converter (ADC)

The ESP32 has 18 x 12 bits ADC input channels. These are the GPIOs that can be used as ADC and respective channels

- ADC1_CH0 (GPIO 36)
- ADC1_CH3 (GPIO 39)
- ADC1_CH4 (GPIO 32)
- ADC1_CH5 (GPIO 33)
- ADC1_CH6 (GPIO 34)
- ADC1_CH7 (GPIO 35)
- ADC2_CH0 (GPIO 4)
- ADC2_CH2 (GPIO 2)
- ADC2_CH3 (GPIO 15)
- ADC2_CH4 (GPIO 13)
- ADC2_CH5 (GPIO 12)
- ADC2_CH6 (GPIO 14)
- ADC2_CH7 (GPIO 27)
- ADC2_CH8 (GPIO 25)
- ADC2_CH9 (GPIO 26)

5. Digital to Analog Converter (DAC)

There are 2 x 8 bits DAC channels on the ESP32 to convert digital signals into analog voltage signal outputs. These are the DAC channels:

- DAC1 (GPIO25)
- DAC2 (GPIO26)

6. RTC GPIOs

There is RTC GPIO support on the ESP32. The GPIOs routed to the RTC low-power subsystem can be used when the ESP32 is in deep sleep.

These RTC GPIOs can be used to wake up the ESP32 from deep sleep when the Ultra Low Power (ULP) co-processor is running. The following GPIOs can be used as an external wake up source.

- RTC_GPIO0 (GPIO36)
- RTC_GPIO3 (GPIO39)
- RTC_GPIO4 (GPIO34)
- RTC_GPIO5 (GPIO35)
- RTC_GPIO6 (GPIO25)
- RTC_GPIO7 (GPIO26)
- RTC_GPIO8 (GPIO33)
- RTC_GPIO9 (GPIO32)
- RTC_GPIO10 (GPIO4)
- RTC_GPIO12 (GPIO2)
- RTC_GPIO13 (GPIO15)
- RTC_GPIO14 (GPIO13)
- RTC_GPIO15 (GPIO12)
- RTC_GPIO16 (GPIO14)
- RTC_GPIO17 (GPIO27)

7. PWM

The ESP32 LED PWM controller has 16 independent channels that can be configured to generate PWM signals with different properties. All pins that can act as outputs can be used as PWM pins (GPIOs 34 to 39 can’t generate PWM).

To set a PWM signal, you need to define these parameters in the code:

- Signal’s frequency
- Duty cycle
- PWM channel
- GPIO where you want to output the signal.

8. I2C

The ESP32 has two I2C channels and any pin can be set as SDA or SCL. When using the ESP32 with the Arduino IDE, the default I2C pins are:

- GPIO 21 (SDA)
- GPIO 22 (SCL)

If you want to use other pins when using the wire library, you just need to call:

```
Wire.begin(SDA, SCL);
```

> **Note**
>
> The absolute maximum current drawn per GPIO is 40mA according to the "Recommended Operating Conditions" section in the ESP32 datasheet.

10. SPI

By default , the pin mapping for SPI is :

SPI	MOSI	MISO	CLK	CS
VSPI	GPIO 23	GPIO 19	GPIO 18	GPIO 5
HSPI	GPIO 13	GPIO 12	GPIO 14	GPIO 15

11. Interrupts

All GPIOs can be configured as interrupts .

12. Strapping Pins

The ESP32 chip has the following strapping pins **:**

- GPIO 2
- GPIO 4
- GPIO 5 (must be HIGH during boot)
- GPIO 12 (must be LOW during boot)
- GPIO 15 (must be HIGH during boot)

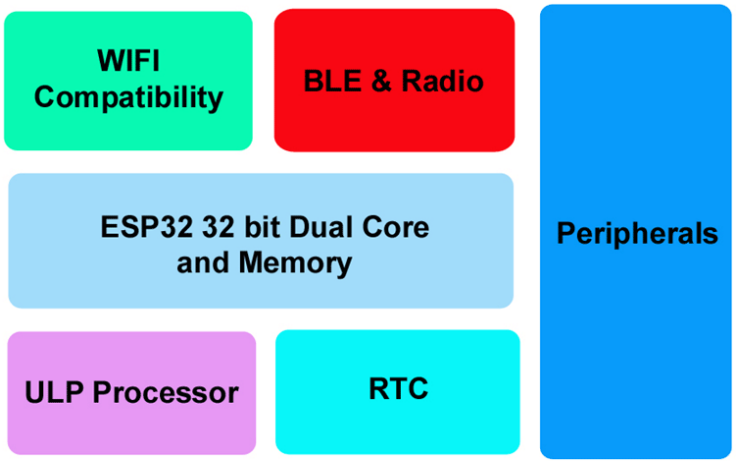
These are used to put the ESP32 into bootloader or flashing mode. On most development boards with built-in USB/Serial, you don't need to worry about the state of these pins. The board puts the pins in the right state for flashing or boot mode

13. Enable (EN)

Enable (EN) is the 3.3V regulator's enable pin. It's pulled up, so connect to ground to disable the 3.3V regulator. This means that you can use this pin connected to a pushbutton to restart your ESP32 .

4.1.8 Power saving in esp32 :

In order to understand how ESP32 achieves power saving, we need to know what's inside the chip. The following illustration shows function block diagram of ESP32 chip



At the heart of the ESP32 chip is a Dual-Core 32-bit microprocessor along with 448 KB of ROM, 520 KB of SRAM and 4MB of Flash memory .

It also contains WIFI module, Bluetooth Module, Cryptographic Accelerator (a co-processor designed specifically to perform cryptographic operations), the RTC module, and lot of peripherals .

ESP32 Power Modes

Thanks to the ESP32's advanced power management, it offers 5 configurable power modes. As per the power requirement, the chip can switch between different power modes. The modes are:

- Active Mode
- Modem Sleep Mode
- Light Sleep Mode
- Deep Sleep Mode
- Hibernation Mode

Each mode has its own distinct features and power saving capabilities. Let's look in to them one by one.

ESP32 Active Mode :

In this mode all the features of the chip are active.

As the active mode keeps everything (especially the WiFi module, the Processing Cores and the Bluetooth module) ON at all times, the chip requires more than 240mA current to operate. Also we observed that if you use both WiFi and Bluetooth functions together, sometimes high power spikes appear (biggest was 790mA).

power consumption during Active power mode, with RF working is as follows:

Mode	Power Consumption
Wi-Fi Tx packet 13dBm~21dBm	160~260mA
Wi-Fi/BT Tx packet 0dBm	120mA
Wi-Fi/BT Rx and listening	80~90mA

Obviously, this is the most inefficient mode and will drain the most current. So, if we want to conserve power we have to disable them (by leveraging one of the other power modes) when not in use.

ESP32 Modem Sleep :

In modem sleep mode everything is active while only WiFi, Bluetooth and radio are disabled. The CPU is also operational and the clock is configurable.

In this mode the chip consumes around 3mA at slow speed and 20mA at high speed.

To keep WiFi/Bluetooth connections alive, the CPU, Wi-Fi, Bluetooth, and radio are woken up at predefined intervals. It is known as **Association sleep pattern**.

During this sleep pattern, the power mode switches between the active mode and Modem sleep mode.

ESP32 can enter modem sleep mode only when it connects to the router in station mode. ESP32 stays connected to the router through the **DTIM beacon mechanism**.

In order to save power, ESP32 disables the Wi-Fi module between two DTIM Beacon intervals and wakes up automatically before the next Beacon arrival.

The sleep time is decided by the DTIM Beacon interval time of the router which is usually 100ms to 1000ms.

ESP32 Light Sleep :

The working mode of light sleep is similar to that of modem sleep. The chip also follows association sleep pattern.

The difference is that, during light sleep mode, digital peripherals, most of the RAM and CPU are clock-gated.

During light sleep mode, the CPU is paused by powering off its clock pulses, while RTC and ULP-coprocessor are kept active. This results in less power consumption than in modem sleep mode which is around 0.8mA.

Before entering light sleep mode, ESP32 preserves its internal state and resumes operation upon exit from the sleep. It is known Full RAM Retention.

`esp_light_sleep_start()` function can be used to enter light sleep once wake-up sources are configured.

ESP32 Deep Sleep :

In deep sleep mode, the CPU, most of the RAM and all the digital peripherals are powered off. The only parts of the chip that remains powered on are: RTC controller, RTC peripherals (including ULP co-processor), and RTC memories (slow and fast).

The chip consumes around 0.15 mA(if ULP co-processor is powered on) to 10µA.

During deep sleep mode, the main CPU is powered down, while the ULP co-processor does sensor measurements and wakes up the main system, based on the measured data from sensors. This sleep pattern is known as **ULP sensor-monitored pattern**.

Along with the CPU, the main memory of the chip is also disabled. So, everything stored in that memory is wiped out and cannot be accessed. However, the RTC memory is kept powered on. So, its contents are preserved during deep sleep and can be retrieved after we wake the chip up.

That’s the reason, the chip stores Wi-Fi and Bluetooth connection data in RTC memory before disabling them.

So, if you want to use the data over reboot, store it into the RTC memory by defining a global variable with `RTC_DATA_ATTR` attribute. For example, `RTC_DATA_ATTR int bootCount = 0;`

In Deep sleep mode, power is shut off to the entire chip except RTC module. So, any data that is not in the RTC recovery memory is lost, and the chip will thus restart with a reset. This means program execution starts from the beginning once again.

Unlike the other sleep modes, the system cannot go into Deep-sleep mode automatically. `esp_deep_sleep_start()` function can be used to immediately enter deep sleep once wake-up sources are configured.

By default, ESP32 will automatically power down the peripherals not needed by the wakeup source. But you can optionally decide what all peripherals to shut down/keep on. For more information .

ESP32 Hibernation mode :

Unlike deep sleep mode, in hibernation mode the chip disables internal 8MHz oscillator and ULP-coprocessor as well. The RTC recovery memory is also powered down, meaning there’s no way we can preserve any data during hibernation mode.

Everything else is shut off except only one RTC timer on the slow clock and some RTC GPIOs are active. They are responsible for waking up the chip from the hibernation mode.

This reduces power consumption even further. The chip consumes around 2.5µA only in hibernation mode.

SMART Security System

Introduction

As we all are very familiar with the term “Security ". Always we want a personal room, where nobody can’t enter this roomwithout our permission. Nowadays security is the mostimportant thing. So, we need to secure a room at our home and office for protecting our important accessories anddocuments.

Passwords are the single most effective cyber security tool wehave, and making good use of them requires no technical skillwhatsoever. Every year since 2010, the password management company Splash Data has culled the web for leaked user passwords from breaches, and compiled the mostoutstanding data into a Top 100 Worst Passwords list. And every year, inevitably, the top two entries are “123456” and “password”. Almost three percent of all passwords they find are “123456”. Having a simple password is like having nopassword at all. Variations on common passwords–like “passw0rd” or “123456789”–simple passwords–like “abc123” or “11111”–using your own name or the name of the service you're signing up for, and other quick tricks of the sort shouldall be forbidden. As easy as they may be for you to remember, they'll be orders of magnitude easier for a hacker to crack.

In our project we have make a “Password Based Door LockingSystem” using an ESP32. It will be more efficient for the peoples in the field of security. It will be implemented in any places like our Houses, Institutions Banks and any Public Places. We can only able open the door if we entered correct password for door and if users entered an incorrect password,then message will be display or door will not be open.

4.2.1 Components

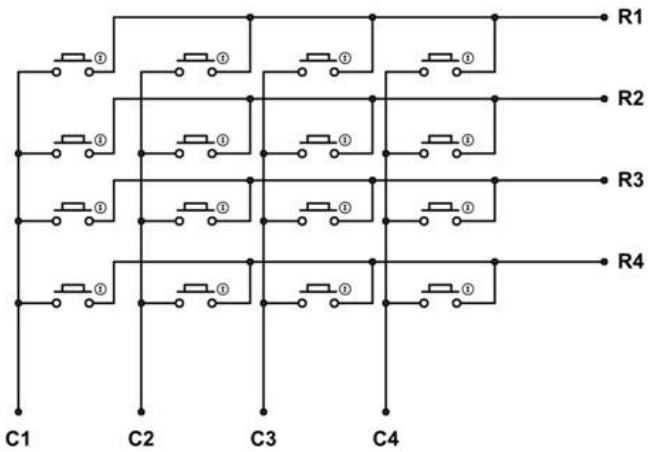
- Keypad 4x4
- I2C PCF8574
- LCD 16x2
- Interface I2c For LCD
- Servo motor
- Push button

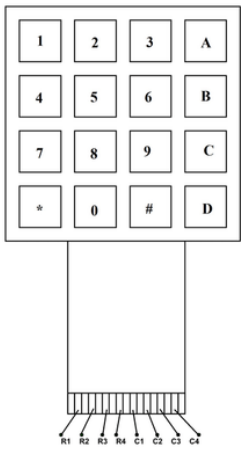
Keypad :

4X4 KEYPAD MODULES are available indifferent sizes and shapes. But they all have same pin configuration. It is easy to make 4X4 KEYPAD by arranging 16buttons in matrix formation by yourself.

As given in above table, a 4X4 KEYPAD will have eight terminals. In them four are rows of matrix and four are columns of matrix. These 8 PINS are driven out from 16 buttons present in the module. Those 16 alphanumeric digits on the module surface are the 16 buttons arranged in matrix formation.

The internal structure of 4X4 KEYPAD module is shown below.





Features

- Maximum Voltage across EACH SEGMENT or BUTTON: 24V
- Maximum Current through EACH SEGMENT or BUTTON:30mA
- Maximum operating temperature: 0°C to + 50°C
- Ultra-thin design
- Adhesive backing
- Easy interface
- Long life.

I2C PCF8574 :

Overview

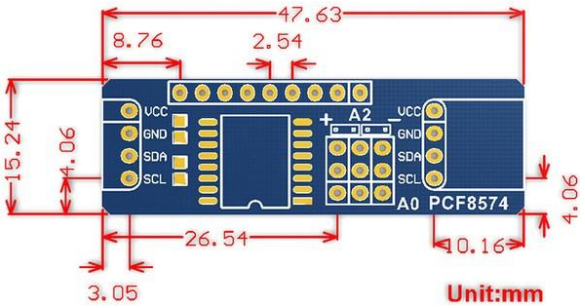
The PCF8574 IO Expansion Board is used as remote 8-bit I/O expander for I2C-bus. Up to 8 PCF8574 IO Expansion Board can be connected to the I2C-bus, providing up to 64 I/O ports.

The PCF8574 IO Expansion Board features I2C pin header on one side, and I2C connector on the opposite side. Hence, it's more flexible to connect the board to your development system. The board also supports I2C cascading, allowing the use of multi module connected to the I2C bus at the same time by connecting the pin header and connector.

Features

- 8 bi-directional data lines
- Loop-thru feature allows expansion of up to 8 modules / 64 data lines
- I2C interface with jumper adjustable addresses
- Interrupt output capability
- 3.3V and 5V compatible

Dimension



LCD :

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

"In our project we used LCD 16x2"

Features of the LCD

- The operating voltage of this LCD is4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mAwith no backlight
- Every character can be built with a5×8 pixel box
- The alphanumeric LCDs alphabets& numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue &Green Backlight
- It displays a few custom generated characters

I2C LCD :

This is a RoHS compliant I2C Serial LCD Daughter board that can be connected to a standard HD44780 compatible 16×2 or 20×4 Character Display Module that supports 4bit mode.

Specifications :

- Supply voltage: +5 V
- Supports the I2C protocol
- With backlight and contrast adjustment potentiometer
- 4 Line Output easier

Push button :

Push buttons are used for switch mechanisms in embedded systems. A switch connected to an IO pin when pressed can change the state of the pin to low or high depending on its initial state.
The change can be identified in firmware and can make the controller work accordingly.

Features :

- Operating Force: 2.5 N
- Current Rating: 50 mA
- Voltage Rating DC: 24 VDC
- Series: B3F

"We used the push button to move the servo motor and open the door"

Servo motor :

A servo motor is a rotational or translational motor to which power is supplied by a servo amplifier and serves to apply torque or force to a mechanical system, such as an actuator or brake.

Servo motors allow for precise control in terms of angular position, acceleration, and velocity. This type of motor is associated with a closed-loop control system. A closed-loop control system considers the current output and alters it to the desired condition.

The control action in these systems is based on the output of the motor. It uses a positive feedback system to control the motion and final position of the shaft.

Features :

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

In our project servo motor is used for opening the gate while rotating

Why servo motor?

Precision : Servo motors entail highly precise operation, hence why they are commonly used in CNC machinery for movement of slide axis.

Speed : Servo motors offer high speed rotation, and more torque in a small package.

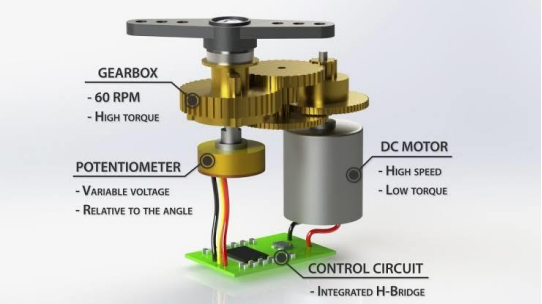
Encoder : Translates rotary or linear motion to a digital signal.

Versatility : Wide range of use for servo motors in a variety of applications.

Closed Loop : Servo motors use feedback signal to control the system.

Components of servo motor :

Inside servo there is a pretty simple set-up: a small DC motor, potentiometer, and a control circuit. The motor is attached by gears to the control wheel.



As the motor rotates, the potentiometer's resistance changes, so the control circuit can precisely regulate how much movement there is and in which direction.

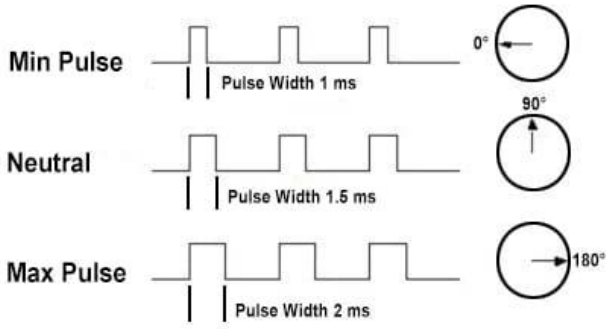
Working Principle of servo motor :

we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer’s angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

How is the servo controlled ?

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement.

The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn the servo in a clockwise direction toward the 180° position.



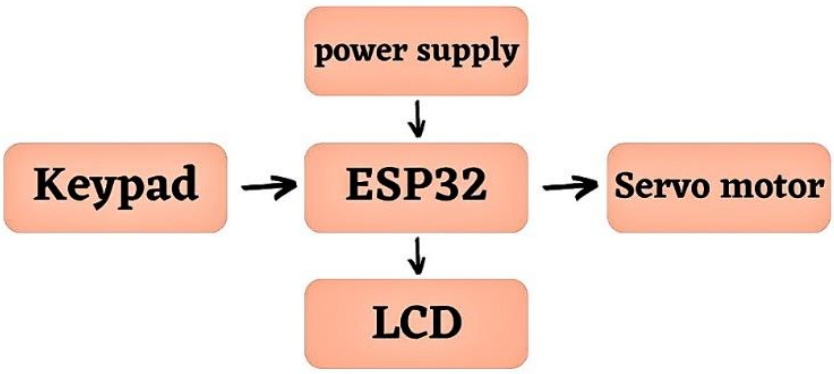
When these servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

4.2.2 Working principle

The user can enter a password which is suitable to their needs. The entered password during installation will be saved as ENTER PASSWORD. During initial stage the system will get locked. Again when the user enters a password, the entered password is checked with the predefined set password. If the password matches then the servo motor deflects and the door gets unlocked. Whenever the individual wants to enter into their houses he or she has to enter the correct password.

If the password entered is correct or not the ESP32will check in its database.

If the password entered matches with the set password, the LCD will display unlocked message on its screen and the door gets unlocked allowing the individual to enter.



4.2.3 How it work

This system shows how to open and control the door by pressing the keypad , as well as by push button .

Starting system will start the beginning by each step

Pushbutton :

1. when pressed with the door closed, the door will open .
2. when pressed with the door opened ,the door will closed.

Press Keypad :

1. “Enter Password “ , Write down the number of password , I want to show on the screen .
2. IF press “ # “, it means I am entering numbers to show up on the screen if they are right or wrong , if right ,the door will open right away .
3. IF press “ * “ , it means I can cancel any number .
4. IF you miswrite the code more than 4 times ,it will wait 30 seconds and start the program again.

Get Password :

Is an intervention function that stores numbers in array .

Check the Password :

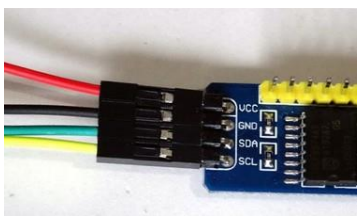
Function that checks for password if true or false .

4.2.4 How to connect:

First of all, we are going to make a connection to the keyboard 4×4 To connect the keyboard to the esp32 but we have reduced the number of pins by I2C PCF8574.

- Connecting the two together, note that we do not connect the INT pin.

- Connect Power (VCC, GND and I2C lines connected to ESP32)
  - SCL connected to D22
  - SDA connected to D21



An I2C has only 4 pins that interface it to the outside world.

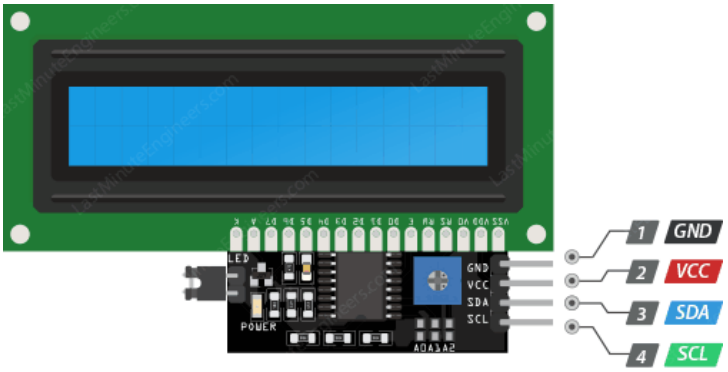
Connections are as follows :

GND is a ground pin and should be connected to the ground .

VCC supplies power to the module and the LCD. Connect it to the 5V output of the ESP32 or a separate power supply.

SDA is a Serial Data pin. This line is used for both transmit and receive. Connect to D21.

SCL is a Serial Clock pin. This is a timing signal supplied by the Bus Master device. Connect to D22.

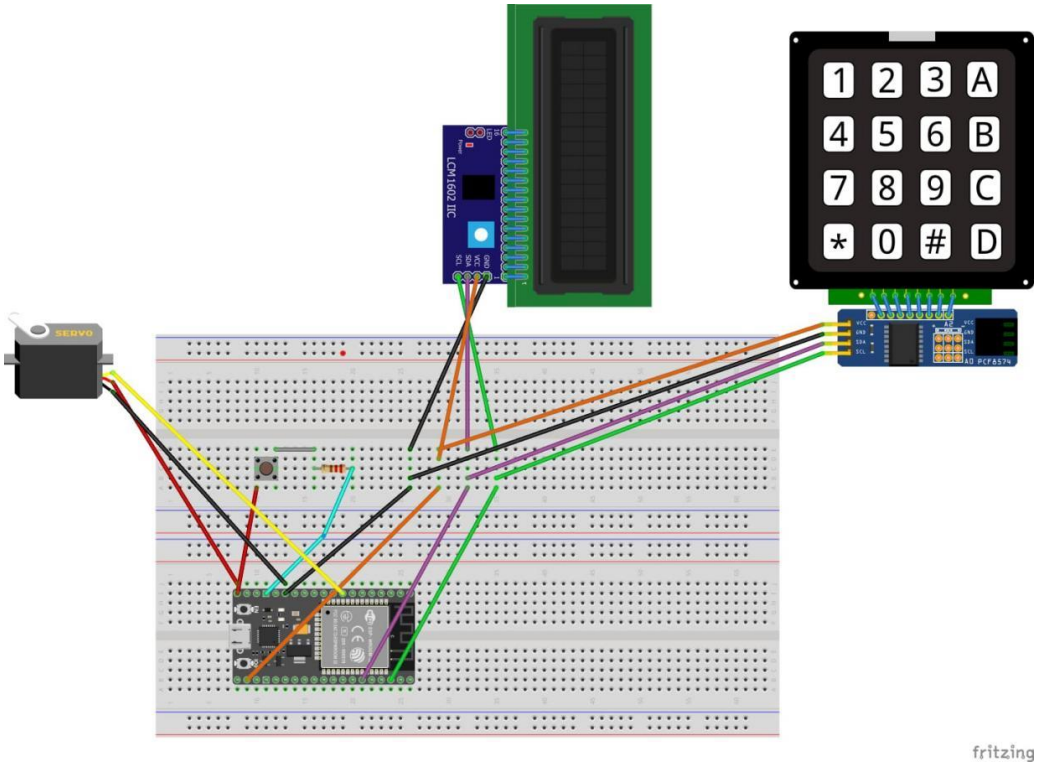


Push button one terminal is connected VCC of ESP32 and other terminals of a push button is common with D39 and resistor 1K ohm.

Servo motors have three wires: power, ground, and signal. The power is usually red, the GND is black or brown, and the signal wire is usually yellow.

- **GND** to common GND
- **VCC** to **+Ve** of the battery
- **Signal** to D25

4.2.5 Circuit Design



4.2.6 Libraries

keypad library :

Keypad is **a library for using matrix style keypads with the ESP32 .**

As of version 3.0 it now supports multiple key presses. This library is based upon the Keypad Tutorial. It was created to promote Hardware Abstraction. It improves readability of the code by hiding the pin Mode and digital Read calls for the user.

I2CKEYPAD keypad

(const uint8_t device Address, Two Wire *wire = &Wire)

The constructor sets the device address and optionally allows to selects the I2C bus to use.

- `bool keypad.Begin()` The return value shows if the PCF8574 with the given address is connected properly.

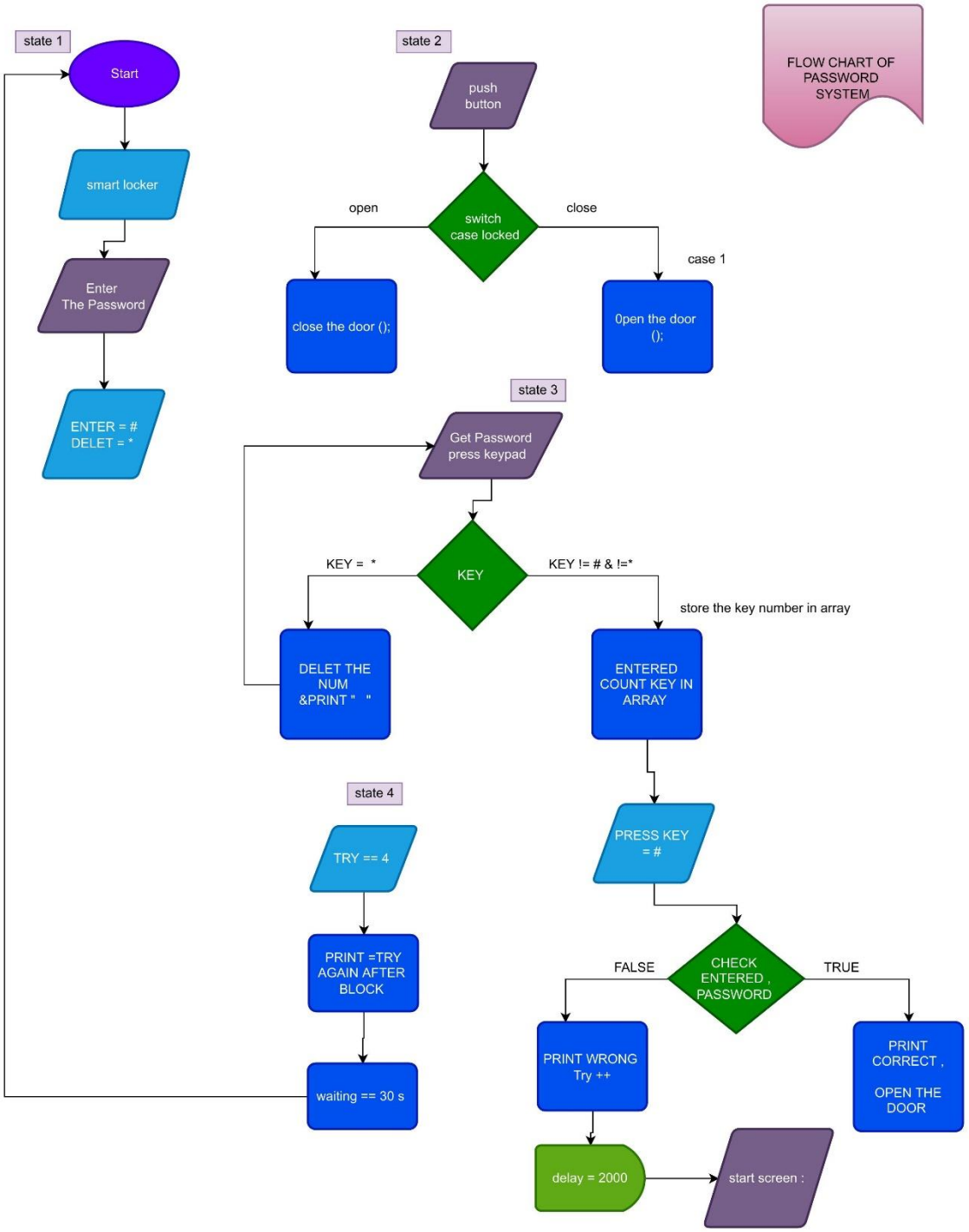
- **`bool begin (uint8_t sda, uint8_t scl)`** for ESP32. The return value shows if the PCF8574 with the given address is connected properly.
- **`keyPad.isConnected()`** returns false if the PCF8574 cannot be connected to.
- **`uint8_t keypad. Get key ()`** Returns 0……15 for regular keys, 16 if no key is pressed and 17 in case of an error.
- **`Keypad.getLastKey()`** Returns the last **valid** key pressed 0…..15. Initially it will return 16 (no Key).
- **`Keypad.isPressed()`** Returns true if one or more keys of the keypad is pressed, however it is not checked if multiple keys are pressed.

I2c library :

We need to add library to Arduino liquid crystal and i2c library "`Wire.h`". This library help to communicate with I2C device. Then include "`LiquidCrystal_I2C.h`" for better communication with display.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
```

4.2.7 Flowchart



Firefighter System

Introduction

Fire comes under the most common reason for the loss in the workplaces. And it is also one of the biggest reasons for the accidental loss of human resources at the workplace. Also, the numbers of fire accidents are not only increasing every year, but they are also becoming dangerous to every year. Even a small fire can cause a lot of loss in the business, so it is really important to have proper fire prevention at the workplace.

Protection from fire damage is essential to the preservation of library and archival materials. A firefighting system is probably the most important of building services, its aim is to protect human life and property. Buildings must be constructed in accordance with the building code that is in effect when an application for a building permit is made. Fire Fighting, techniques and equipment are used to extinguish fires and limit the damage caused by them. And it consists of large tanks, pumping system, network of pipes, and hydrants or sprinklers. All repositories, house library and archival materials should be equipped with a fire detection and alarm system wired directly to the local fire department 24-hour monitor. Most firefighting consists of applying water to the burning material, cooling it to the point at which combustion is no longer self-sustaining. Fires involving flammable liquids, certain chemicals, and combustible metals often require special extinguishing agents and techniques. With some fuels the use of water may actually be dangerous.

4.3.1 Objectives

Fire safety reduces the risk of injury and building damage that fires can cause. Developing and implementing fire safety protocols in the workplace is not only required by law but it is crucial to everyone's safety that may be in the building during a fire emergency.

- prevent the occurrence of fire and explosion .
- reduce the risk to life caused by fire .
- reduce the risk of damage caused by fire to the ship, its cargo and the environment .
- contain, control and suppress fire and explosion in the compartment of origin .

4.3.2 Four Basic Principles of Fire Safety Training

- Reduce Fire Hazards in Your Workplace.
- Keep an Eye on Fire-Prone Rooms.
- Keep up-to-Date the Fire Detection and Suppression System.
- Mark Emergency Exits.

4.3.3 Components

- Flame sensor ky-026
- Buzzer
- Mini water Pump 5v
- Dual-Channel Relay Module

Flame sensor ky-026

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire.KY-026 flame sensor module for Arduino detects infrared light emitted surroundings for the occurrence of fire.

It is based on the YG1006 sensor which is a high speed and high sensitive NPN silicon phototransistor.

Module has both digital and analog outputs and a trimmer potentiometer to adjust the sensitivity.

The module is commonly used in fire-flame detection systems.

KY-026 module Specification

- Operating Voltage: DC 3.3V to 5.5V
- Maximum Current: 15mA
- Infrared Wavelength Detection: 760 nm to 1100 nm
- Sensor Detection Angle: 60°
- LED Lights Indicators:
  - Power indicator (LED1)
  - Trigger indicator (LED2)
- Board Dimensions: 1.5cm x 3.6cm [0.6in x 1.4in]

Pin details

VCC = 3.3V to 5V DC
GND = Ground
DO = Digital Output
AO = Analog Output

Dual-Channel Relay Module

The dual-channel relay module contains switching relays and the associated drive circuitry to make it easy to integrate relays into a project powered by a microcontroller. On the left are two terminal blocks, which are used to connect mains wires to the module without soldering.

the relay coil is rated for 5VDC, and the contacts are rated for 10A at 250VAC or 30VDC, or 125VAC or 28VDC.

The switching transistors amplify the signal from the inputs enough to drive the relay. The freewheeling diodes prevent voltage spikes across the switching transistors. The status LEDs turn on when the relay is active and indicate switching.

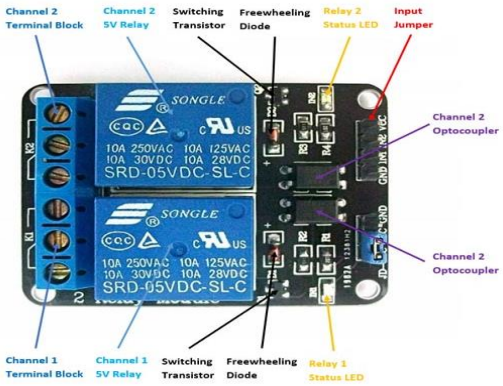
The optocouplers are used to provide additional isolation between the input and the relays. The isolation can be selected using the V_{CC}/JDV_{CC} jumper.

The input jumper has two input and two power pins and can be easily used to connect to jumper wires and other microcontrollers and sensors.

In our project we use duel relay because of weather system also need relay on circuit

Dual-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Trigger current – 5mA
- Current when relay is active - ~70mA (single), ~140mA (both)
- Relay maximum contact voltage – 250VAC, 30VDC
- Relay maximum current – 10A



Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc.

It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal and it is connected to 5v (ESP32 26 pin) .

the negative terminal is represented with the '-' symbol or short terminal and it is connected to the GND .

Rated Voltage : 6V DC

Operating Voltage : 4-8V DC

Rated current : < 30mA

Sound Type : Continuous Beep

Resonant Frequency : ~2300 Hz

Mini water pump

Micro dc 3-6v micro submersible pump mini water pump for fountain garden mini water circulation system diy project this is a low cost, small size submersible pump motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220ma. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. The dry run may damage the motor due to heating and it will also produce noise.

Features :

- Voltage: 2.5-6V
- Maximum lift: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outside diameter: 7.5mm / 0.3"
- Inside diameter: 5mm / 0.2"
- Diameter: Approx. 24mm / 0.95"
- Length: Approx. 45mm / 1.8"
- Height: Approx. 30mm / 1.2"
- Material: Engineering plastic
- Driving mode: DC design, magnetic driving

4.3.4 Working principle

Inside the module consist of a 5mm YG1006 infra-red receiver LED, an LM393 dual differential comparator, a trimmer potentiometer, six resistors, and two indicator LEDs are used.

The working principle of the KY-026 flame sensor module circuit is simple. The sensor basically detects IR (Infra-Red) light wavelength between 760 nm – 1100 nm (nanometer) that is emitted from the fire flame.

The operating voltage is dc +3.3V to +5V, LED1 shows as a power indicator in the circuit board.

YG1006 IR sensors like all other photo sensors work on the principle that a photon of sufficient energy can knock out electrons so that the resistance of the circuit is changed.

LM393 comparator integrated circuit convert this resistance and gives two types of output values.

One is Logic value in IC pin-2 and the other is Numerous value in IC pin-5 through the potentiometer.

When the sensor detects the fire, a HIGH signal (or logic 1) will give in digital output pin, otherwise, it gives logic 0.

However, a high numeric value will return when there's no flame near and it'll drop to near zero in the presence of fire.

Turn the potentiometer clockwise to increase the detection threshold and counter-clockwise to decrease it.

The LED2 turn ON only if the sensor detects a flame.

4.3.5 How it work

When flame sensor feel fire automatically the buzzer make sound and water pump start pumping water on fire till it ends

- Esp32 gets analog reads from the flame sensor.
- If the analog read of the sensor is lower than 1000 , Esp32 realize that there is big fire.
- Esp32 send the water pump a signal to pump a water and send buzzer a signal to alarm people.
- Then Esp32 check the analog read again till it be greater than 4000.
- When the analog read be greater than 4000 , Esp32 realize that all fires are extinguished.
- When all fires are extinguished , Esp32 send water pump a signal to stop pumping water.
- Then Esp32 wait a signal from alarm button to close the buzzer.

4.3.6 How to connect

From flame sensor we have 3-pins

- VCC pin to 5v
- Negative pin to GND
- Analog input pin to Microcontroller (ESP32).

Buzzer have 2-pins

- Positive input pin on microcontroller
- Negative pin to GND.

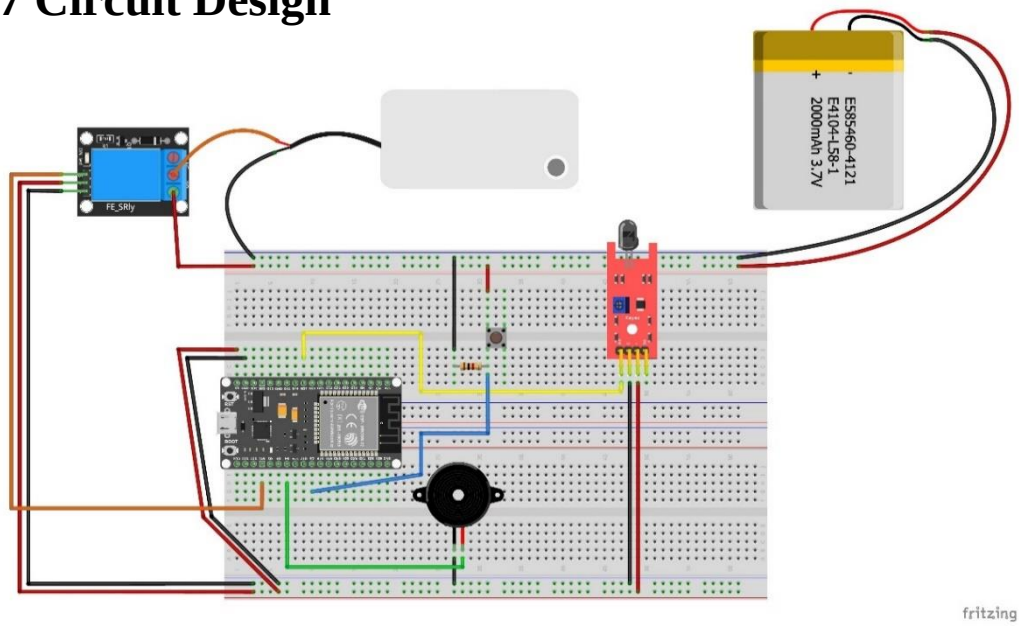
Relay Have 3-pins form each side we use 5 pins from them

1. **First 3-pins:**
   - Negative pin to GND
   - INPUT pin to microcontroller
   - VCC pin to 5v
2. **Second 2-pins :**
   - Normally Opened (NO) connected to 5v
   - Common (COM) connected to Positive pin on water pump

Water pump

- Positive pin connected to (COM) on Relay
- Negative pin connected to GND

4.3.7 Circuit Design



4.3.8 Sensor Programming

1. Define A0 pin As an input

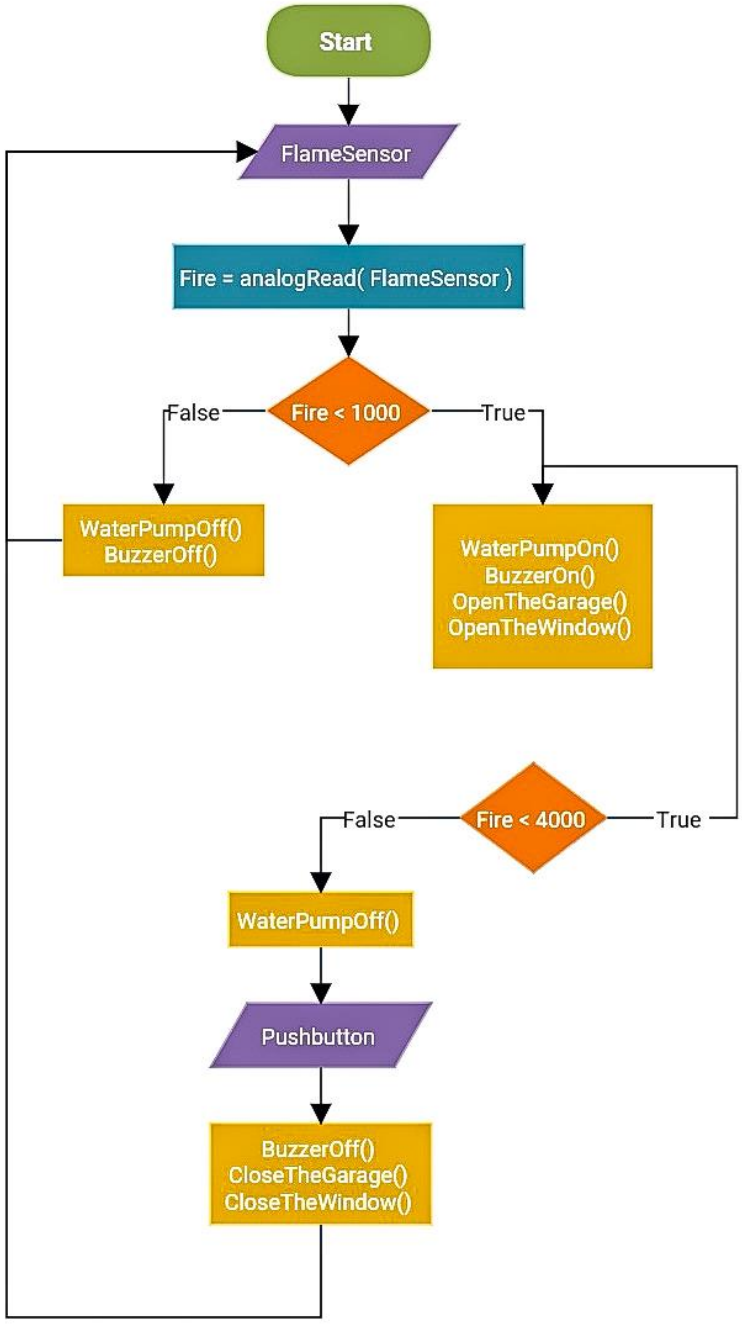
```
pinMode(A0,INPUT);
```

2. Get analog value from the A0 pin

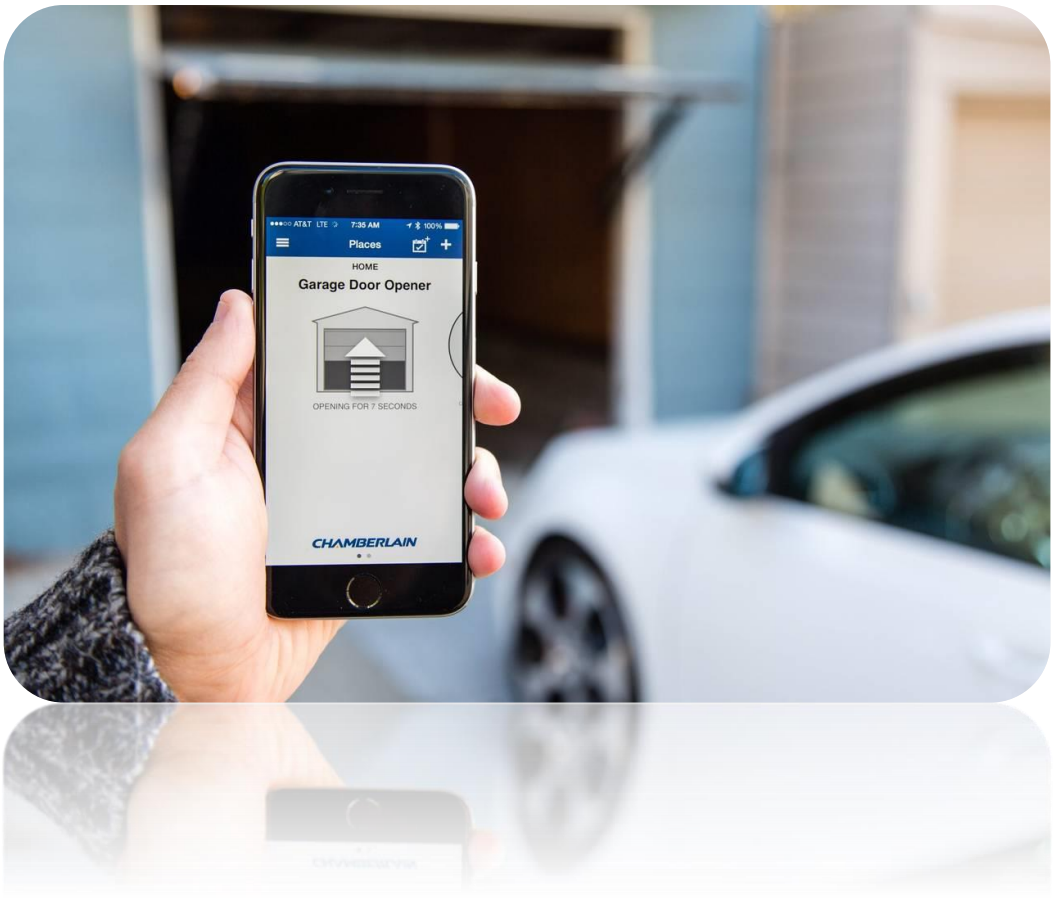
```
analogRead(A0);
```

3. if A0 value is lower than 4029 it means that there is fire

4.3.9 Flowchart



SMART Garage Door



Introduction

Many countries are interested in the idea of developing technology to help the human in his daily life to save his time and effort, as countries have been interested in developing the field of smart homes to facilitate the life of humanity. However, many companies have been pursuing smart ideas such as smart lighting, voice orders to activate and extinguish devices, smart safety systems, self-closing and opening doors, as well as smart garages. The idea of opening and closing smart doors for garages depends on the theory of sensor work. However, the theory is to sense the movement of the car and when a signal is received, the sensor sends orders to the device responsible for opening and closing the doors to open the door for 10 seconds, at the end of the duration the sensor works again to see if there is a barrier still present or not. If there is a barrier, the sensor gives orders to give another 10 seconds, but if there are no barriers, the sensor gives orders to close the door. Moreover, The project consists of several parts explaining the idea of smart garage door that will be addressed during the research paper.

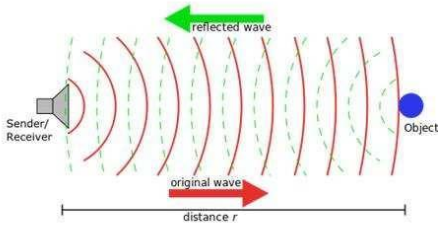
4.4.1 Objectives

- Opening and closing of doors is always a tedious job, especially in places like shopping malls, hotels and theatres where a person is always required to open the door for visitors.
- For people in wheelchairs (disabled persons), it is very difficult to open the door
- It will provide comfort and fix the problems like forgetting keys
- Open Your Garage Door from Anywhere
- Never Forget to Close Your Garage Door

4.4.2 Components

1. Ultrasonic sensor (HC-SR04)
2. Servo motor
3. Pushbutton

Ultrasonic sensor (HC-SR04) :



This application is based on sound wave reflection. Longitudinal pressure waves in the medium in which they travel are what sound waves are. Subjects with dimensions greater than the wavelength of the impinging sound waves reflect them; the reflected waves are referred to as the echo. The distance from the source to the subject can be accurately computed if the speed of sound in the medium is known and the time taken for the sound waves to travel the distance from the source to the subject and back to the source is measured.

The familiar concept of the sensor is the application's measurement principle. The medium for the sound waves in this case is air, and the sound waves used are ultrasonic because they are inaudible to humans. Assuming that the speed of sound in air is 1100 feet per second at room temperature and that the measured time for the sound waves to travel the distance from the source to the subject and back to the source is t seconds, the distance d is calculated using the formula d=1100 X 12 X t inches. Because sound waves travel twice as far as they do from the source to the subject, the actual distance between the source and the subject is d/2.

A single I/O pin is used to initiate an ultrasonic burst (well above human hearing range) and then "listen" for the echo return pulse. The sensor measures the time required for the echo return and sends this value to the microcontroller via the same I/O pin as a variable-width pulse. Ultrasonic sensors have a wide range of applications, including "detection" of what cannot be seen, "measurement" of length, thickness, and quantity, and "destruction" of objects.

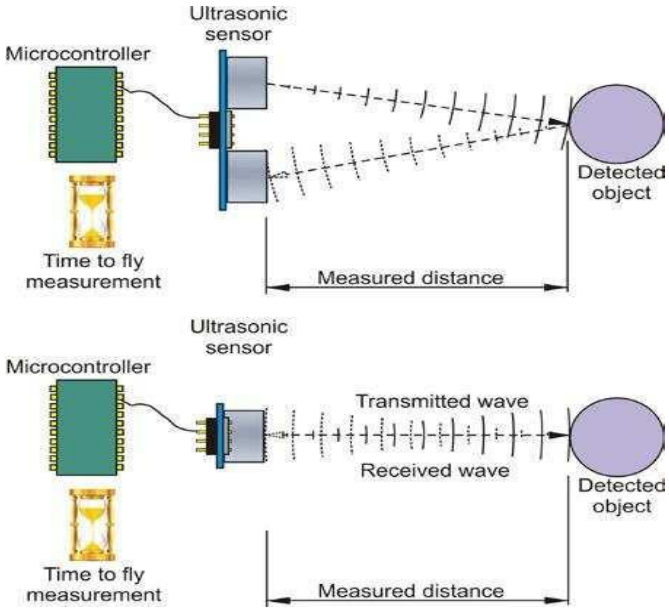
Ultrasonic sensors are commonly used for anti-collision and rangefinder purposes by measuring the distance to an obstacle [1]. Security systems, parking assistant systems, interactive animated exhibits, and robotic navigation are some application ideas where Ultra Sonic sensors can be used.

Features :

Here’s a list of some of the HC-SR04 ultrasonic sensor features and specs for more information, you should consult the sensor’s datasheet:

- Power Supply :+5V DC
- Quiescent Current : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1″ – 13ft
- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS TTL pulse
- Echo Output Signal: TTL pulse proportional to the distance range
- Dimension: 45mm x 20mm x 15mm

Operation theory of Ultrasonic sensor (HC-SR04) :



Servo motor :

It was previously explained in **smart security system** , Page NO. 21

Pushbutton

It was previously explained in **smart security system** , Page NO. 20

4.4.3 Working principle

- The working principle of this module is simple. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.
- Ultrasonic sensors are a great solution for the detection of clear objects. For liquid level measurement, applications that use infrared sensors, for instance, struggle with this particular use case because of target translucence.
- For presence detection, ultrasonic sensors detect objects regardless of the color, surface, or material (unless the material is very soft like wool, as it would absorb sound.)

4.4.4 How to connect

The beginning of the idea depends on connecting components of the project by ;

1. Connecting the Ultrasonic sensor to the ESP32 by connecting the VCC pin to the 5v , the GND pin to the common ground, the Trig pin to the ESP32 Trigger Input Pin(32) , and the Echo pin to the ESP32 Echo Output Pin (34) .
2. connecting an Push button(pin 15) to control the servo (garage door) .
3. Connecting the servo motor to esp32 ; the red wire to the 5v , the brown wire to common ground, and the orange wire to the ESP32 output pin (27) .

4.4.5 How it work

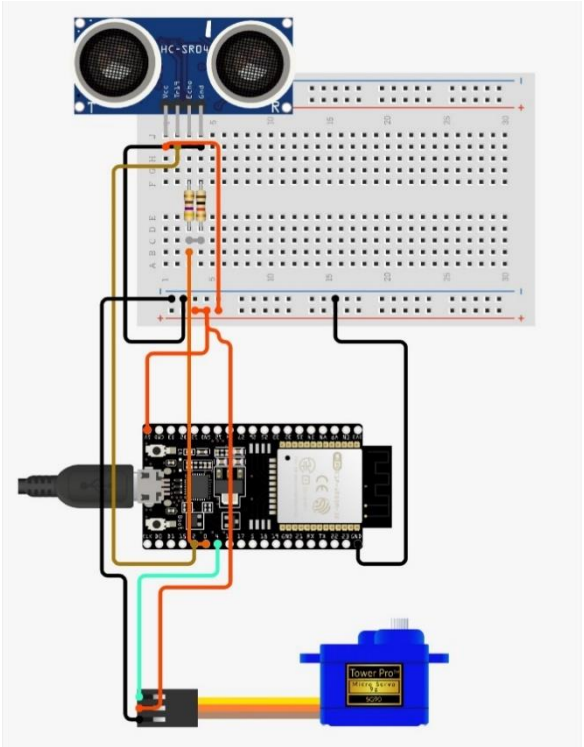
When the driver comes to a halt in front of the sensor, the sensor begins sending sound signals from the trigger to see what is blocking it. These signals are then sent back to the echo, which informs the microcontroller that there is an obstacle in front of it, and the microcontroller sends signals to the servomotor to open the door. The sensor waits 10 seconds before sending another signal to determine whether or not there is an obstacle in front of it. If there is an obstacle in front of it, the sensor sends a command to the microcontroller, which instructs the servomotor to give another 10 seconds. If there is no obstacle in front of the sensor, it sends a signal to the microcontroller, which instructs the servomotor to close the door.

1. The servo motor is set at a 90 degree angle.
2. An ultrasonic signal is sent from the ultrasonic sensor from the TRIG for 10 microseconds to hit the car body and then returned to be received by the ECHO.

3. Using the Pulsin() function, the total transmit and receive time is calculated in microseconds Then it is divided by 2 to find out the time of arrival of the signal to the car.
4. Since the speed of ultrasound is known and equal to 340 meters per second, the time (in seconds after conversion) can be multiplied by the speed and the distance in meters can be obtained and then divided by 100 to convert it to cm.

- The previous process can be calculated through the equation
- distance_cm = 0.017 * duration_us
- If the distance is less than the minimum (distane_thereshold) , which is 14 cm, the controller gives the command servo.write(90) to turn the servo motor at an angle of 90 degrees, and the door opens automatically It can also be opened by a button or a mobile app.
- Then the Millis() function calculates 10 seconds, which is enough time for the car to pass, and then the door closes again after the servo returns to zero after the ten seconds have elapsed, and so on.

4.5.6 Circuit Design



4.4.7 Libraries and functions

`ESP32Servo`

The library for dealing with the servo motor and controlling its rotation angle for the controller ESP32

`pulseIn()`

Reads a pulse (either HIGH or LOW) on a pin. For example, if value is HIGH, pulseIn() waits for the pin to go from LOW to HIGH, starts timing, then waits for the pin to go LOW and stops timing. Returns the length of the pulse in microseconds or gives up and returns 0 if no complete pulse was received within the timeout.

The timing of this function has been determined empirically and will probably show errors in longer pulses. Works on pulses from 10 microseconds to 3 minutes in length.

`millis()`

Returns the number of milliseconds passed since the Arduino board began running the current program. This number will overflow (go back to zero), after approximately 50 days.

syntax : `time = millis()`

`Servo.write()`

Writes a value to the servo, controlling the shaft accordingly. On a standard servo, this will set the angle of the shaft (in degrees), moving the shaft to that orientation.

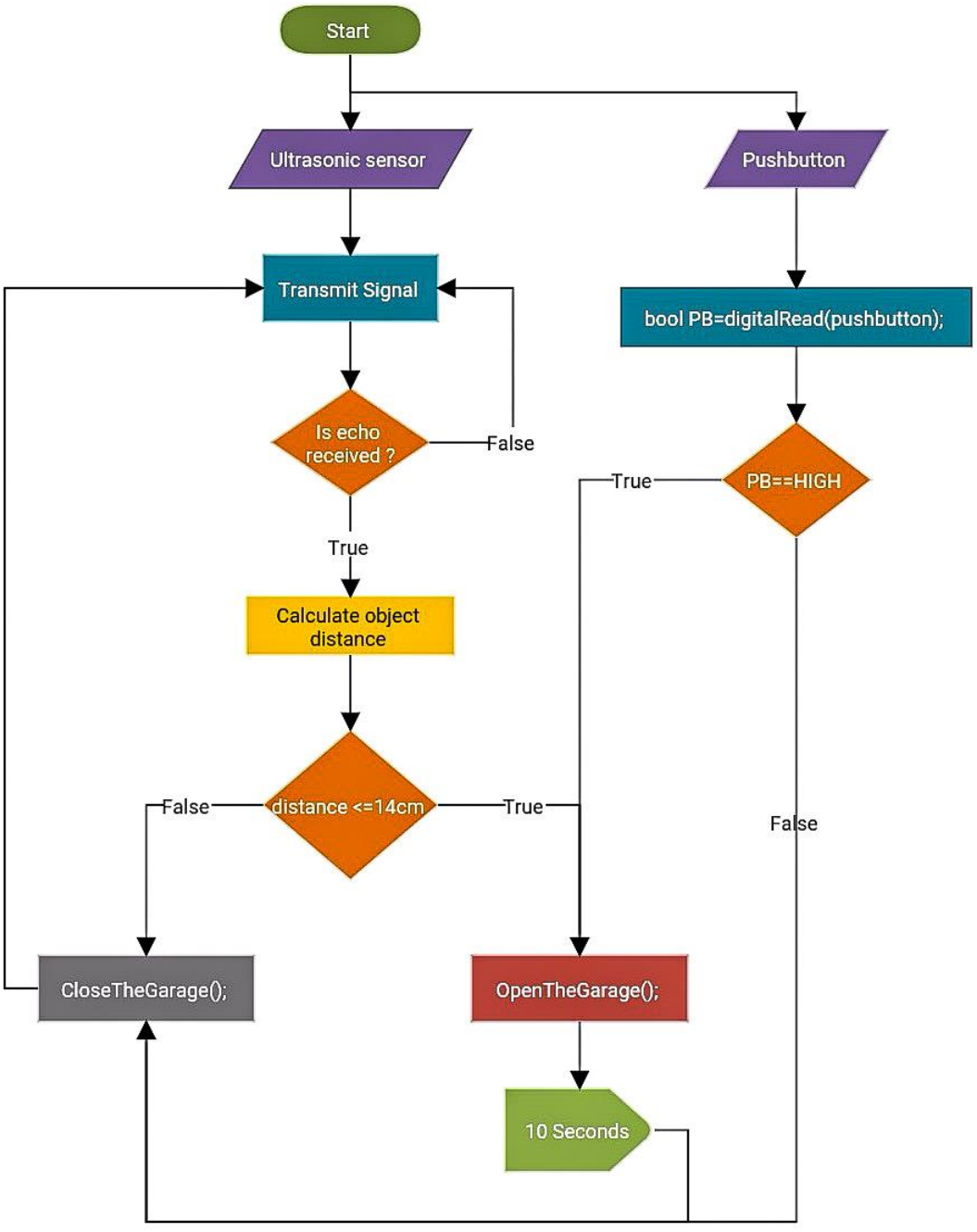
On a continuous rotation servo, this will set the speed of the servo (with 0 being full-speed in one direction, 180 being full speed in the other, and a value near 90 being no movement).

`Servo.attach()`

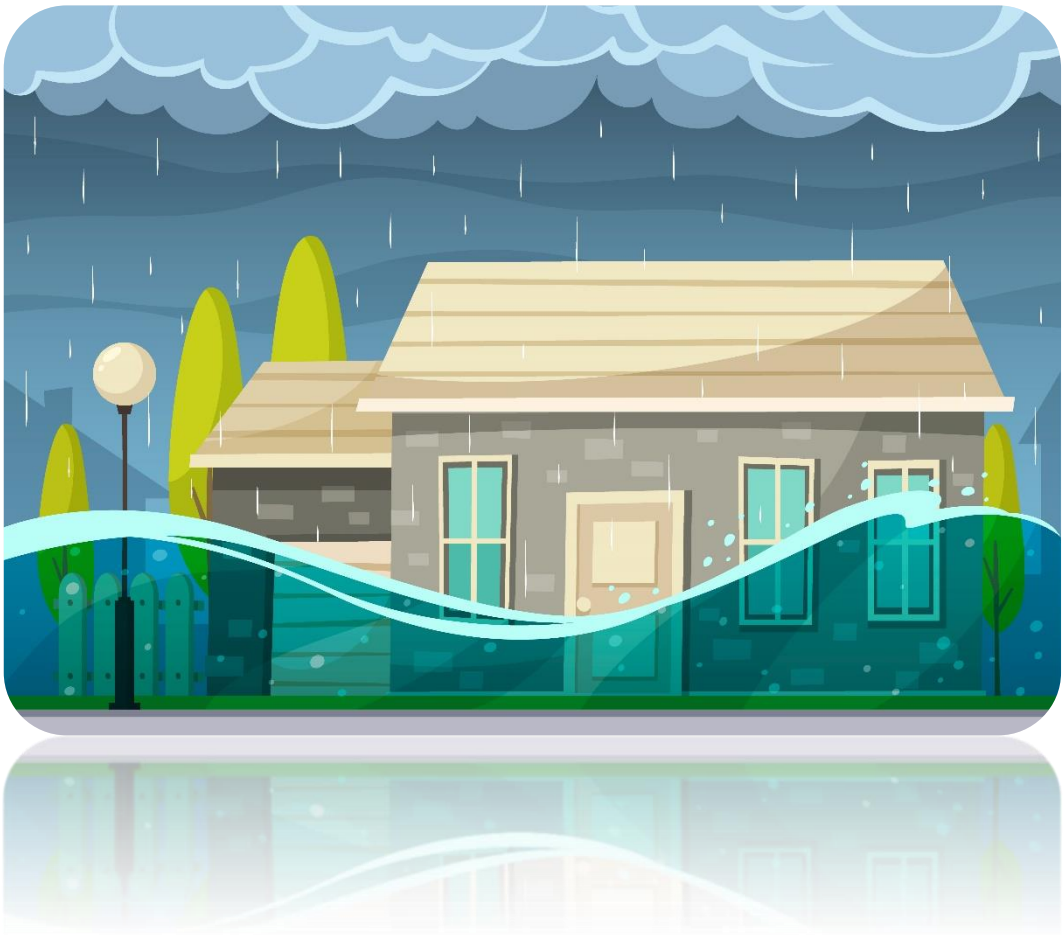
Attach the Servo variable to a pin.

Note that in Arduino 0016 and earlier, the Servo library supports servos on only two pins: 9 and 10.

4.4.8 Flowchart



Rain Detector System



Introduction

With the weather being as unpredictable as ever, it's easy to leave your skylights open, only for it to suddenly start raining, leaving the interior below at risk. With the rain sensor, however, you can stop this from happening.

You can use the sensor to monitor rain or slushy snow/hail and send closure requests to electronic shutters, windows, awnings or skylights whenever the rain is detected.

Rain does bring us cool air , comfortable and relax . It also brings in some inconveniences into our life . We travel out with our umbrella . Closing the window to keep the rain out . Worrying about the clothing that you are drying outside now Rain is a daily affair that we have to be constantly paying attention to.

4.5.1 Objectives

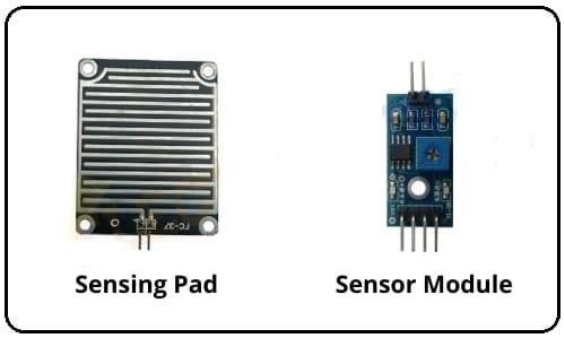
- we need smart system that can help us live with the inconvenience raining situation .
- system can detect the rain and alert us
- smart system can remind us to close our windows
- it can automatically send out a notification to alert us

4.5.2 Components

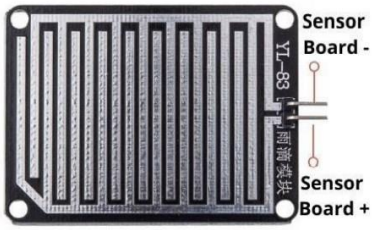
- Rain Sensor
- Servo Motor
- Pushbutton

Rain Sensor

A typical rain sensor has two components.



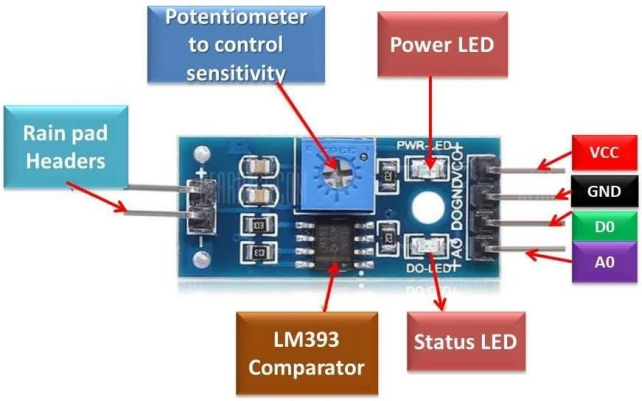
1. The Sensing Pad :



this rain board have two output pins. The sensor contains a sensing pad with series of exposed copper traces that is placed out in the open, possibly over the roof or where it can be affected by rainfall. acts as a variable resistor whose resistance varies according to the amount of water on its surface. Usually these traces are not connected but are bridged by water

2. The Module :

The sensor also contains an electronic module that interfece the sensing pad to the ESP32 . The module includes two power pins, two input pins and two output pins . also, on interfacing module you can find resistors, potentiometer to adjust sensitivity, LM393 comparator and two LEDS . The power LED will light up when the module is powered on . The status LED will light up when the digital output goes LOW .



Where the output pins of the module are

- AO pin : gives Analog Output
- DO pin : gives Digital Output

Servo Motor

It was previously explained in **smart security** system , Page NO. 21

Push button

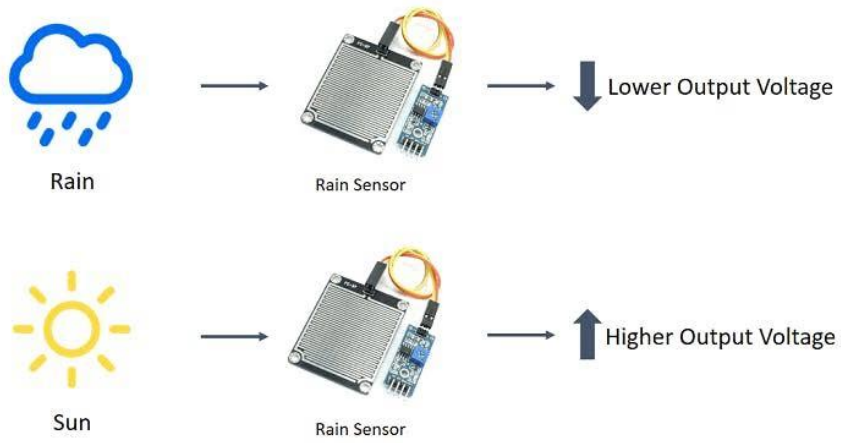
We used the push button to control the servo (window)

It was previously explained in **smart security** system , Page NO. 20

4.5.3 Working principle

The rain sensor working principle is pretty simple. The sensing pad includes a set of uncovered copper traces which mutually work like a variable resistor or a potentiometer. Here, the sensing pad resistance will be changed based on the amount of water falling on its surface. So, here the resistance is inversely related to the amount of water .

When the water on the sensing pad is more, the conductivity is better & gives less resistance. Similarly, when the water on the surface pad is less, the conductivity is poor & gives high resistance. So the output of this sensor mainly depends on the resistance.

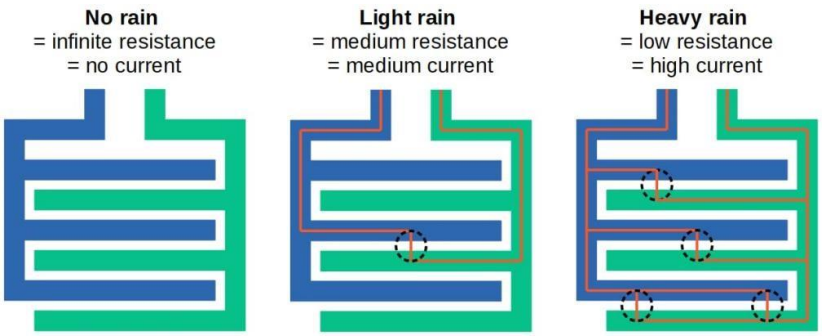


servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop. The feedback device supplies information such as current, velocity, or position to the servo controller, which adjusts the motor action depending on the commanded parameters.

4.5.4 How Sensor Work

at no rain there is no connection between the two copper tracks and the resistance is infinite. During light rain there are some water drops that land on the surface of the rain board and connect the two conductor tracks. Because water is conductive, the resistance of the rain board decreases resulting in a medium resistance.

If there is heavy rain, more and more rain drops falling on the board and further decrease the resistance until the resistance is 0Ω and the circuit is shorted



On the module you find multiple resistors that functions are the voltage divider to provide an analog signal. Therefore as input we get a resistance from the rain board and the module converts this resistance into a voltage drop between the analog pin and ground.

The biggest part on the module is the potentiometer to adjust the sensitivity of the rain detector. The potentiometer is only a variable resistor whose resistance is changed with the setting wheel at the top.

We need this potentiometer to compare the resistance of the potentiometer with the resistance of the rain board.

This comparison done by the LM393 comparator

Which consists of two independent precision voltage comparators and is specially designed to operate from a single power supply and

used to digitize analog signal and is made available at an Digital output

If the resistance of the rain board is lower than the threshold, defined by the potentiometer, the digital output of the module changes from 1 HIGH to 0 LOW.

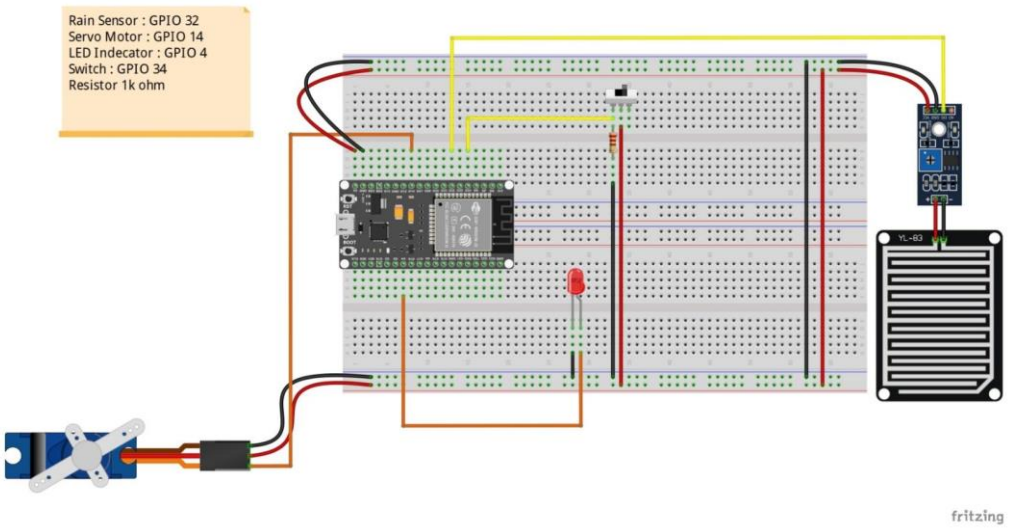
Working Steps :

1. Esp32 gets digital reads from the rain sensor
2. If the digital read of the sensor is LOW , Esp32 realize that there is rain
3. Esp32 send the motor a signal to close the window and print “Raining” on the weather LCD
4. Then after rain stop , the digital read of the sensor will be HIGH , the Esp32 realize that the rain stopped and print “Sunny” on the weather LCD
5. When there is no rain, Esp32 check the switch if on , send the motor a signal to open the window else , send the motor a signal to close the window

4.5.5 How to connect

The input pins of the module connected to the two output pins of sensing pad and the output pins of module to your microcontroller (ESP32).
the VCC and GND of the module connected to 5V and 0V sequentially of the regulator 5V and D0 connected to digital input of ESP32.
Servo motor has three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU (ESP32) .
we added an on/off Push button to control the servo (window)

4.5.6 Circuit Design



4.5.7 Libraries and functions

ESP32Servo.h :

Allows ESP32 boards to control servo, tone and analogWrite motors using Arduino semantics .

This library can control many types of servos. It makes use of the ESP32 PWM timers : the library can control up to 16 servos on individual channels No attempt has been made to support multiple servos per channel.

To include the library :

```
#include <ESP32Servo.h>
```

Methods

1. attach( )

attach the servo variable to a pin .

syntax : `servo.attach(pin);`

```
servo.attach(pin,min,max);
```

2. write( )

Writes a value to the servo, controlling the shaft accordingly. On a standard servo, this will set the angle of the shaft (in degrees), moving the shaft to that orientation .

syntax : `servo.write(angle);`

3. writeMicroseconds( )

Writes a value in microseconds (us) to the servo, controlling the shaft accordingly. On a standard servo, this will set the angle of the shaft. On standard servos a parameter value of 1000 is fully counter-clockwise, 2000 is fully clockwise, and 1500 is in the middle .

syntax : `servo.writeMicroseconds(us);`

4. Read( )

Read the current angle of the servo

syntax : `servo.read();`

5. Attached( )

Check whether the servo variable is attached to a pin

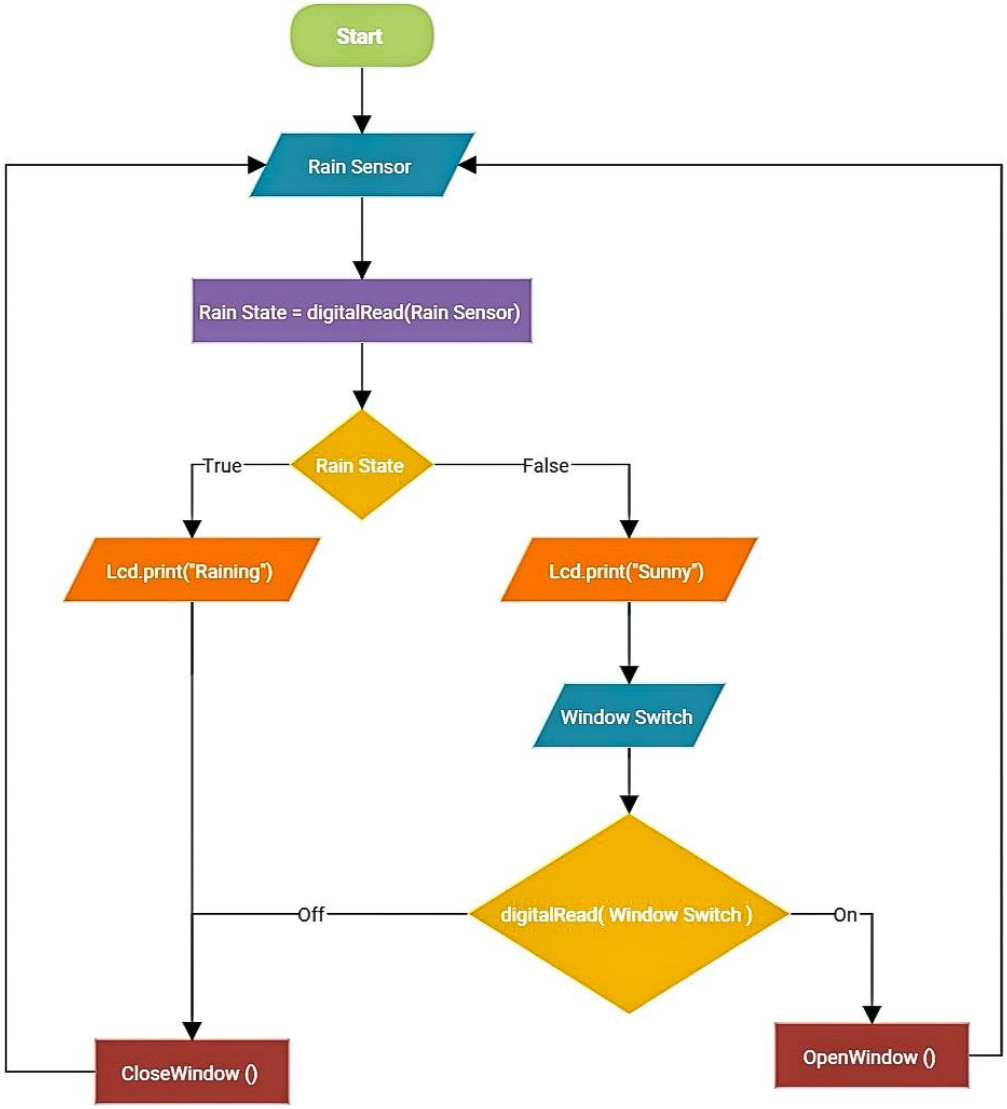
syntax : `servo.attached();`

6. Detach( )

Detach the servo variable from its pin

syntax : `servo.detach();`

4.5.8 Flowchart



Weather Monitoring System

Introduction

The Weather is more than just understanding that hot air rises or how hurricanes form ; it's also about understanding how the weather and changes in the weather affect our lives , homes , and health . When you think of the weather in those terms , it's everywhere . The difference between the relative humidity inside of the house and outside of the house can affect our homes , health , and hobbies . How our bodies react to the weather affects our health and safety , and understanding how the weather affects the world around us can affect the way we live our lives

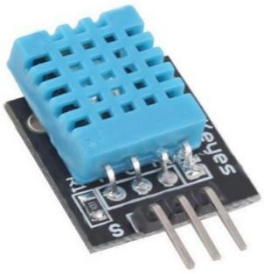
4.6.1 Objectives

- The objective of this project is to design a weather monitoring system in which a microcontroller is interfaced with sensors, LCD and Mini Cooling Fan.
- Provides Comfortable to people they live in home
- Alarms us of climate change when we are not at home
- Reducing consumption

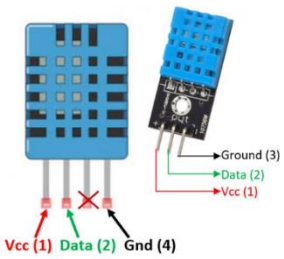
4.6.2 Components

- DHT11 Sensor
- LCD (16x2)
- I2C
- Fan 5v
- Relay

DHT11 Sensor :



The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.



The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%.

The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins(at our project we used the module)

DHT11 Specifications :

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

5V Mini Cooling Fan :

Specifications:

- Operating voltage: 5V
- Current: 0.2 A
- Brushless DC fan
- Fan dimensions: 30mm x 30mm x 8mm
- Wire length: 3.25" / 80mm
- Fan weight: 6.2g / 0.22oz
- Mounting screws & nuts included

In our system we use Mini cooling Fan to decrease the feeling Hot when temperature is Above 30 °C

LCD (16x2) & I2C :

It was previously explained in **smart security system** , Page NO. 19

Dual-Channel Relay Module :

It was previously explained in **Firefighter System** , Page NO. 34

4.6.3 Working principle

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature . The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure , process this changed resistance values and change them into digital form.

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor , which causes a decrease in its resistance value with increase in temperature.

To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

4.6.4 How System Work

The DHT11 uses just one signal wire to transmit data to the Microcontroller . Power comes from separate 5V and ground wires . The DHT11 is a basic , ultra low-cost digital temperature and humidity sensor . It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed) . Its fairly simple to use , but requires careful timing to grab data . The only real downside of this sensor is you can only get new data from it once every 2 seconds , the sensor readings can be up to 2 seconds old .

After sensing the temperature it will be shown on LCD and it send the signal to ESP32 and if its above 30°C fan automatically works , IF its not above 30°C fan will not work.

4.6.5 How To Connect

We are utilizing a (16x2) LCD display to showcase sensor data locally and it can display 16 alphanumeric characters in 2 rows.

An I2C display module is used in this project to reduce the number of wires that connect from microcontroller to LCD display to four ; otherwise we need to connect 16 wires.

I2C display module operates on I2C bus and has the following four pins :

- SDA : Serial data.
- SCL : Serial clock.
- VCC : 5V.
- GND : ground.

The VCC pin connects to 5V of the power supply module and GND connects to GND of the supply, the SDA connects to pin 21 on ESP-32 and SCL connects to pin 22.

DHT11 have 3 pins to connect:

- VCC pin connected to 5v
- GND pin connected to ground
- Data Pin connected on ESP-32 As Input

Relay have 3-pins form each side we use 5 pins from them :

First 3-pins

- Negative pin to GND
- Input pin to microcontroller
- VCC pin to 5v

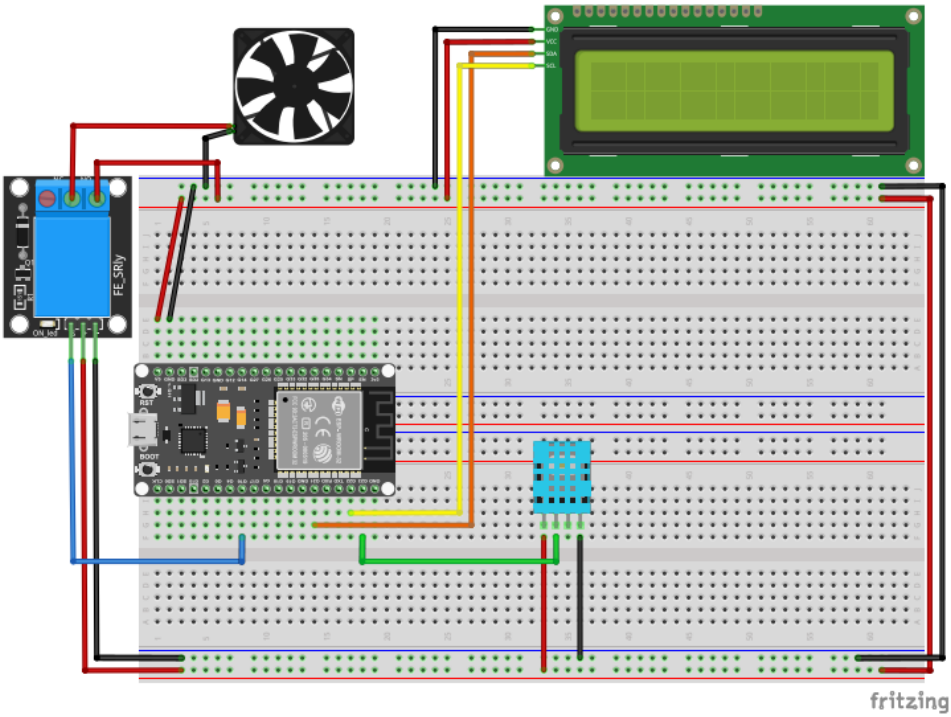
Second 2-pins

- Normally Opened (NO) connected to 5v
- Common (COM) connected to Positive wire on Mini cooling Fan

Mini cooling fan :

- Positive wire connected to (COM) on Relay
- Negative wire connected to GND

4.6.6 Circuit Design



4.6.7 Libraries

```
#include <DHT.h>
```

1. Then define the digital pin in which the DHT11 is connected to.

```
#define DHTPIN 2   // Digital pin connected to the DHT sensor
```

2. Define the type of DHT Sensor. Since we're using a DHT11 sensor, we can write like this.

```
#define DHTTYPE DHT11  // DHT 11
```

3. Then define the DHT parameter to Initialize DHT sensor.

```
DHT dht(DHTPIN, DHTTYPE);
```

4. Inside the void setup function, Initialize the Serial Communication and the DHT Sensor.

```
Void setup() {
            Serial.begin(9600);
            Dht.begin();
            }
```

5. Get the readings from the sensor

```
Float h = dht.readHumidity();          // read humidity
Float t = dht.readTemperature();       // read temperature
```

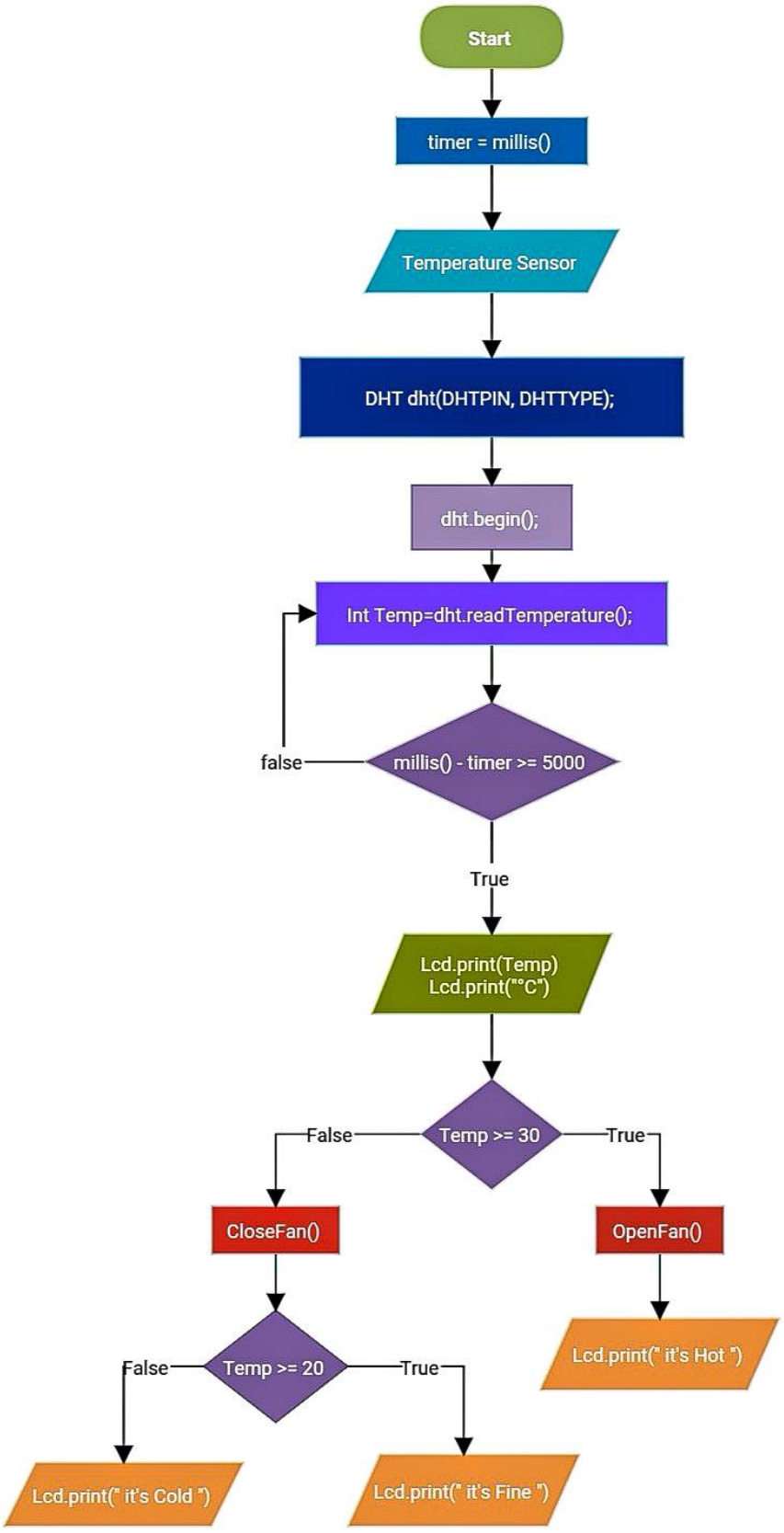
Millis( ) :

It was previously explained in **smart security** system , Page NO. ....

I2c Library :

It was previously explained in **smart security** system , Page NO. ....

4.6.8 Flowchart



Chapter Five

Mobile Application

Introduction

Mobile application or app is a computer program or software application designed to run on a mobile device such as a phone, tablet, or watch. Mobile applications often stand in contrast to desktop applications which are designed to run on desktop computers, and web applications which run in mobile web browsers rather than directly on the mobile device.

Increasingly, smart home apps control and manage multiple systems within the house, connected through a home automation hub. Some people start with a hub and add connected devices incrementally. Smart home starter kits, available from a number of vendors, include all the components necessary to connect and manage systems in the home: sensors, networking, the communications hub and the mobile app.

Smart home apps usually allow the user to create groups actions for particular situations. For example, might include locking the doors and setting the security system, as well as adjusting the heating/cooling, window coverings and lighting

5.2 Objectives

- makes it possible to control all the things in the house without any problem or difficulty, even if a person is not very tech savvy, he will easily be able to understand how these things work with following some guides, and can feel connected to the house 24/7 Even if the owner is not at home.
- saving time is provides many options to easily accomplish time-consuming daily activities . because everything can be easily done with one click in the smart home app.

- Remote monitoring capability which provides monitoring of systems in the home at all times, resulting in the owner feeling comfortable, whether it is fire alarm alerts or notifications from the alarm system, the owner will feel peace of mind because he knows that His family and home are safe from dangers.
- Complete Device Control it gives homeowners complete control of their devices anywhere, where many tasks can be done, whether it is turning on the lights or turning on the thermostat so that one does not feel Cold when you get out of bed in the morning.
- increase safety
- energy saving

5.3 systems which App Control

1. **home lights control**

The application helps to control all the lighting of the house such as the bedroom, bathroom, kitchen and reception room to save energy in the absence of presence in the place and also provide complete comfort to the user by pressing the button to close or open the lighting

2. **fan control**

The application helps control the fan by turning it off or on

3. **display the weather**

Showing the weather condition helps to know the temperature of the house to take the necessary measures to protect from high temperature and provide the maximum possible comfort for the user

4. **opening and clothing doors**

There is a button to close and open the garage door To help open the garage door without the need to get out of the car

And there is a button to open or close the main gate to help the user to keep the house safe from the other

5. opening and clothing the windows

The application helps to control the closing and opening windows to help to keep the house safe from the rain and the thieves.

6. send email and notification to the mobile

A Mobil App is sending emails and notification to the mobile phone in the event of fire or rain . To help quickly take the necessary measures to maintain the house.

5.4 Blynk platform

In our project we use **Blynk** platform to create an application

Blynk is a full suite of software required to prototype, deploy, and remotely manage connected electronic devices at any scale:

from personal IOT projects to millions of commercial connected products.

With Blynk anyone can connect their hardware to the cloud and build a no-code iOS, Android, and web applications to analyze real-time and historical data coming from devices, control them remotely from anywhere in the world, receive important notifications, and much more…

Blynk is a multi-tenant solution.

You can configure how users get access to the data by setting roles and configuring permissions .

Applications made with Blynk are ready for the end-users .

Whether it is your family member , an employee , or someone who has purchased your product , they will be able to download the app , connect the device and start using it .

Blynk also offers a white-label solution (part of the Business Plan) , which means that you can add your company logo , app icon , choose the theme , colors , and publish the app to App Store and Google Play under your company name .

These apps will work with your devices.

what you need to Create an App using Blynk

1. A Smartphone

Android OS version 4.2+ iOS version 9+ Blynk doesn't run on Windows Phones, Blackberries and other dead platforms. Sorry . You can also run Blynk on emulators

2. IOT Hardware

Blynk can run on over 400 hardware modules .

The most popular are:

- ESP8266
- ESP32
- Node MCU
- Arduino (any model)
- Raspberry Pi (any model)
- Particle (any model)

3. Internet Connection

To connect your hardware to the Internet, you can choose almost any module either built-in, or external shields .

4. Supported connectivity

- WIFI
- Ethernet
- Cellular (GSM, 2g, 3g, 4g, LTE)
- Serial
- USB via your PC
- Bluetooth (BETA)

5.5 Creating a App using Blynk

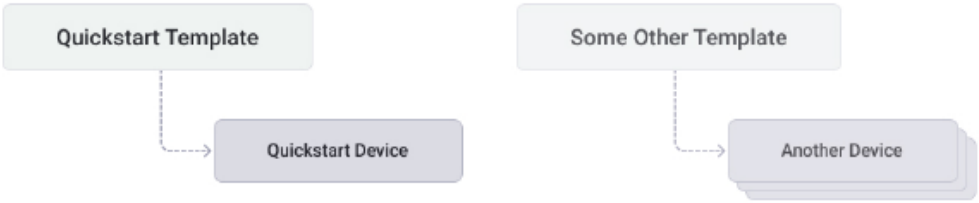
1. Create a Blynk account using Blynk Console or Blynk App for iOS or Android .
2. Switch to Developer Mode in Blynk Console or Blynk .
3. App have supported hardware (ESP32, Arduino, Raspberry Pi). The list of supported devices.
4. Be familiar with the basics of electric circuitry and know how to at least blink an LED using Arduino boards, know how to install libraries, etc.

Here is what happened during the Quick start flow:

1. website automatically created a Quick start Template.
2. Using this Quick start Template, then created a Quick start Device.
3. For this device, we generated the sketch with all the needed parameters.
4. uploaded the sketch to board and it used the parameters to connect to Blynk Cloud and to become visible in the apps.

What is a Device Template?

In Blynk, we use Device Templates to make it easy to work with multiple devices that perform the same functions. On a high level, Device Template is a set of configurations. Once you have created a template, you can create devices from this template and they will inherit all of the same configurations.



In the diagram above, you can see that we've created a Quick start Template and one Quick start device. When you decide to create your own device, you will first create your own Template and then create devices from it.

Think about smart home switches. They all perform a similar function and it's safe to assume that they should have the same data model, GPIOs, firmware code, etc. You can create Smart Switch template and use it to create multiple smart home switches.

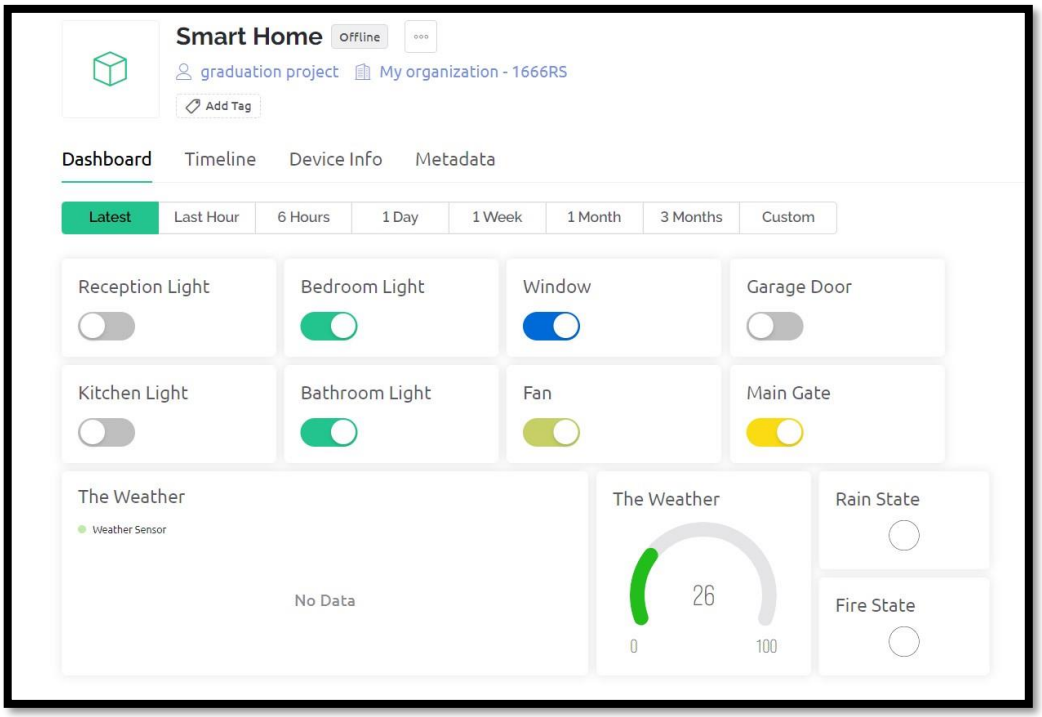
5.6 Device Template Elements :

Template ID

The most important element of the template is Template ID. This is a unique identifier of every template which should be specified in the code on your device. If you check the code we generated for your device, you will see it there:

1. #define BLYNK_TEMPLATE_ID "Some Template ID"
2. #define BLYNK_DEVICE_NAME "Quick start Device"

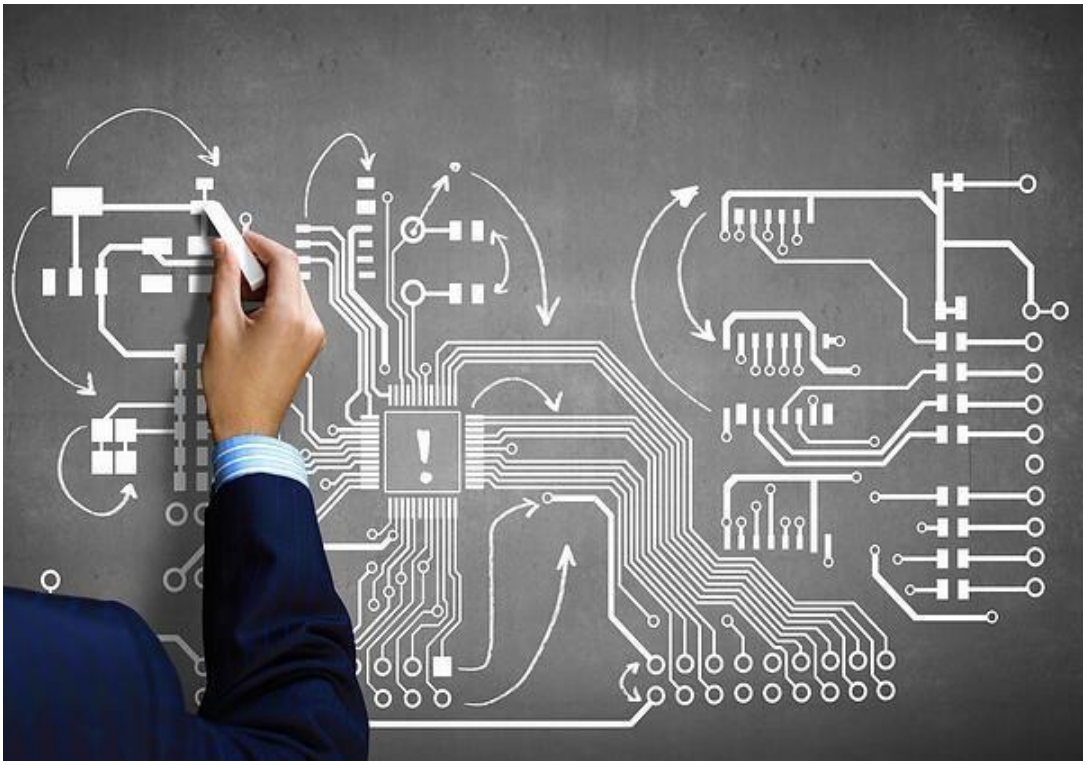
5.7 Website Dashboard



5.8 Mobile dashboard

Chapter Six

Printed Circuit Boards (PCB)



Introduction

A printed circuit board is a rigid structure that contains electrical circuitry made up of embedded metal wires called traces, and larger areas of metal called planes. Electronic components are soldered to the top, bottom, or both layers of the board onto metal pads. These pads are connected to the board circuitry allowing the components to be interconnected together. The board may be composed of either a single layer of circuitry, circuitry on the top and bottom, or of multiple layers of circuitry stacked together.

Circuit boards are built with a dielectric core material with poor electrical conducting properties to make the circuitry transmission as pure as possible, and then interspaced with additional layers of metal and dielectric as needed. The standard dielectric material used for circuit boards is a flame resistant composite of woven fiberglass cloth and epoxy resin known as FR-4, while the metal traces and planes for the circuitry are usually composed of copper. Printed circuit boards are used for a variety of purposes. You can find simple circuit boards in toys or controllers, while advanced circuit boards are used in computers and telecommunications.

Some boards are made with flexible materials thereby allowing them to be used in unique cases and enclosures that require them to bend around other features of the device. Some boards are built with specialized materials due to the high frequencies that they operate at, while other boards have heavy layers of copper in them for high powered circuits used in industrial control panels and other similar applications.

There are boards designed for extreme environments such as underground sensors or the engine compartment of your car. Specialized circuit boards are used for aviation, space, and military applications that impose strict tolerances on their manufacturing and performance.

6.2 Benefits of Printed Circuit Boards

Printed circuit boards (PCBs) are a massive part of just about every piece of electronic equipment that we have in our everyday lives. The computer you use, the phone in your pocket, your television, and so much more rely on these boards. It is through the use of PCBs that many electronics have been able to be reduced in size over the years, although there are certainly some large and complex circuit boards that are still used in many pieces of equipment .

- **A Compact Solution**

  A printed circuit board can contain a number of parts and elements. Because they utilize copper tracks rather than actual wires, it allows for the same types of results without using current-carrying wires It's possible to have highly complicated circuits in very small packages.

- **Saving Time and Energy**

  One of the best benefits of using printed circuit boards is the amount of time that can be saved. Connecting components traditionally takes a lot of time, whereas the circuit board will take far less time to assemble once the design is complete. It is easy and intuitive to use and it provides a relatively simple way to design and test the printed circuit board before moving on to the rest of the process.

- **No Loose Connections**

  The connections in the printed circuit board are made through the copy tracks, and as long as they have been manufactured properly, There is no need to to deal with short circuits or loose connections.

- **A Reliable Option**

  It’s no accident that so many companies and individuals today are making use of printed circuit boards. They are a reliable solution that can work for a wide range of uses and products both large and small.

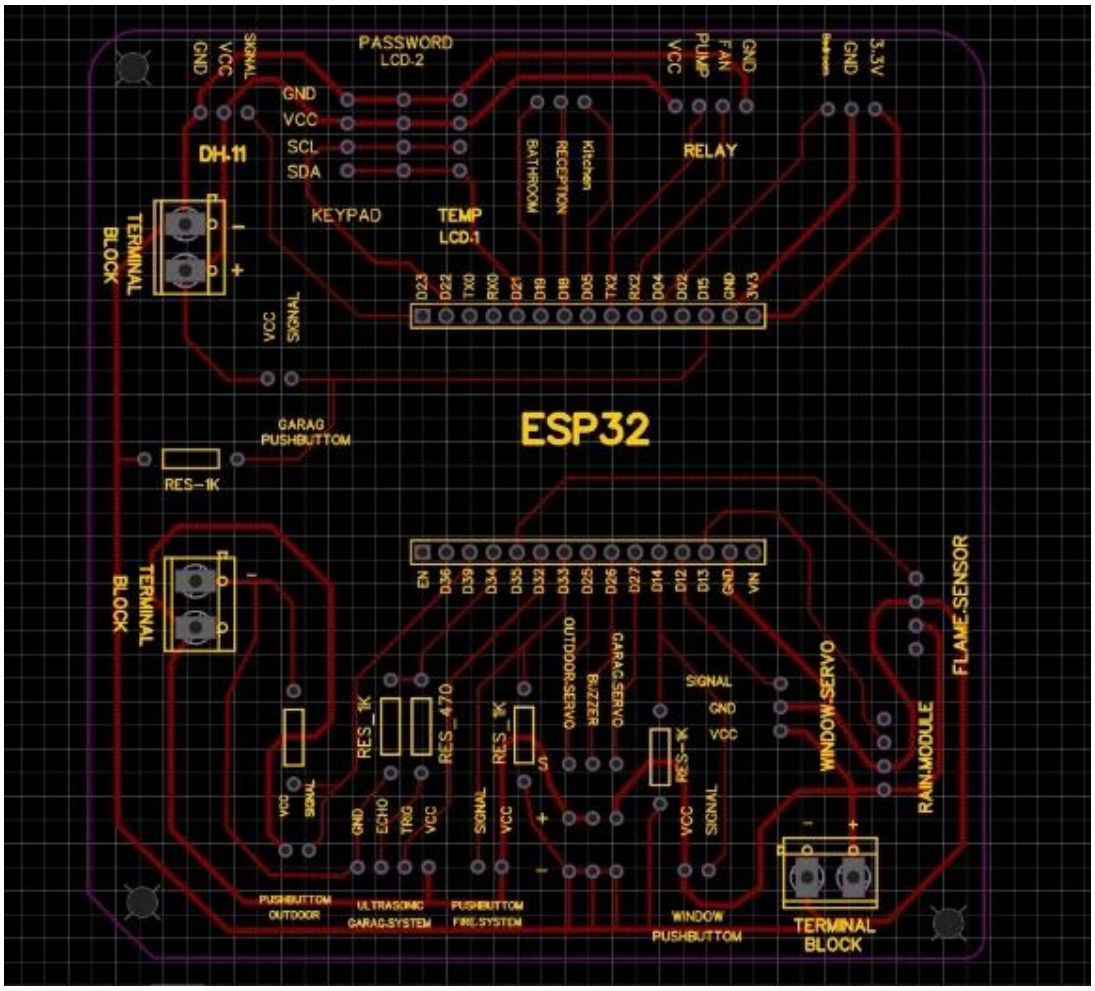
- **Low Costs**

  There are fewer components being used in most cases, which helps to reduce the cost to an affordable level for most companies.

Systems That Was Connected On PCB :

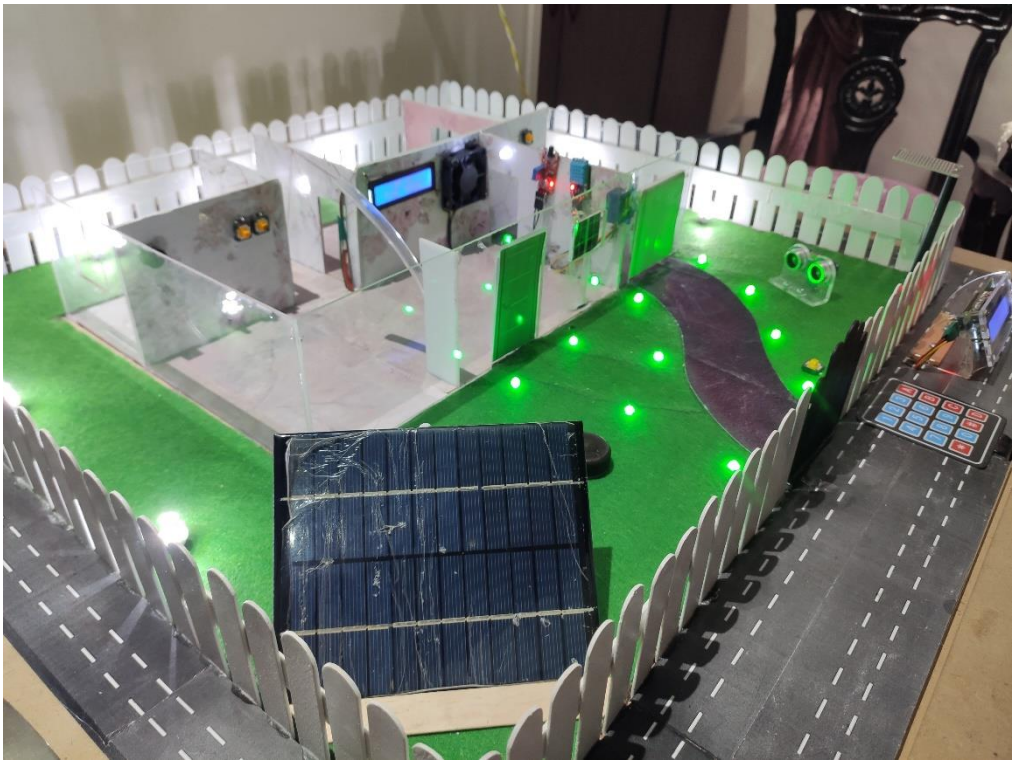
1. Security System
2. Fire Fighting System
3. Rain Detector System
4. Garage Door System
5. Weather Monitoring System
6. Inside House Lighting System

6.3 PCB Design



Chapter Seven

Maquette Design



Introduction

At the beginning, we started making a house-shape kit to be a miniature copy of the house design on the ground in order to simulate the way the sensors work and to communicate the idea and the overall picture of the house systems and the way they work and to be a simple and short way to deliver the idea to the listener.

7.2 maquette components

1. The Maquette base made of MDF wood fiber
2. the walls of the maquette made of poly crystal
3. The outer wall is made of wood sticks
4. The outer floor of the house is made of broadcloth (green)
5. Solar panel
6. Ultrasonic sensor
7. Rain sensor (YL-83)
8. keypad
9. 2 LCD
10. Fan
11. 3 Servo Motors
12. 12v LEDs
13. 5v LEDs
14. Flame sensor
15. DHT11 Sensor
16. Mini water pump
17. LDR sensor

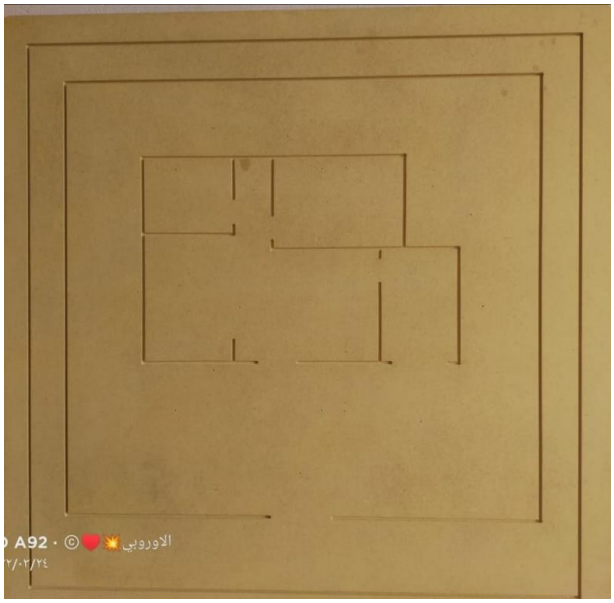
7.3 The design of the maquette

The maquette consists of 1 bedroom, kitchen, living room, 1 bathroom, 1 balcony and a garage, and each room has its own LED to provide good lighting system for the house

7.4 The house basement

The house base is made of MDF wood fiber as it is strong and flexible enough to withstand drilling and screwing operations without breaking or cracking…

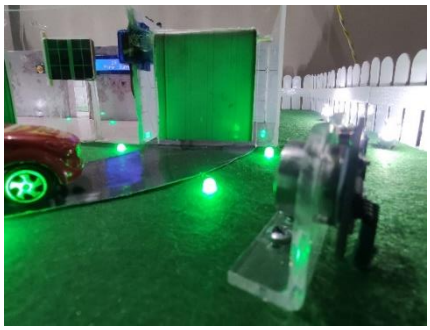
Base measures are 72 cm long x 72 cm wide x 10 mm high.

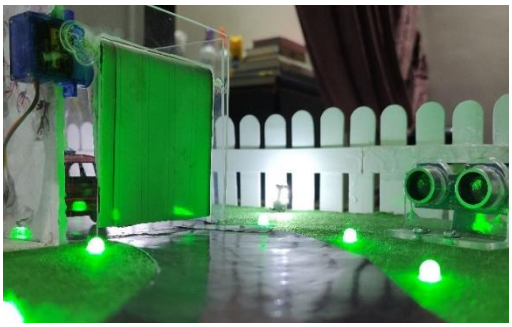


At the beginning we drilled 3 mm for the area of the house and the outer wall to interlock the walls in it then we used super glue to stick the walls together (inner & outer walls) then we used broadcloth (green) to make the outer garden looks like a grass then we started screwing the sensors and sticking the outer LEDs in the ground.

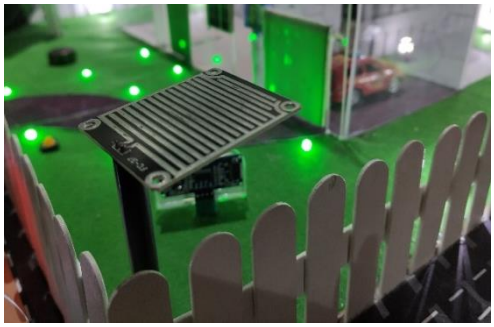
7.5 Systems On Maquette

The ultrasonic sensor: used to sense the car motion and open the garage door.

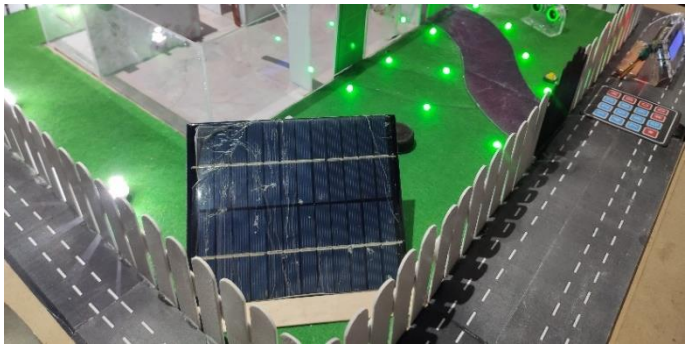




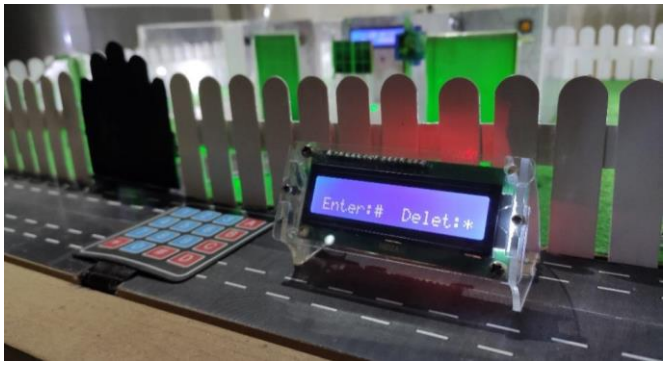
The rain sensor: used to close the windows in case of raining to protect the house from getting wet.



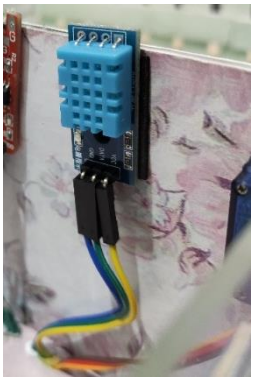
Solar panel: to provide house it's own electricity



The keypad and the outer LCD: to write the password of the outer doors as is used as a security system.



DHT11 sensor , the inner LCD and the fan : used to measure the temperature and write it on the LCD then the fan works automatically when the weather is hot to cool down the house.



Fire sensor and water pump: used to alarm in case if there is a fire in the house and to turn on the water pump automatically to putdown the fire.

LEDs: used to provide lighting system to the garden and the house which works automatically after sunset.

LDR sensor: sense the sun and after sunset it turn on the lights.

Servomotors: used to open and close the main gate, the windows and the garage doors.

The house:

The walls of the house are made of poly crystal, some of them are white and some of them are transparent to make it easier to see the systems inside the house and to add aesthetic appearance.

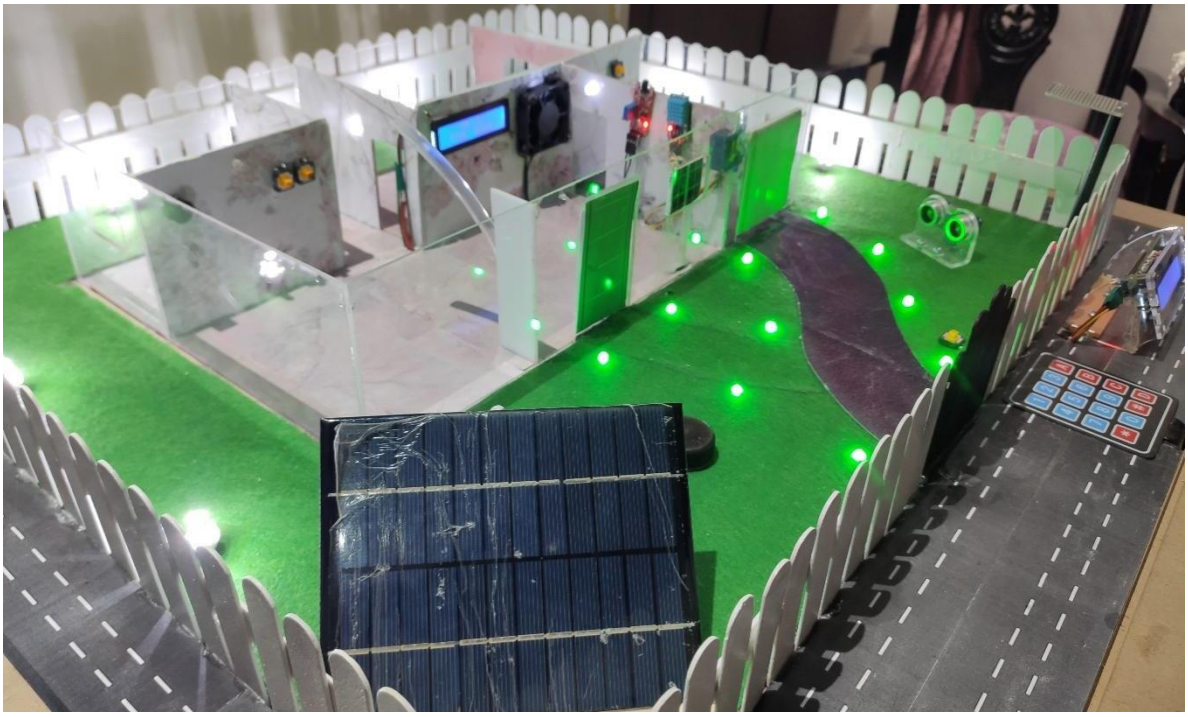
The house measures are 28 cm long x 41 cm width x 10 cm height .

And there is also a drawer under the maquette to carry the PCP circuit and the wires that connect systems to each other mad of MDF woof fiber as the same size of the maquette.

At the end there is a cover made of transparent poly crystal too used to prevent the dust from reaching the maquette and to provide more protection for it.

Summery:

The maquette is made to simulate the real house systems and to show how it works and the motion of every thing in it in addition to deliver the idea of the smart home



Conclusion

Smart homes promise to create adaptive, supportive and assistive living environments.

Likewise, smart home holds great promises for rectifying the major concerns towards the building sector according to its potentials in managing the building energy consumption, dealing with the environmental issues, and offering consistent health monitoring and controlling. Smart homes can be considered a promising solution for the future of AEC industry according to their flexibility, adaptability and dynamic features.

Traditionally, residential buildings are not flexible enough to correspond to the diversity of users' demands. They generally follow a singular pattern to meet the residents' demands. As such, several issues can be derived from this inflexibility. These include increasing the energy consumption and environmental emissions. However, smart homes can revolutionize the traditional relationship between users and homes. They increase the level of users' participation in controlling the household energy consumption. Smart homes can be responsive/interactive towards the residents' needs. They deliver a consistent health caring, monitoring and control system. They provide a behavioral map and respond to any detected deviations from the developed pattern. Furthermore, smart environments recognize the level of users' activities in buildings and regulate the household energy consumption based on users' presentence.

Smart homes improve the static relationship between users and traditional buildings to a flexible and interactive one. Smart homes should improve the linkages and communications between the occupants and the living environments resulting in ensuring a highly independent and convenient lifestyle.

In recent years, smart homes were mainly introduced as highly automated living environments through deploying sophisticated technologies. However, future research should draw more attention to the environmental performance of smart homes for ensuring a significant contribution to the current endeavors towards creating greener and smarter cities.

In near future, smart homes will become more intertwined with 'adaptability', 'self-adjustability', and 'self-learning capability' features in order to automatically respond to the entire needs of users and local contexts. With the high costs of the existing intelligent technologies as a key challenge, governmental sectors and policy makers are highly recommended to develop new initiatives such as incentivized programs for the proliferation of smart homes into future urban areas. The findings encourage scientists and researchers to focus on the further exploration and analytical evaluation of the social and environmental benefits of smart homes by using cross-disciplinary collaborative approaches from the viewpoints of architects and urban planners as well as civil, environmental, mechanical and computer engineers. Furthermore, future research is necessary to evaluate possible policies for encouraging the use of smart homes. Finally, further investigations towards ensuring the economic feasibility of the proliferation of smart homes as part of the urban sustainability agendas should be encouraged.

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