2. ***ABSTRACT***

[7] In recent years, there has been a tremendous increase in the world of smart devices, including intelligent homes. These allow interaction between people and everyday activities in the home that can be automated. Through sensory activity and data analysis, the household can autonomously respond to situations at home and warn users against possible anomalies and shortcomings. The IoT concept of a smart home described in this project uses a low energy wireless IoT elements with simple installation and implementation of sensors to create a smart home without a necessity to reconstruct a household. The concept of this project is based on own solution using Arduino and it provides an overview of current data and information about the smart home anywhere and anytime in a unique application for Android. This application includes Smart Gate Light, Smart Parking System and Smart DoorBell System. These can be controlled without the help of a human being.

3. ***INTRODUCTION***

Nowadays, the term Internet of Things (IoT) is becoming widely used in the area of Information and communication technology. The primary objective of IoT is an interconnection of electronic devices, systems and services for the purpose to provide more data that can be converted into information and information converted to the knowledge that can be subsequently applied. From the knowledge gained in this way, the systems can make decisions and autonomously perform activities. In practice, it means that the more devices can provide data about the real world, the more available data that can be analyzed we get and the more knowledge[1]-[7] that can be used. The IoT can be divided into two categories. The first category is formed of Industrial Internet of Things (IIoT) .

into which belongs, for example, industrial automation, transport industry, power industry and healthcare. The second category is formed of Consumer Internet of Things

(CIoT) that is focused primarily on smart home, smart shopping or payment for goods and services using the NFC included in the mobile phone. This paper is mainly focused on the second category of the IoT, the Consumer Internet of Things, more specifically on smart home applications. These applications are very popular among users especially because they allow to automate activities in the household that the users would otherwise have to take care of ourselves. They can, for example, control air condition, regulate heating in individual rooms, manage swimming pool heating, care of aquariums, control lighting in rooms with the ability to control its intensity, operate alarm or mechanical lock setting. If you are not sure whether you turned off an iron or other electric appliance in the morning rush, you can remotely disconnect it from your socket by using your mobile phone, tablet or computer. These applications can excite their users not only with the convenience they offer but also with their low price. Nowadays, it is possible to buy devices that are capable of integration with IoT, whose price does not exceed several ones or tens of United States dollars.

Home automation is one of the most common applications in the world of IoT, and not only a lot of scientific works and institutions are concerned, but also many companies that offer tailored solutions. Unlike expensive commercial solutions where the price of the sensor can run into several tens of United States dollars, open-source projects offer much cheaper solutions. One of the open source applications is the Frugal Labs IoT Platform (FLIP) [8], whose architecture consists of the FLIP control board, the Raspberry Pi-based gateway, custom Cloud solutions and web applications. The control board is based on Atmel's ATmega328p [9] microchip with expandable WiFi and Bluetooth communication modules. The control board supports a total of 6 sensor types that can be managed by web applications that are used to control FLIP devices and to acquire sensor data. There are also other home automation companies (Xiaomi, the Smart Home Kit [10], Samsung SmartThings [11]) that are focused on developing their default gateways and sensors that can be managed by mobile applications. The advantage of these projects is the implementation of a smart household without more in depth technical knowledge.

4. PROPOSED WORK : -

4.1 Hardware used:

i) Arduino Board

ii) Ultrasonic Sensor HC-SR04

iii) Buzzer

iv) LED

v) 220 ohm and 10K ohm resistor

vi) LDR (Photoresistor)

vii) Jumper wires

viii) Breadboard

ix) PIR Sensor

Software used:

- Arduino IDE

4.2 Descriptions :-

Here is a description of the individual components of the system:

i) ARDUINO BOARD:- The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by USB or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes pre programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Technical specifications

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

Pins

General pin functions : -

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector

(5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.

- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields that block the one on the board.

Special pin functions

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analogReference() function.[7]

In addition, some pins have specialized functions:

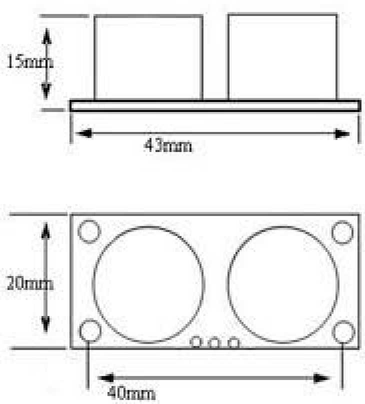
- **Serial** / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- **External interrupts**: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite() function.
- **SPI** (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) / I^2C: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs

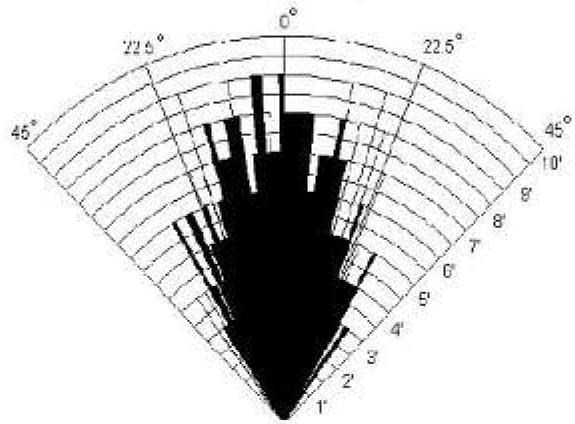
ii) Ultrasonic Sensor HC-SR04:-

Specifications

- Power supply: 5V DC

- Quiescent current: <2mA
- Effectual angle: <15°
- Ranging distance: 2cm – 500 cm
- Resolution: 1 cm
- Ultrasonic Frequency: 40k Hz

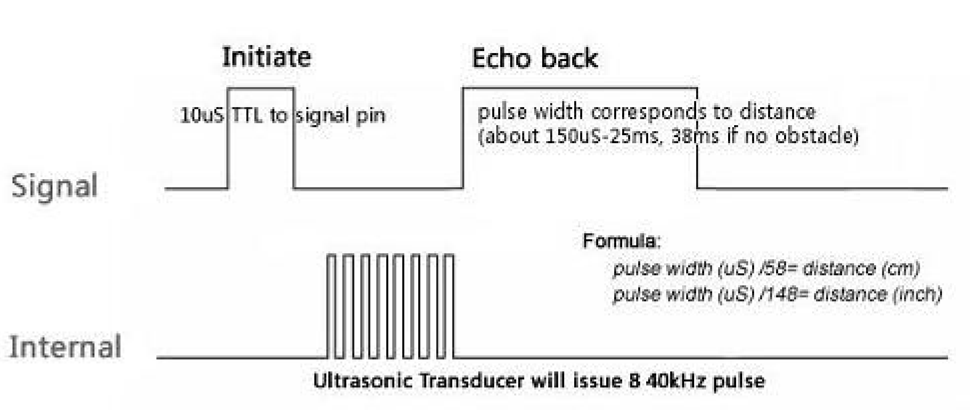




Practical test of performance,

Best in 30 degree angle

Sequence chart



A short ultrasonic pulse is transmitted at the time 0, reflected by an object. The sensor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is called a cycle period. The recommended cycle period should be no less than 50ms. If a 10μs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40kHz ultrasonic signal and detect the echo back. The measured distance is proportional to the echo pulse width and can be calculated by the formula above. If no obstacle is detected, the output pin will give a 38ms high level signal.

iii) Buzzer: A **buzzer** or **beeper** is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. Piezoelectric buzzers, or piezo buzzers, as they are sometimes called, were invented by Japanese manufacturers and fitted into a wide array of products during the 1970s to 1980s. This advancement mainly came about because of cooperative efforts by Japanese manufacturing companies.

iv) LED: A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when a current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photon) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Appearing as a practical electronic component in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are used in remote-control circuits, such as those used with a wide variety of consumer electronics. The first visible-light LEDs were

of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with high light output.

Early LEDs were often used as indicator lamps, replacing small incandescent bulbs, and in seven-segment displays. Recent developments have produced high-output white light LEDs suitable for room and outdoor area lighting. LEDs have led to new displays and sensors, while their high switching rates are useful in advanced communications technology.

LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. LEDs are used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes, lighted wallpaper, plant growing light, and medical devices.

Unlike a laser, the light emitted from an LED is neither spectrally coherent nor even highly monochromatic. However its spectrum is sufficiently narrow that it appears to the human eye as a pure (saturated) color. Nor, unlike most lasers, is its radiation spatially coherent, so that it cannot approach the very high brightness characteristic of lasers.

<u>v) 220 ohm and 10K ohm resistor:</u> 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. High-power resistors that can dissipate many watts of electrical power as heat, may be

used as part of motor controls, power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

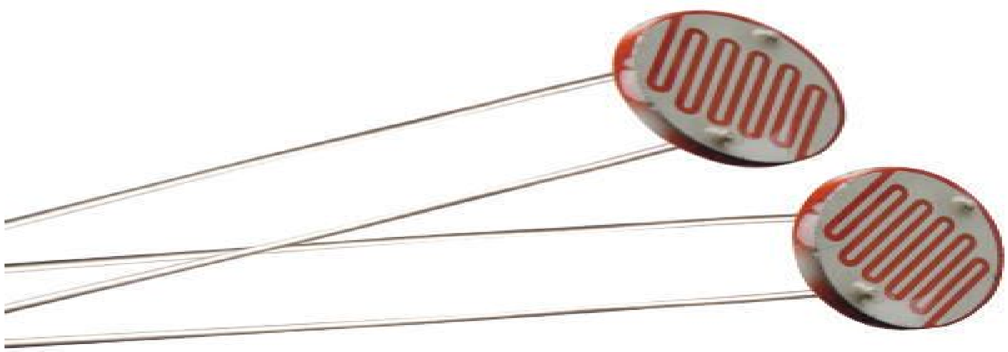
Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.

vi) LDR (Photoresistor): A **photoresistor** (or **light-dependent resistor**, **LDR**, or **photo-conductive cell**) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light-activated and dark-activated switching circuits.

A photoresistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several megaohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and their hole partner) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

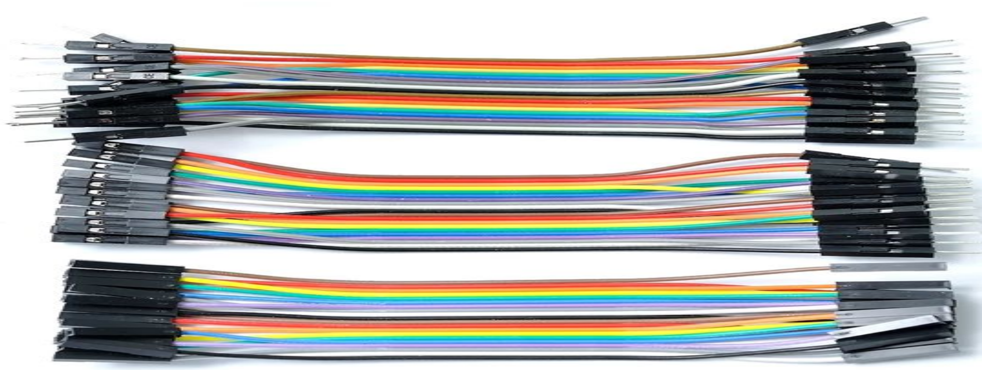
A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by



phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

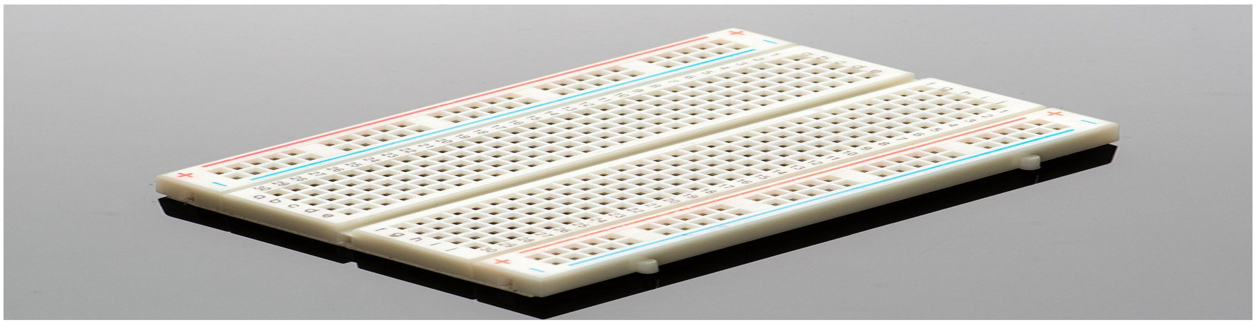
vii) Jumper Wire :-

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn’t get much more basic than jumper wires.



viii) Breadboard :-

A **breadboard** is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

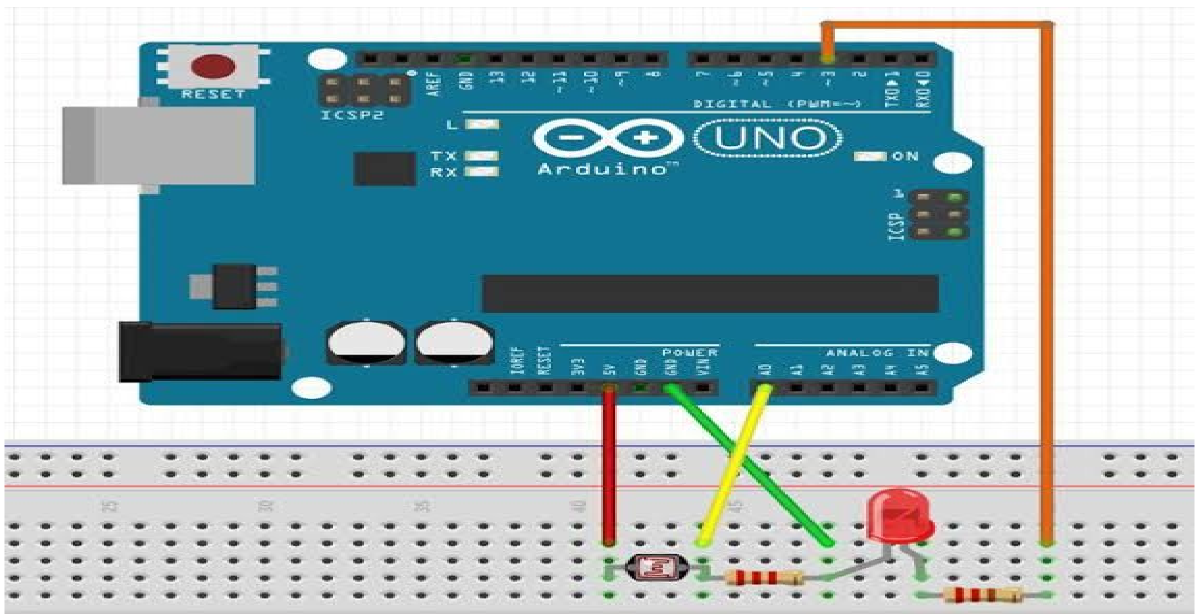


ix) PIR Sensor : -

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

5. System Design : -

1. For Smart Gate Light System using LDR :-



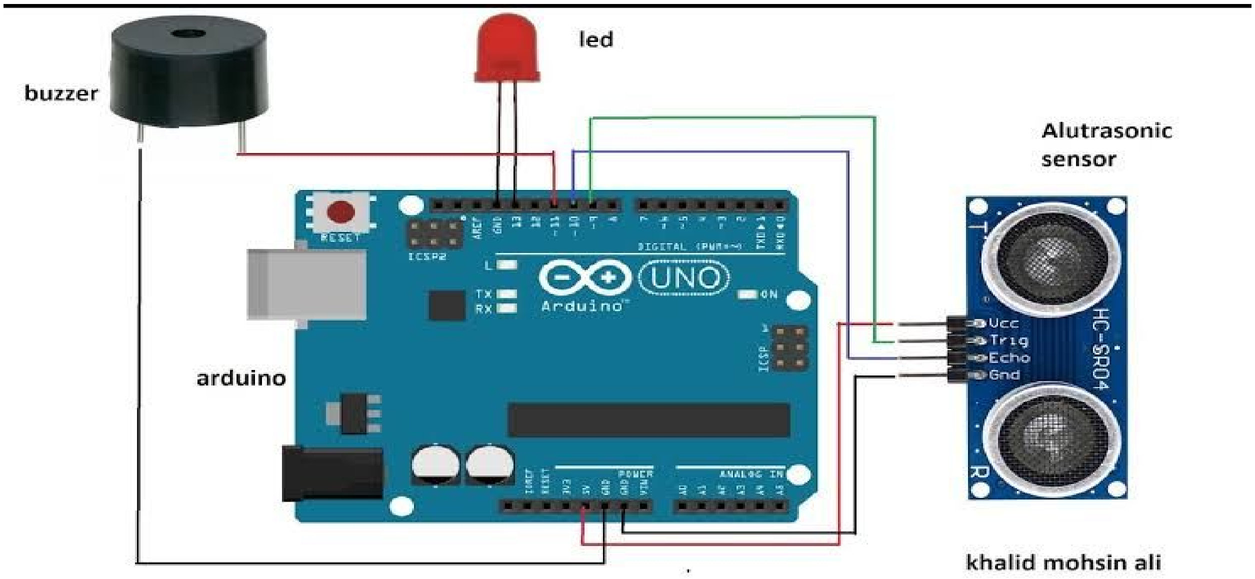
Components used for Smart Gate Light System : -

1. **Arduino UNO Board**
2. **LDR sensor**
3. **Resisters**
4. **LED**
5. **Bread Board**
6. **Jumper Wires**

Connections : -

1. **One leg of LDR ------- A0 (Arduino) -------- Resistor (1 leg)**
2. **Another leg of LDR -------- 5v (Arduino)**
3. **Resistor (another leg) -------- GND (Arduino)**
4. **LED big leg ----------- GND**
5. **LED small leg --------- Pin 13 (Arduino)**

2. For Smart Parking System :-



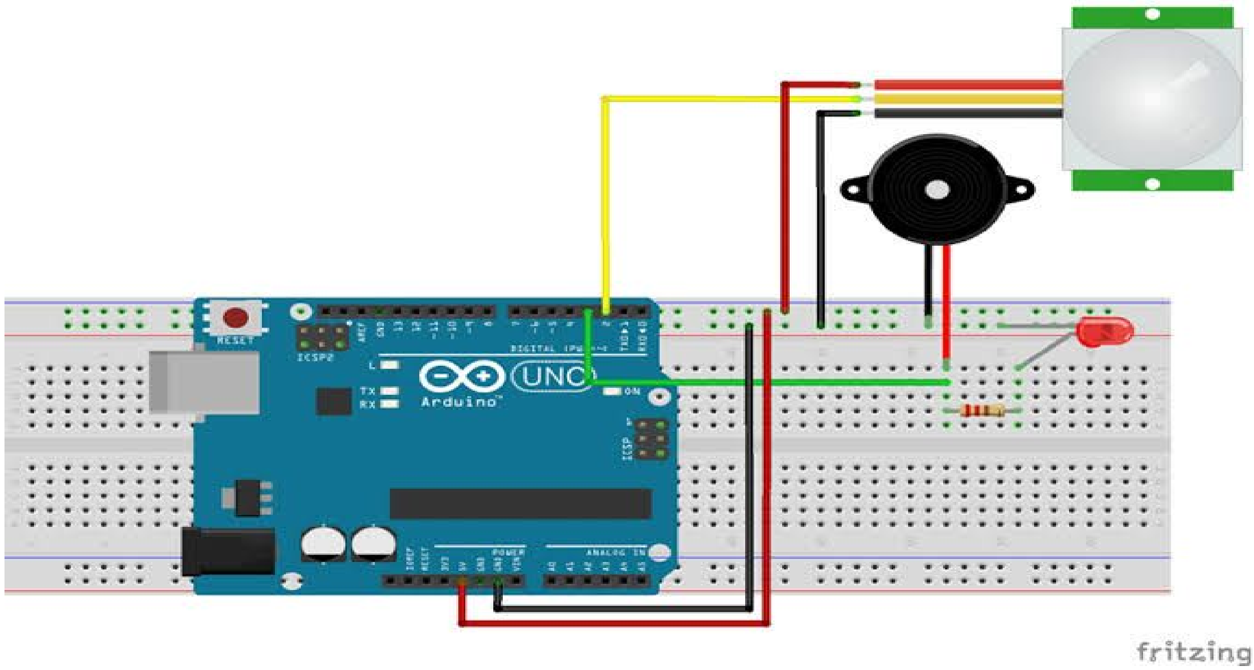
Components used for Smart Parking System : -

1. **Arduino Uno Board**
2. **Buzzer**
3. **Ultrasonic Sensor**
4. **LED**
5. **Jumper Wires**

Connections : -

1. **Big leg of Buzzer ------ Pin 11 (Arduino)**
2. **Small leg of Buzzer ------ Pin GND (Arduino)**
3. **Big leg of LED -------- Pin 13 (Arduino)**
4. **Small leg of LED -------- Pin GND (Arduino)**
6. **Vcc pin of Ultrasonic ------- Pin 5v (Arduino)**
7. **Trig pin of Ultrasonic -------- Pin 9 (Arduino)**
8. **Echo pin of Ultrasonic -------- Pin 10 (Arduino)**
9. **GND pin of Ultrasonic --------- PIn GND (Arduino)**

3. <u>For Smart DoorBell System : -</u>



Components required : -

1. **Arduino UNO Board**
2. **PIR Sensor**
3. **Buzzer**
4. **LED**
5. **Jumper Wires**
6. **Resistor**
7. **Bread Board**

Connections : -

1. **Big leg of Buzzer ------ Pin 3 (Arduino)**
2. **Small leg of Buzzer ------ Pin GND (Arduino)**
3. **PIR GND -------- GND (Arduino)**
4. **PIR Output ---------- Pin 2 (Arduino)**
5. **PIR Vcc --------- 5v (Arduino)**
6. **Big leg of LED -------- One leg of Resistor**
7. **Small leg of LED -------- GND**

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CONTENTS : -