# 6 MONTHS INDUSTRIAL TRAINING REPORT

**On “IoT BASED HOME AUTOMATION SYSTEM”**

**Held at National Institute of Electronics and Information Technology, Chandigarh**

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**SUBMITTED TO**

**Chandigarh College of Engg. and Technology, PANJAB UNIVERSITY, CHANDIGARH**

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**Signature of Student**

# ABSTRACT

We are living in an age where tasks and systems are fusing together with the power of IoT to have a more efficient system of working and to execute jobs quickly. The Internet of Things (IoT) shall be able to incorporate transparently and seamlessly a large number of different systems, while providing data for millions of people to use and capitalize. Building a general architecture for the IoT is a very complex task, mainly because of the extremely large variety of devices, link layer technologies, and services that may be involved in such a system.

Home automation gives you access to control devices in your home from a mobile device anywhere in the world. Home automation more accurately describes homes in which nearly everything -- lights, appliances, electrical outlets, heating and cooling systems -- are hooked up to a remotely controllable network. From a home security perspective, this also includes alarm system and all of the doors, windows, locks, smoke detectors, surveillance cameras and any other sensors that are linked to it.

Home automation is a step toward what is referred to as the "Internet of Things," in which everything has an assigned IP address, and can be monitored and accessed remotely.

The first and most obvious beneficiaries of this approach are "smart" devices and appliances that can be connected to a local area network via Ethernet or Wi-Fi. However, electrical systems and even individual points, like light switches and electrical outlets, were also integrated into home automation networks and businesses have even explored the potential of IP-based inventory tracking.

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# CHAPTER-1

# INTRODUCTION

Internet of Things (IoT) conceptualizes the idea of remotely connecting and monitoring real world objects (things) through the Internet . When it comes to our house, this concept can be aptly incorporated to make it smarter, safer and automated.Home automation is the process of controlling home appliances automatically using various control system techniques.

When people think about home automation, most of them may imagine living in a smart home: One remote controller for every household appliance, cooking the rice automatically, starting air conditioner automatically, heating water for bath automatically and shading the window automatically when night coming. To some extent home automation equals to smart home. They both bring out smart living condition and make our life more convenient and fast.

In their paper, Tan, Lee and Soh (2002) proposed the development of an Internet-based system to allow monitoring of important process variables from a distributed control system (DCS). This paper proposes hardware and software design considerations which enable the user to access the process variables on the DCS, remotely and effectively.

# CHAPTER 2

# ARDUINO

## 2.1 BACKGROUND

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. One can tell the board what to do by sending a set of instructions to the microcontroller on the board. To do so we use the Arduino programming language (based on Wiring) , and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

## 2.2 USES OF ARDUINO

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50.
- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, one can add AVR-C code directly into the Arduino programs.
- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

# CHAPTER 3

# ARDUINO UNO R3

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It‟s intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

## 3.1 FEATURES OF ARDUINO UNO R3

| | |
|---|---|
| Processor: | 16 Mhz ATmega328 |
| Flash memory: | 32 KB |
| RAM: | 2kb |
| Operating Voltage: | 5V |
| Input Voltage: | 7-12 V |
| Number of analog inputs: | 6 |
| Number of digital I/O: | 14 (6 of them pwm) |

## 3.2 PIN CONFIGURATION

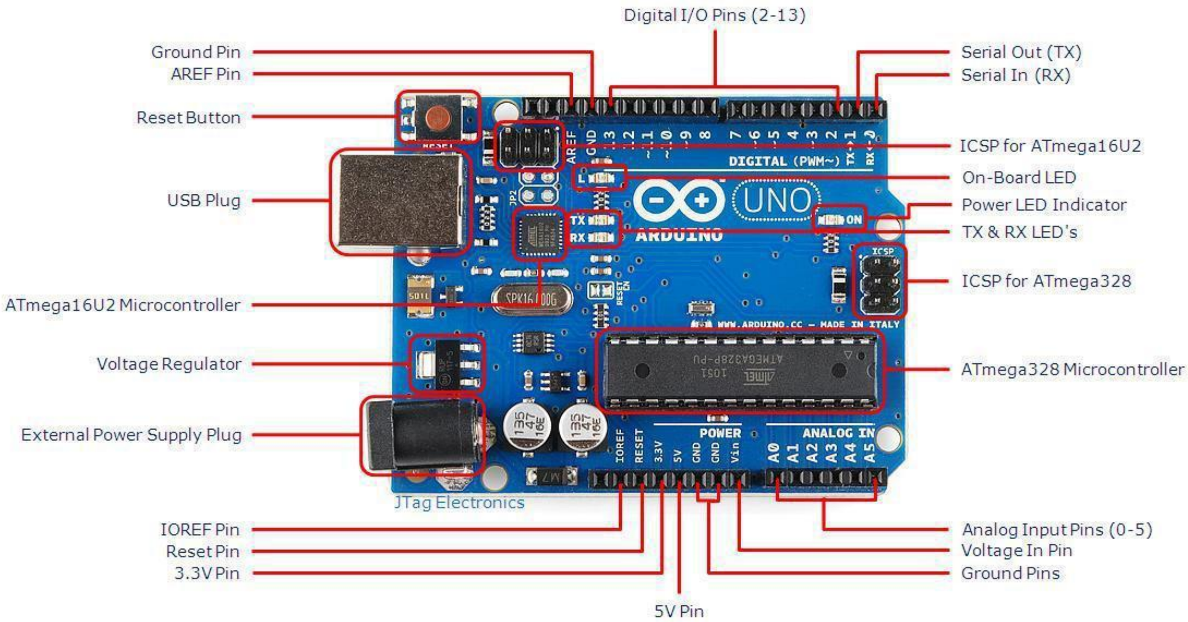
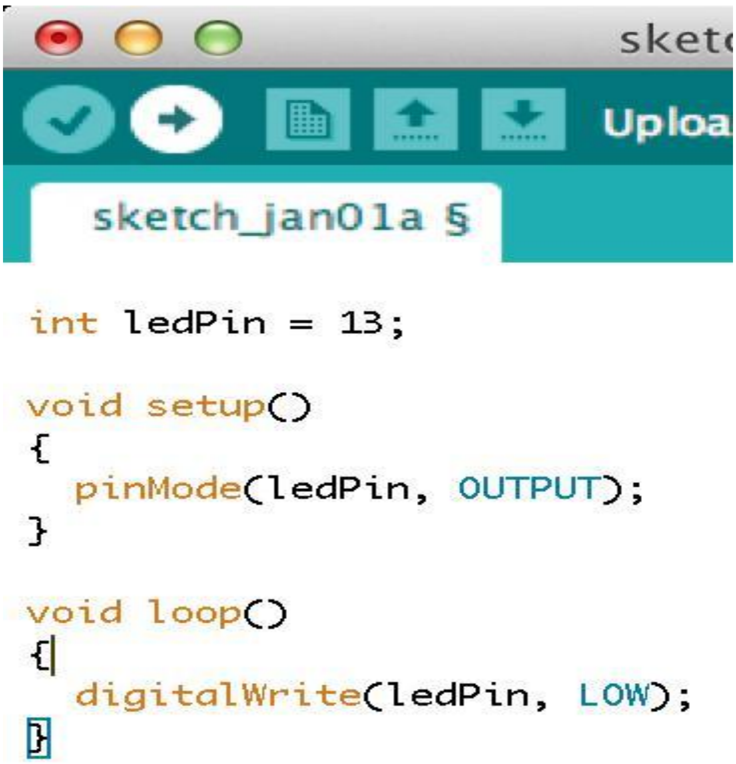



FIG 3.1 Pin Configuration of Arduino Uno R3

## 3.3 USING ARDUINO IDE

First program :

```
int ledPin = 13;
void setup()
{
pinMode(ledPin, OUTPUT);
}
void loop()
{
digitalWrite(ledPin, HIGH);
delay(2000);
digitalWrite(ledPin, LOW);
 delay(2000);
}
```



# CHAPTER 4

# Proteus VSM

## 4.1 INTRODUCTION

Proteus VSM Simulation was the world‟s first schematic based microcontroller simulation tool and soon became a standard for teaching embedded system within education. This supports more processor families along with more embedded peripherals and many technologies.

The Proteus PCB Design and Layout tools have successfully served both commercial and educational needs for over twenty-five years. Students benefits from exposure to professional grade tools with an intuitive user interface and a quick learning curve.

Together with mixed mode SPICE simulation engine Proteus provides a safe, fast and immersive learning environment for students.

The whole learning process takes place in software with the schematic capture module serving as the „virtual hardware‟ and the VSM Studio IDE module enabling firmware development and compilation.

It extends to an area of various controller families, ARM families, basic electronics circuits, arduino families and PCB design.

## 4.2 BASIC ELECTRONIC CIRCUITS

- Full wave rectifier circuit

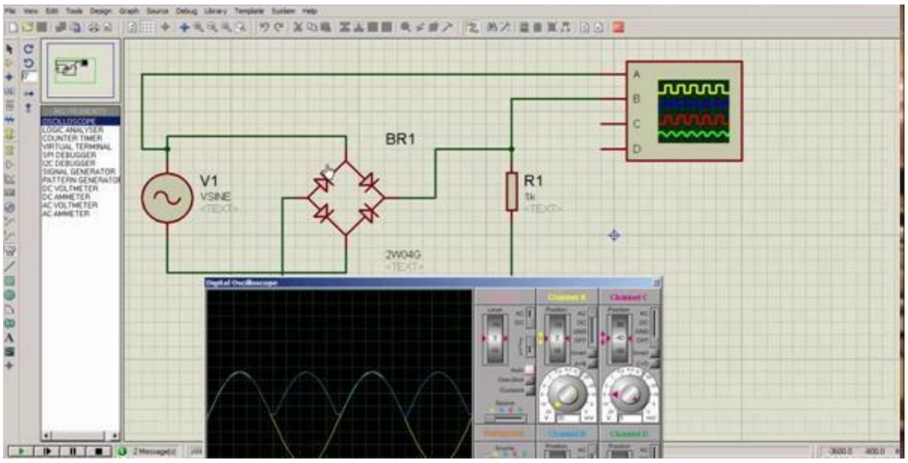



FIG 4.1 Full wave rectifier circuit

- Clipper circuit

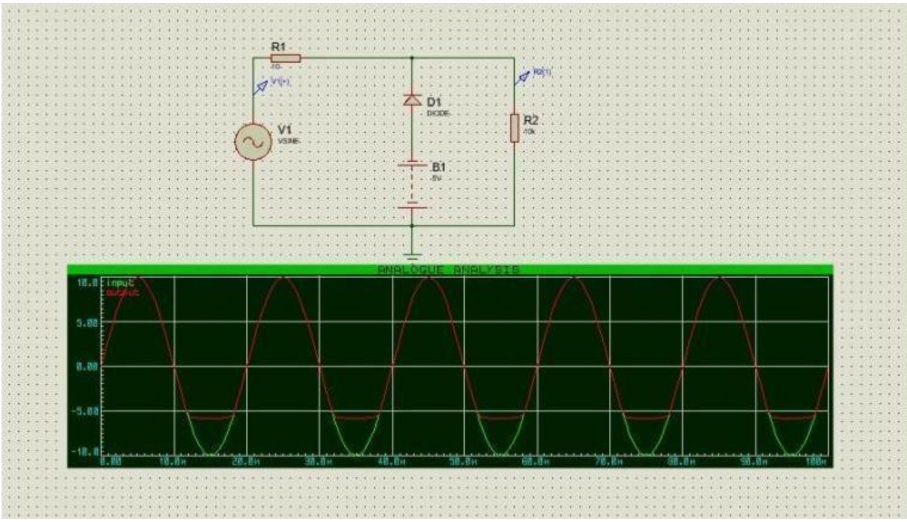



FIG 4.2 Clipper circuit

- Clamper circuit
- Low pass filter
- High pass filter
- Bandpass filter

## 4.3 8051 MICROCONTROLLER

- Keypad and LCD interfacing

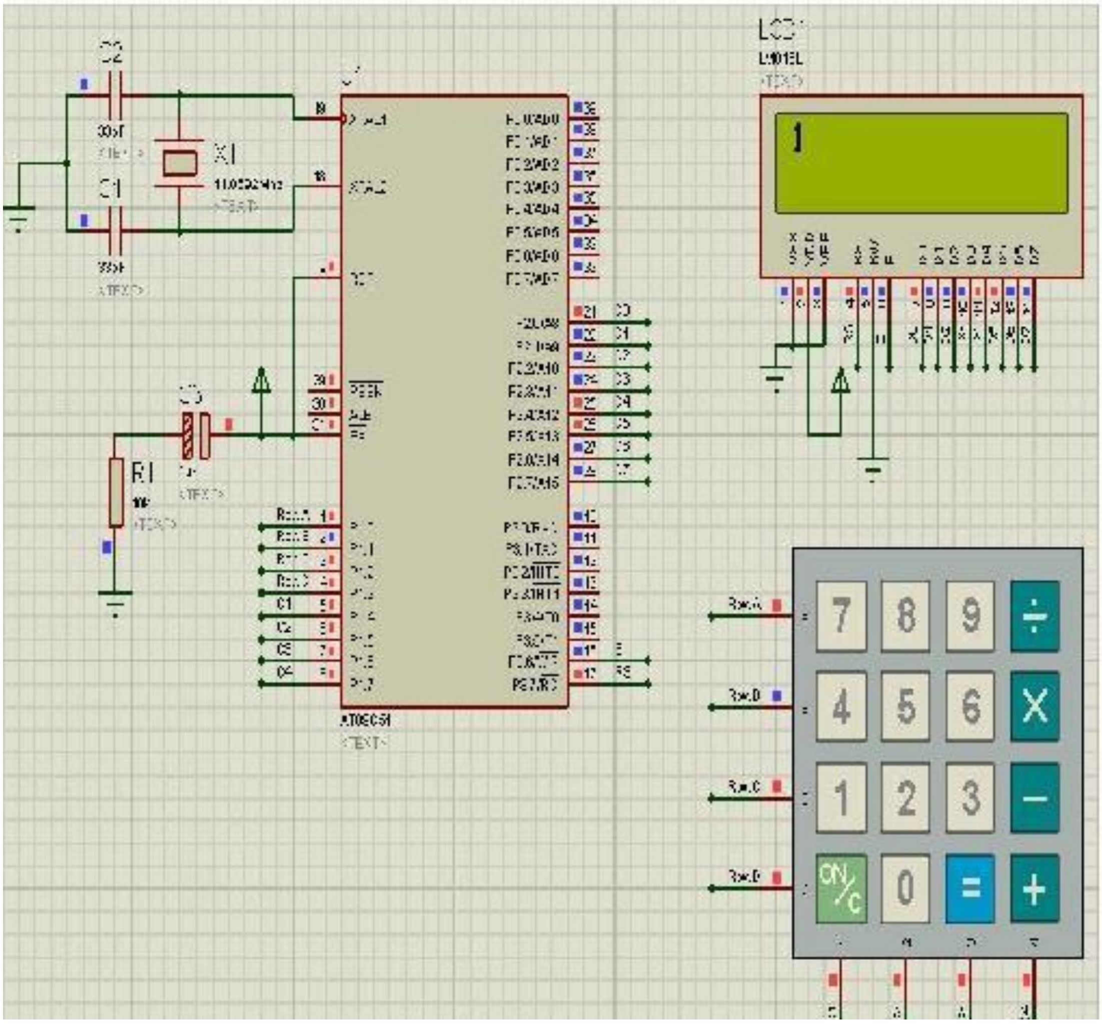



FIG 4.3 Keypad and LCD interfacing

- Blinking of LED
- Buzzer interfacing

## 4.4 ARDUINO

- LED interfacing

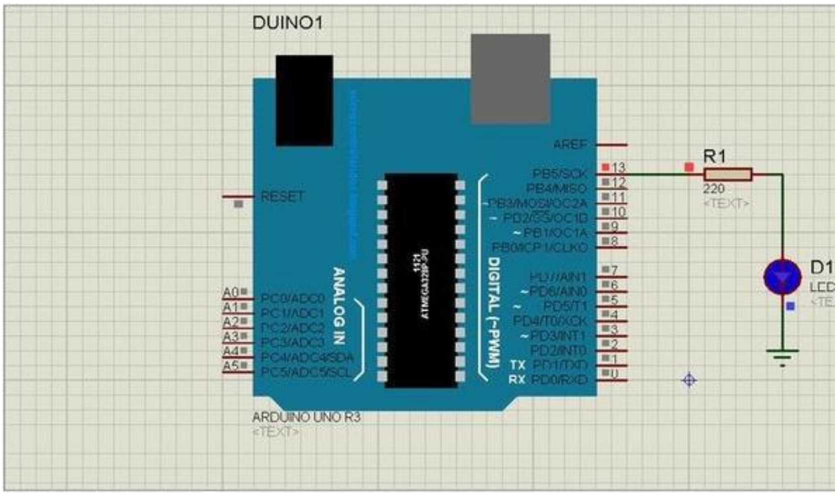



FIG 4.4 LED interfacing (Arduino)

- Buzzer interfacing
- Fading
- Motor interfacing

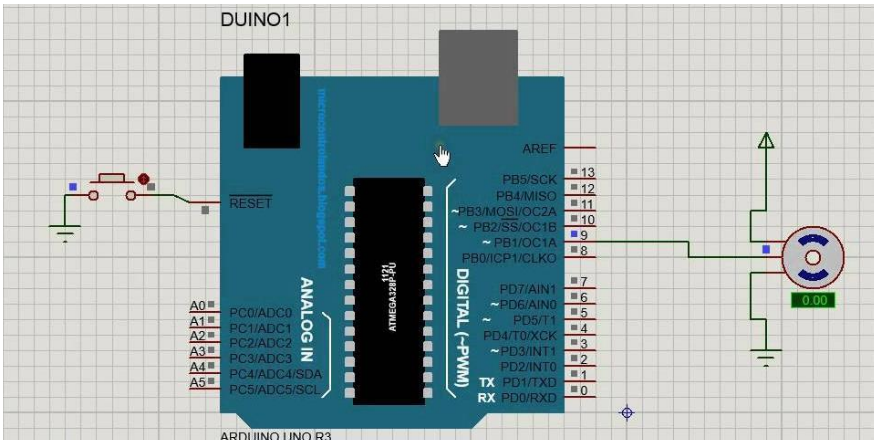



FIG 4.5 Motor interfacing(Arduino)

- LCD interfacing

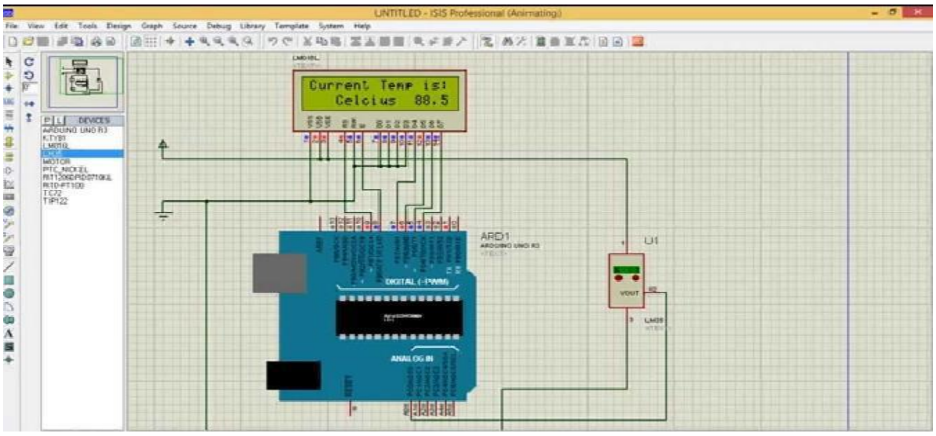



FIG 4.6 LCD interfacing(Arduino)

## 4.5 PIC MICONTROLLER

- LED interfacing

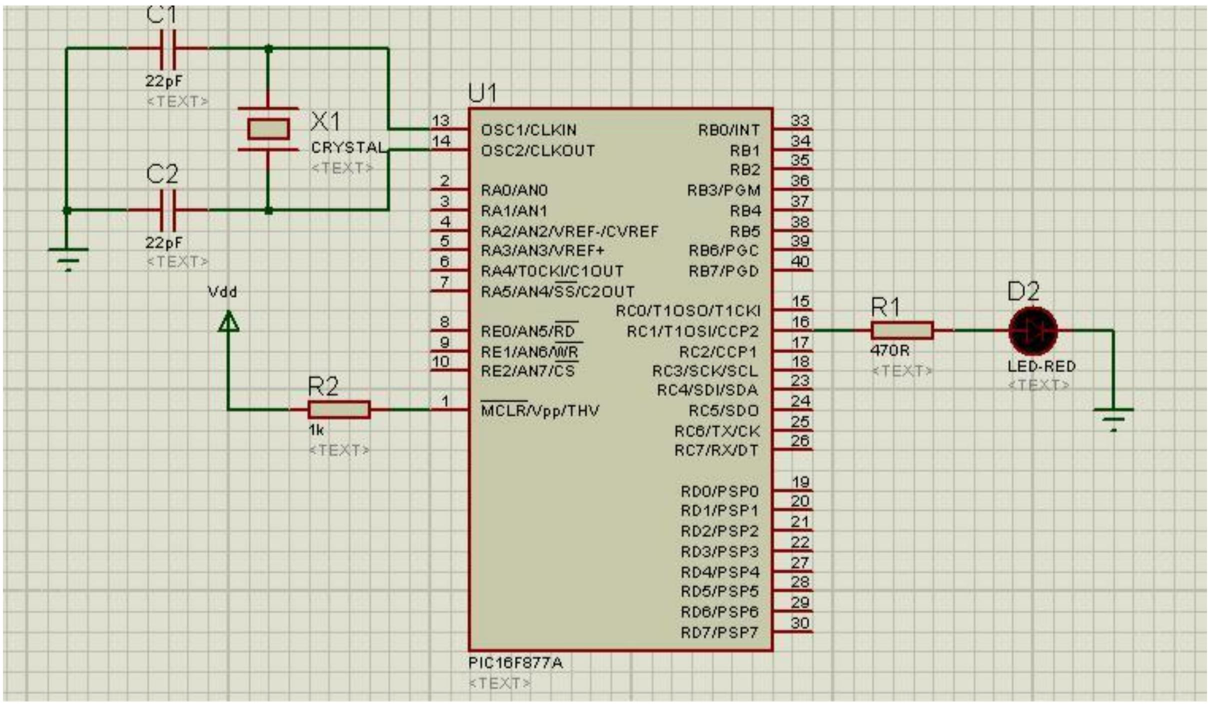



FIG 4.7 LED interfacing(PIC microcontroller)

- LCD interfacing

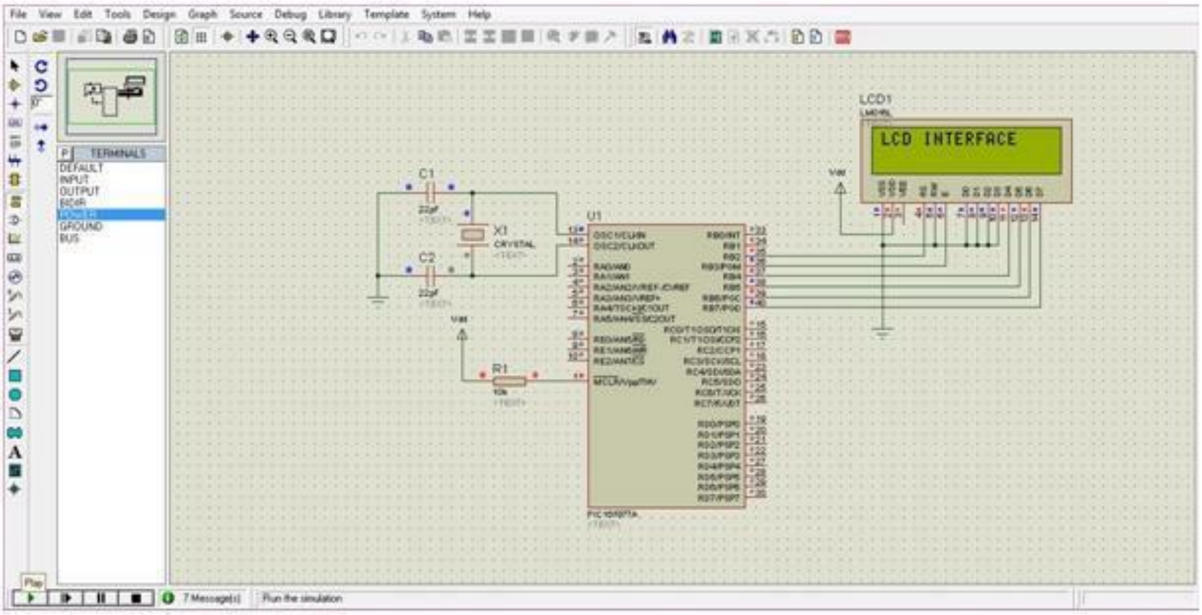



FIG 4.8 LCD interfacing(PIC microcontroller)

## 4.6 ARM (LPC2138)

- LED interfacing

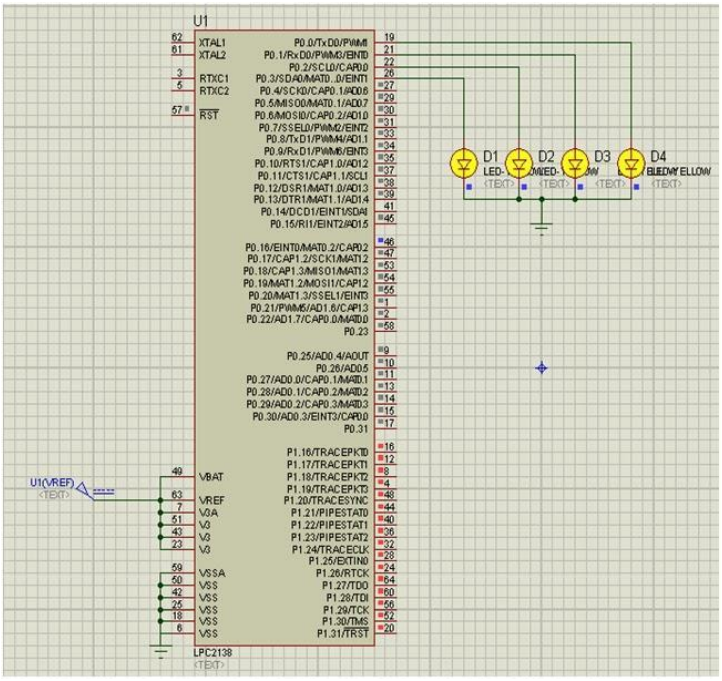



FIG 4.9 LED interfacing(ARM )

- LCD interfacing

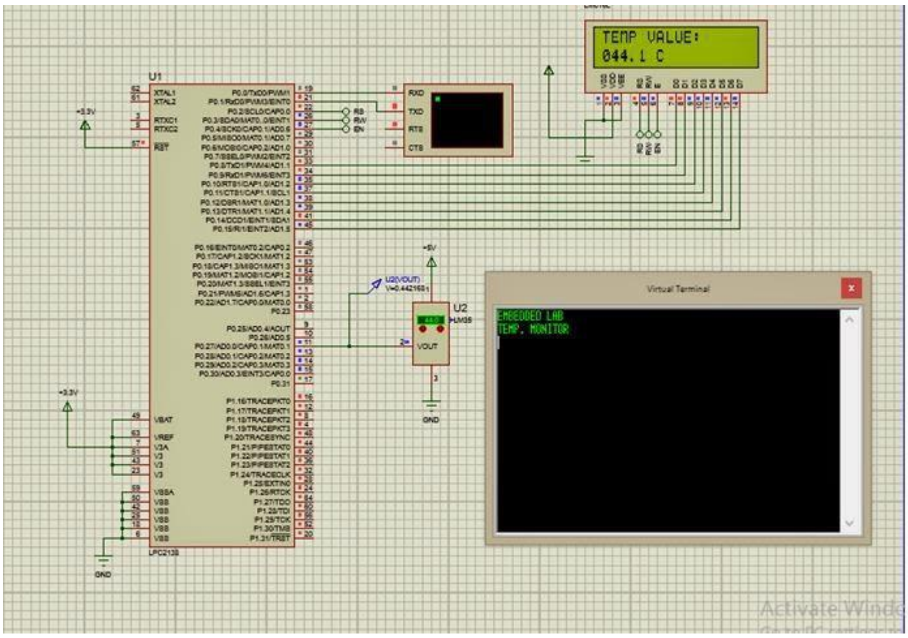



FIG 4.10 LCD interfacing(ARM)

# CHAPTER 5

# INTERNET OF THINGS

**" The Internet of Things is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment." – Gartner**

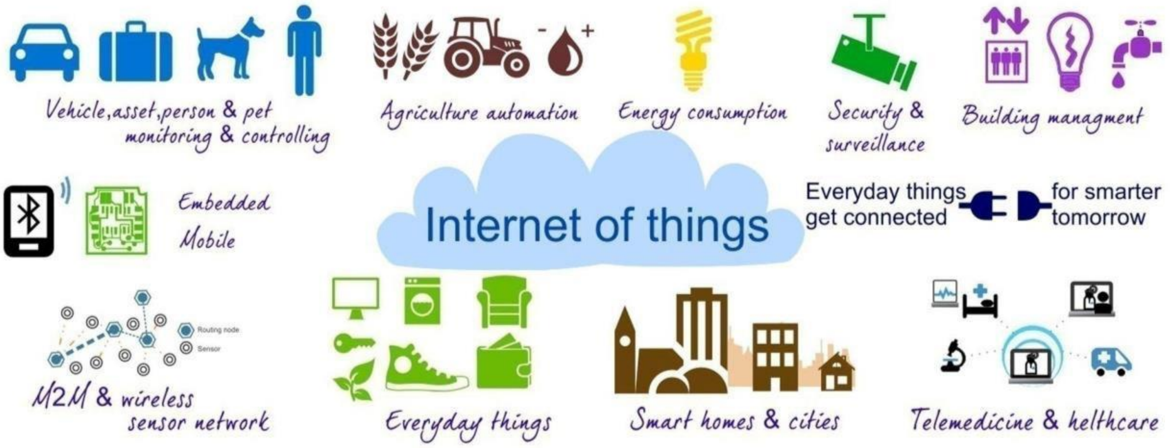



FIG 5.1 Internet of Things – Introduction

Smart systems and IoT are driven by combination of three things :

- Sensors & Actuators
- Connectivity
- People & Processes

## 5.1 SENSORS & ACTUATORS

We are giving our world digital nervous system. Location data using GPS sensors. Eyes and ears using cameras and microphones, along with sensory organs that can measure everything from temperature to pressure changes.

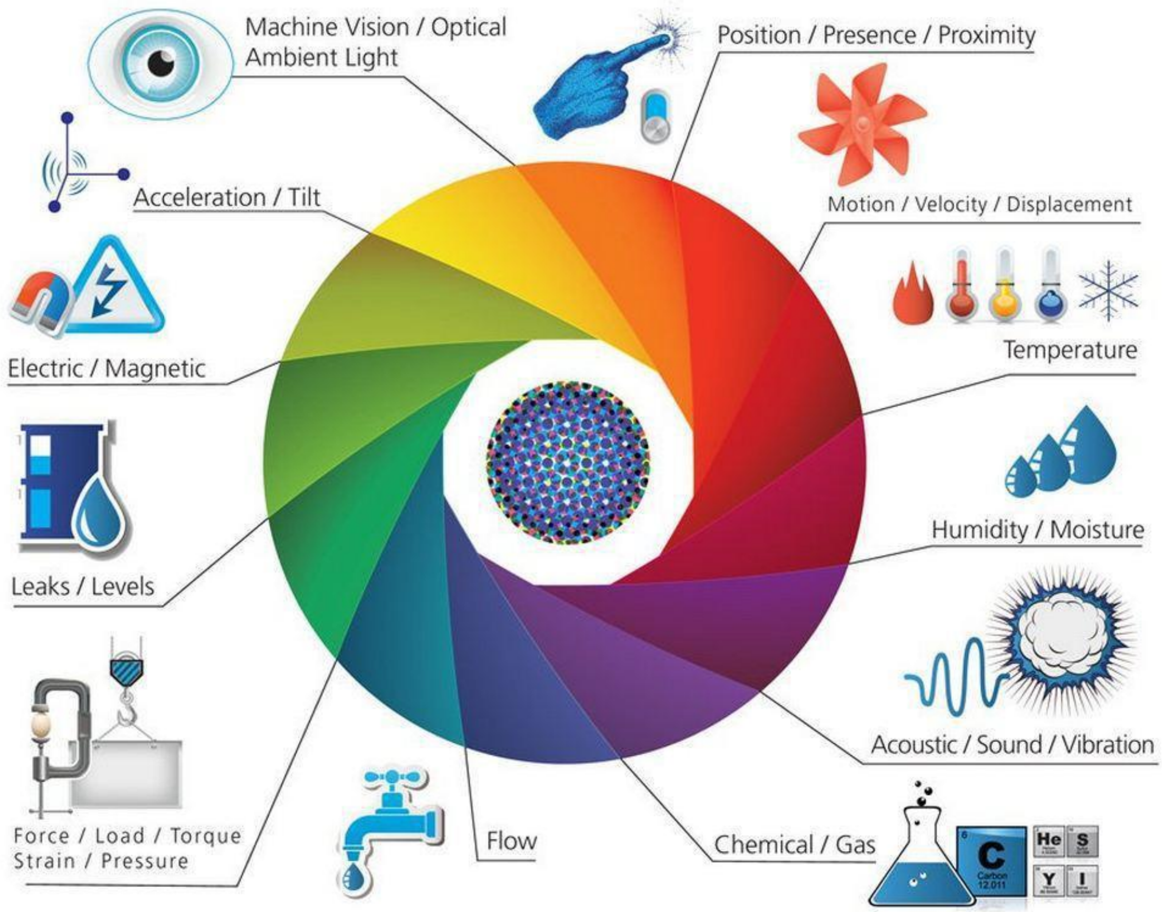



FIG 5.2 Sensors

The embedded systems can be connected to different sensors such as below for collecting the information:

- Humidity sensor
- Level/tilt sensor
- Pressure sensor
- Temperature sensor
- Motion Sensors
- Proximity Sensors
- Optical Sensors
- Acceleration sensors

They can also be connected to actuators to translate the collected or received information into actions, below are some of the actuators:

- Light emitting Diodes [LED]
- Relays
- Motors
- Linear actuators
- Lasers
- Speakers
- LCD or Plasma displays

## 5.2 CONNECTIVITY

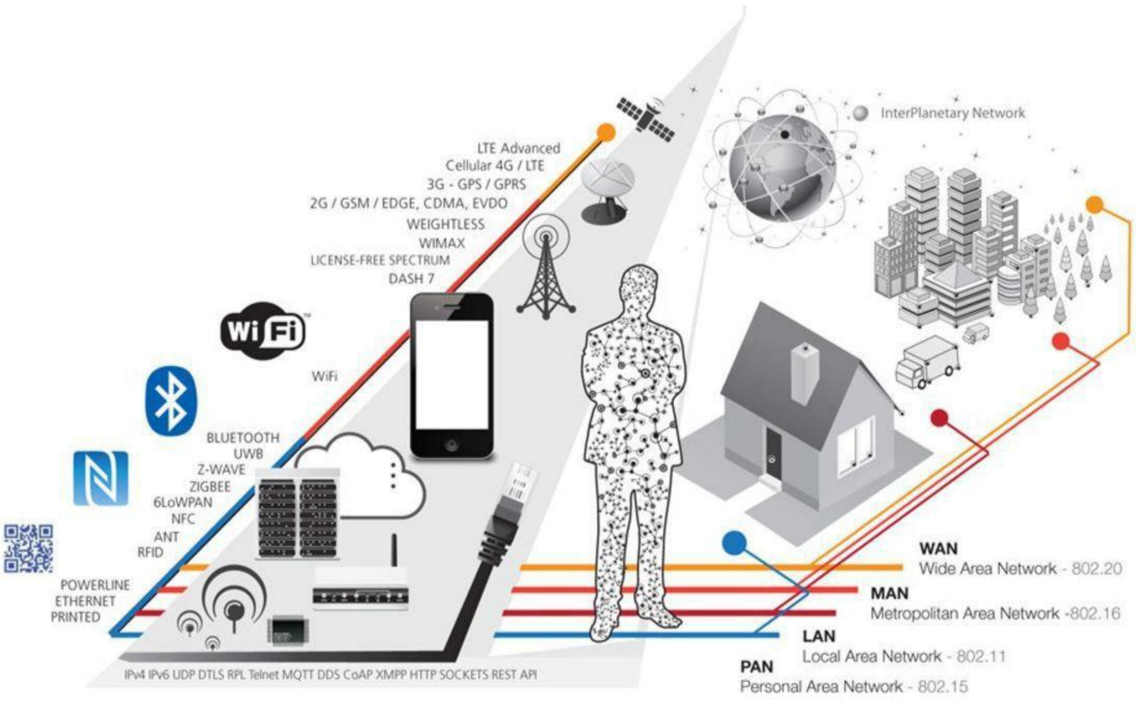



FIG 5.3 Communication devices

The embedded systems can use a range of connectivity to connect with other devices or the internet.

## 5.3 PEOPLE AND PROCESS

The information transmitted via the chosen connectivity can be used by people and processes to take action or re-transmit the info to a different embedded system to be used to perform an action using actuators, below are some examples:

- A gas leak/ smoke is detected by a chemical sensor and the info is transmitted to a monitoring center. Help is dispatched immediately and the affected are informed.
- A home security system detects intrusion, a call is placed to the authorities and owners alerted.
- Load sensor can initiate a communication to the supplier to send more stock enabling the supply chain management automation.
- Car can send the diagnostics to the service center and the service center schedules a repair.
- IoT thermostat sends the information to the cloud which can then be analysed by to manage your energy expenditure.

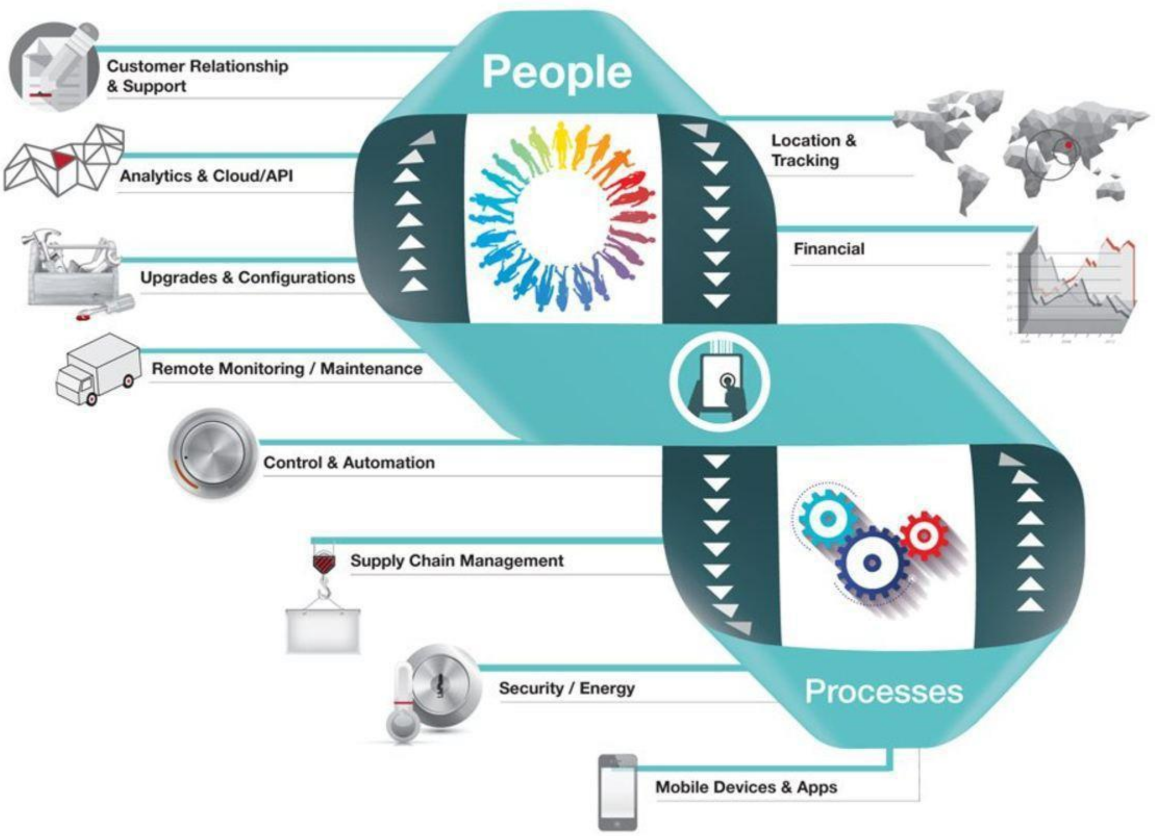



FIG 5.4 People and process

# CHAPTER 6

# IOT ARCHITECTURE

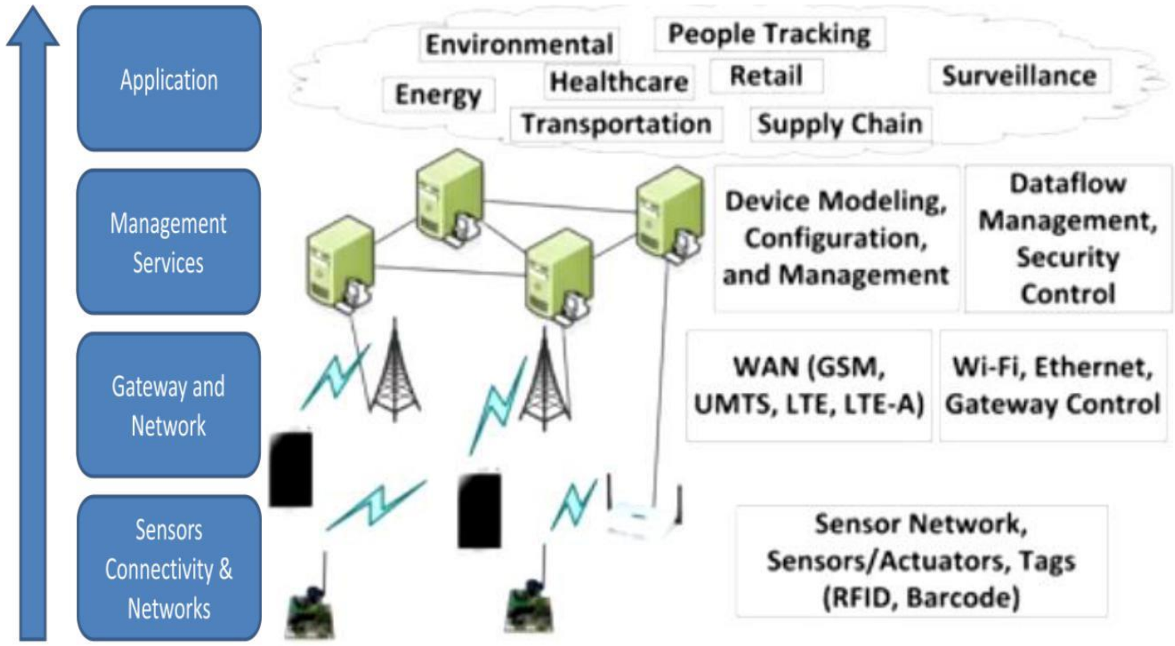



FIG 6.1 IoT Architecture

Most Commonly used Technologies in IoT are:

- RFID
- WiFi IEEE 802.11
- Barcode and QR Code
- Sensors and Smartphones

## 6.1 RFID


FIG 6.2 RFID

- Widely used in Transport and Logistics
- Easy to deploy: RFID tags and RFID readers

The communication range and the frequency depends on the type of technology

## 6.2 WiFi

FIG 6.3 WiFi

- Very common
- Widely used both in indoor and outdoor environments
- General purpose
- Low cost
- Highly interoperable
- Maybe not a good solution in some special conditions

## 6.3 BARCODE AND QR CODE


FIG 6.4 Barcode and QR Code

- Low cost
- No technological difficulties
- Several devices can read a barcode
- Starting point for more complex system
- Example: price comparison

## 6.4 SENSORS AND SMARTPHONES


FIG 6.5 Sensors and smartphones

In the near future almost everybody will probably have a smartphone. A smartphone isn‟t just a mobile phone that has access to the Internet. The iPhone has a lot of different types of sensors.Various sensors are:

- Solid State sensors
- Catalytic sensors
- Gyroscopic sensors

- GPS
- Photoelectric sensors
- Infrared sensors
- Accelerometer sensors
- Photochemistry sensors

## 6.5 DHT11

DHT11 digital is a temperature and humidity sensor. It is a composite Sensor and contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, ensures that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device, and connected with a high-performance 8-bit microcontroller.


FIG 6.6 DHT11

Applications :

HVAC, dehumidifier, testing and inspection equipment, consumer goods, automotive, automatic control, data loggers, weather stations, home appliances, humidity regulator, medical and other humidity measurement and control.

Features:

Low cost, long-term stability, relative humidity and temperature measurement, excellent quality, fast response, strong anti-interference ability, long distance signal transmission, digital signal output, and precise calibration.

## 6.6 DHT11 INTERFACING WITH ARDUINO

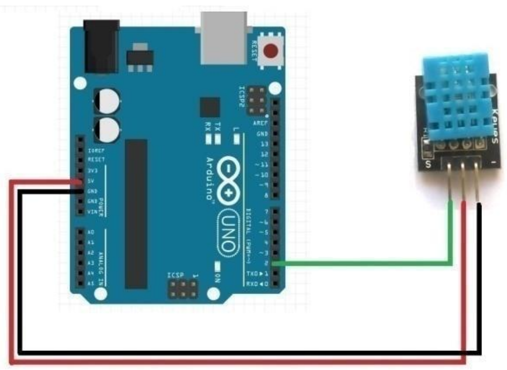


FIG 6.7 DHT11 interfacing with ARDUINO

```
#include <dht.h>
dht DHT;
#define DHT11_PIN 7
void setup(){
Serial.begin(9600);
}
void loop()
{
int chk = DHT.read11(DHT11_PIN);
Serial.print("Temperature = ");
Serial.println(DHT.temperature);
Serial.print("Humidity = ");
Serial.println(DHT.humidity);
delay(1000);
}
```

# CHAPTER 7

# WIFI MODULE (ESP8266)

FIG 7.1 WiFi Module

Espressif Systems‟ Smart Connectivity Platform (ESCP) of high performance wireless SOCs, for mobile platform designers, provides unsurpassed ability to embed Wi-Fi capabilities within other systems, at the lowest cost with the greatest functionality.

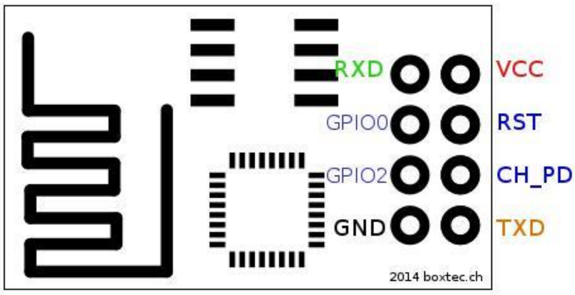



FIG 7.2 Pin configuration of WiFi module

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.ESP8266 is an impressive, low cost WiFi module suitable for adding WiFi functionality to an existing microcontroller project via a UART serial connection.

## 7.1 FEATURES

- CPU ( 32 bit, 26MHz-52MHz, 64KB instruction RAM, 64KB boot ROM, 96KB data RAM), CPU clock speed can reach maximum value of 160 MHz.
- 802.11 b/g/n protocol

- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- It requires 3.3V power–do not power it with 5 volts
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW
- Integrated low power 32-bit CPU could be used as application processor
- GPIO, UART, ADC, I2C, SPI, PWM
- Real Time Operation System (RTOS) is enabled. Currently, only 20% of MIPS (Million Instruction Per Second) has been occupied by the Wi-Fi stack, the rest can all be used for user application programming and development.
- ESP8266 has been designed for mobile, wearable electronics and Internet of Things applications with the aim of achieving the lowest power consumption with a combination of several proprietary techniques.
- The power saving architecture operates in 3 modes:
    - active mode
    - sleep mode
    - deep sleep mode.
- Robust : widest operating temperature range, from -40°C to +125°C.

## 7.2 APPLICATIONS

Applications of ESP8266 include :

- Smart power plugs
- Home automation
- Mesh network
- Industrial wireless control
- Baby monitors
- IP Cameras
- Sensor networks
- Wearable electronics
- Wi-Fi location-aware devices
- Security ID tags
- Wi-Fi position system beacons

## 7.3 ESP8266 AS WEB SERVER

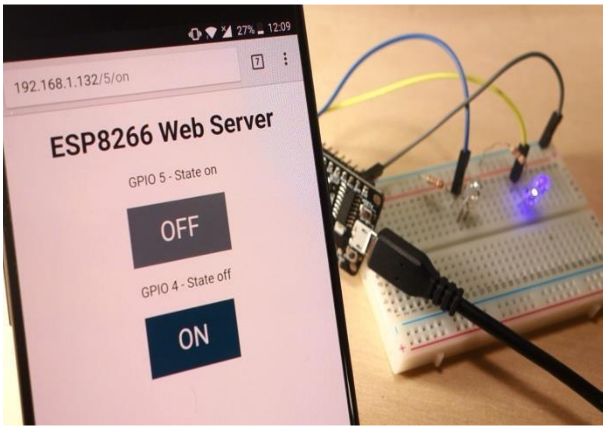



FIG 7.3 ESP8266 as Web Server

```
#include <ESP8266WiFi.h>
const char* ssid = "demo";//type your ssid
const char* password = "12345678";//type your password
int ledPin = 2; // GPIO2 of ESP8266 WiFiServer
server(80);
 void setup() {
  Serial.begin(115200);
  delay(10);
  pinMode(ledPin, OUTPUT);
  digitalWrite(ledPin, LOW);
  // Connect to WiFi network
  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
```

```
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  // Start the server
  server.begin();
  Serial.println("Server started");
  // Print the IP address
  Serial.print("Use this URL to connect: ");
  Serial.print("http://");
  Serial.print(WiFi.localIP());
  Serial.println("/");
}
void loop() {
  // Check if a client has connected
  WiFiClient client = server.available();
  if (!client) { //client ==NULL
    return;
  }
  // Wait until the client sends some
  data Serial.println("new client");
  while(!client.available()){
    delay(1);
  }
  // Read the first line of the request
```

```
  String request = client.readStringUntil('\r');
  Serial.println(request);
  client.flush();
  // Match the request
  int value = LOW;
  if (request.indexOf("/LED=ON") != -1) {
    digitalWrite(ledPin, HIGH);
    value = HIGH;
  }
  if (request.indexOf("/LED=OFF") != -
    1){ digitalWrite(ledPin, LOW);
    value = LOW;
  }
// Set ledPin according to the request
//digitalWrite(ledPin, value);
  // Return the response
  client.println("HTTP/1.1 200 OK");
  client.println("Content-Type: text/html");
  client.println(""); // do not forget this one
  client.println("<!DOCTYPE HTML>");
  client.println("<html>");
  client.print("Led pin is now: "); if(value
  == HIGH) {
    client.print("On");
  } else {
    client.print("Off");
```

```
 }
 client.println("<br><br>");
 client.println("Click <a href=\"/LED=ON\">here</a> turn the LED on pin 2 ON<br>");
 client.println("Click <a href=\"/LED=OFF\">here</a> turn the LED on pin 2 OFF<br>");
 client.println("</html>");
 delay(1);
 Serial.println("Client disonnected");
 Serial.println("");
}
```

# CHAPTER 8

# RASPBERRY PI 3

## 8.1 INTRODUCTION

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. It is used mainly in robotics. It does not include peripherals (such as keyboards, mice and cases). However, some accessories have been included in several official and unofficial bundles.

Several generations of Raspberry Pi‟s have been developed so far. All models feature a Broadcom system on a chip (SoC) with an integrated ARM compatible central processing unit (CPU) and on-chip graphics processing unit (GPU).

Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+; on-board memory ranges from 256 MB to 1 GB RAM. Secure Digital (SD) cards are used to store the operating system and program memory in either SDHC or MicroSDHC sizes. The boards have one to four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm phono jack for audio output. Lower-level output is provided by a number of GPIO pins which support common protocols like I²C. The B-models have an 8P8C Ethernetport and the Pi 3 and Pi Zero W have on-board Wi-Fi 802.11n and Bluetooth.

The organisation behind the Raspberry Pi consists of two arms. The first two models were developed by the Raspberry Pi Foundation. After the Pi Model B was released, the Foundation set up Raspberry Pi Trading, with Eben Upton as CEO, to develop the third model, the B+. Raspberry Pi Trading is responsible for developing the technology while the Foundation is an educational charity to promote the teaching of basic computer science in schools and in developing countries.

The Foundation provides Raspbian, a Debian-based Linux distribution for download, as well as third-party Ubuntu, Windows 10 IoT Core, RISC OS, and specialised media centre distributions. It promotes Python and Scratch as the main programming language, with support for many other languages. The default firmware is closed source, while an unofficial open source is available.

## 8.2 HARDWARE

The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

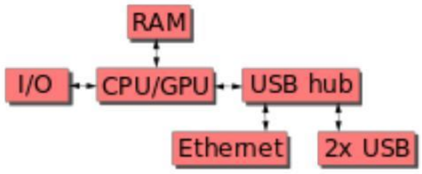



FIG 8.1 Block diagram of Raspberry Pi

This block diagram describes Model B and B+; Model A, A+, and the Pi Zero are similar, but lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB port.

## 8.3 FEATURES

### 1. Performance

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as 10 times the performance of a Raspberry Pi 1. This was suggested to be highly dependent upon task threading and instruction set use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelised tasks.

Raspberry Pi 2 V1.1 included a quad-core Cortex-A7 CPU running at 900 MHz and 1 GB RAM. It was described as 4–6 times more powerful than its predecessor. The GPU was identical to the original. In parallelised benchmarks, the Raspberry Pi 2 V1.1 could be up to 14 times faster than a Raspberry Pi 1 Model B+.

While operating at 700 MHz by default, the first generation Raspberry Pi provided a real-world performance roughly equivalent to 0.041 GFLOPS. On the CPU level the performance is similar to a 300 MHz Pentium II of 1997–99. The GPU provides 1 G pixel/s of graphics processing or 24 GFLOPS of general purpose computing performance. The graphical capabilities of the Raspberry Pi are roughly equivalent to the performance of the Xbox of 2001.

**2. Overclocking**

Most Raspberry Pi chips could be overclocked to 800 MHz, and some to 1000 MHz. There are reports the Raspberry Pi 2 can be similarly overclocked, in extreme cases, even to 1500 MHz (discarding all safety features and over-voltage limitations). In the Raspbian Linux distro the overclocking options on boot can be done by a software command running "sudo raspi-config" without voiding the warranty. In those cases the Pi automatically shuts the overclocking down if the chip reaches 85 °C (185 °F), but it is possible to override automatic over-voltage and overclocking settings (voiding the warranty); an appropriately sized heat sink is needed to protect the chip from serious overheating.

Newer versions of the firmware contain the option to choose between five overclock ("turbo") presets that when used, attempt to maximise the performance of the SoC without impairing the lifetime of the board. This is done by monitoring the core temperature of the chip, the CPU load, and dynamically adjusting clock speeds and the core voltage. When the demand is low on the CPU or it is running too hot the performance is throttled, but if the CPU has much to do and the chip's temperature is acceptable, performance is temporarily increased with clock speeds of up to 1 GHz depending on the individual board and on which of the turbo settings is used.

The seven overclock presets are:

I. none; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting
II. modest; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvolting,
III. medium; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvolting,
IV. high; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvolting,
V. turbo; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvolting,
VI. Pi 2; 1000 MHz ARM, 500 MHz core, 500 MHz SDRAM, 2 overvolting,

VII. Pi 3; 1100 MHz ARM, 550 MHz core, 500 MHz SDRAM, 6 overvolting. In system information CPU speed will appear as 1200 MHz. When in idle speed lowers to 600 MHz.

VIII. In the highest (turbo) preset the SDRAM clock was originally 500 MHz, but this was later changed to 600 MHz because 500 MHz sometimes causes SD card corruption. Simultaneously in high mode the core clock speed was lowered from 450 to 250 MHz, and in medium mode from 333 to 250 MHz.

The Raspberry Pi Zero runs at 1 GHz.

The CPU on the first and second generation Raspberry Pi board did not require cooling, such as a heat sink or fan, even when overclocked, but the Raspberry Pi 3 may generate more heat when overclocked.

**3. Networking**

The Model A, A+ and Pi Zero have no Ethernet circuitry and are commonly connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. On the Model B and B+ the Ethernet port is provided by a built-in USB Ethernet adapter using the SMSC LAN95k14 chip. The Raspberry Pi 3 and Pi Zero W (wireless) are equipped with 2.4 GHz WiFi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) based on Broadcom BCM43438 FullMAC chip with no official support for Monitor mode but implemented through unofficial firmware patching and the Pi 3 also has a 10/100 Ethernet port. The Raspberry Pi 3B+ features dual-band IEEE 802.11b/g/n/ac WiFi, Bluetooth 4.2, and Gigabit Ethernet(limited to approximately 300 Mbit/s by the USB 2.0 bus between it and the SoC).

**4. Peripherals**

FIG 8.2 Model 2B Board

The Model 2B boards incorporate four USB ports for connecting peripherals.

The Raspberry Pi may be operated with any generic USB computer keyboard and mouse. It may also be used with USB storage, USB to MIDI converters, and virtually any other device/component with USB capabilities.

Other peripherals can be attached through the various pins and connectors on the surface of the Raspberry Pi.

**5. Video**

FIG 8.3 Video Board

The early Raspberry Pi 1 Model A, with an HDMI port and a standard RCA composite video port for older displays

The video controller can generate standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions as well as older NTSC or PAL standard CRT TV resolutions. As shipped (i.e., without custom overclocking) it can support these resolutions: 640×350 EGA; 640×480 VGA; 800×600 SVGA; 1024×768 XGA; 1280×720 720p HDTV; 1280×768 WXGA variant; 1280×800 WXGA variant; 1280×1024 SXGA; 1366×768 WXGA variant; 1400×1050 SXGA+; 1600×1200 UXGA; 1680×1050 WXGA+; 1920×1080 1080p HDTV; 1920×1200 WUXGA.

Higher resolutions, such as, up to 2048×1152, may work or even 3840×2160 at 15 Hz (too low a frame rate for convincing video). Note also that allowing the highest resolutions does not imply that the GPU can decode video formats at those; in fact, the Pis are known to not work reliably for H.265 (at those high resolutions), commonly used for very high resolutions (most formats, commonly used, up to Full HD, do work).

Although the Raspberry Pi 3 does not have H.265 decoding hardware, the CPU is more powerful than its predecessors, potentially fast enough to allow the decoding of H.265-encoded videos in software. The GPU in the Raspberry Pi 3 runs at higher clock frequencies of 300 MHz or 400 MHz, compared to previous versions which ran at 250 MHz.

The Raspberry Pis can also generate 576i and 480i composite video signals, as used on old-style (CRT) TV screens and less-expensive monitors through standard connectors – either RCA or 3.5 mm phono connector depending on models. The television signal standards supported are PAL-BGHID, PAL-M, PAL-N, NTSC and NTSC-J.

**6. Real-time clock**

None of the current Raspberry Pi models have a built-in real-time clock, so they are unable to keep track of the time of day independently. As a workaround, a program running on the Pi can retrieve the time from a network time server or from user input at boot time, thus knowing the time while powered on. To provide consistency of time for the file system, the Pi does automatically save the time it has on shutdown, and re-installs that time at boot.

A real-time hardware clock with battery backup, such as the DS1307, may be added (often via the I²C interface).

**7. Operating systems**

FIG 8.4 Raspberry Pi – SD Card

Various operating systems for the Raspberry Pi can be installed on a MicroSD, MiniSD or SD card, depending on the board and available adapters; seen here is the MicroSD slot located on the bottom of a Raspberry Pi 2 board.

The Raspberry Pi Foundation recommends the use of Raspbian, a Debian-based Linux operating system. Other third-party operating systems available via the official website include Ubuntu MATE, Windows 10 IoT Core, RISC OS and specialised distributions for the Kodimedia centre and classroom management.

## 8.4 MAJOR AREAS OF USE

### 1. Use in education

As of January 2012, enquiries about the board in the United Kingdom have been received from schools in both the state and private sectors, with around five times as much interest from the latter. It is hoped that businesses will sponsor purchases for less advantaged schools. The CEO of Premier Farnell said that the government of a country in the Middle East has expressed interest in providing a board to every schoolgirl, to enhance her employment prospects.

In 2014, the Raspberry Pi Foundation hired a number of its community members including ex-teachers and software developers to launch a set of free learning resources for its website. The Foundation also started a teacher training course called Picademy with the aim of helping teachers prepare for teaching the new computing curriculum using the Raspberry Pi in the classroom.

### 2. Use in home automation

There are a number of developers and applications that are leveraging the Raspberry Pi for home automation. These programmers are making an effort to modify the Raspberry Pi into a cost-affordable solution in energy monitoring and power consumption. Because of the relatively low cost of the Raspberry Pi, this has become a popular and economical solution to the more expensive commercial alternatives.

### 3. Use in industrial automation

In June 2014, TECHBASE, Polish industrial automation manufacturer designed the world's first industrial computer based on the Raspberry Pi Compute Module, called ModBerry. The device has numerous interfaces, most notably RS-485/232 serial ports, digital and analogue inputs/outputs, CAN and economical 1-Wire buses, all of which are widely used in the automation industry. The design allows the use of the Compute Module in harsh industrial environments, leading to the conclusion that the Raspberry Pi is no longer limited to home and science projects, but can be widely used as an Industrial IoT solution and achieve goals of Industry 4.0.

In March 2018, SUSE announced commercial support for SUSE Linux Enterprise on the Raspberry Pi 3 Model B to support a number of undisclosed customers implementing industrial monitoring with the Raspberry Pi.

**4. Use in commercial products**

OTTO is a digital camera created by Next Thing Co. It incorporates a Raspberry Pi Compute Module. It was successfully crowd-funded in a May 2014 Kickstarter campaign.

Slice is a digital media player which also uses a Compute Module as its heart. It was crowd-funded in an August 2014 Kickstarter campaign.

## 8.5 LAMP ON Raspberry Pi

A raspberry pi is connected to internet.

1. Apache web server is set up:

Apache is a popular web server application that can be installed on the Raspberry Pi to allow it to serve web pages.

On its own, Apache can serve HTML files over HTTP. With additional modules it can serve dynamic web pages using scripting languages such as PHP. Install apache---

a) Opening a terminal window by selecting Accessories>Terminal from the menu.
b) Installing the "apache2" package by typing the following command into the terminal and pressing "enter": sudo apt-get install apache2 –y

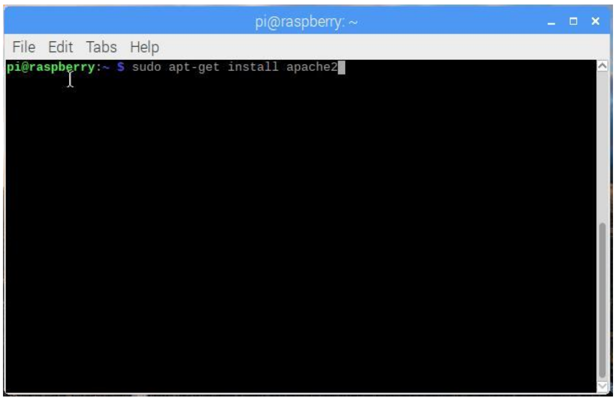



FIG 8.5 Installing Apache

Test the web server---

By default, Apache puts a test HTML file in the web folder that we will be able to view from our Pi or another computer on the network.

a) Open the Apache default web page on your Raspberry Pi:

b) Open Chromium by selecting **Internet** > **Chromium Web Browser** from the menu.

c) Enter the address http://localhost.

A window opens up :

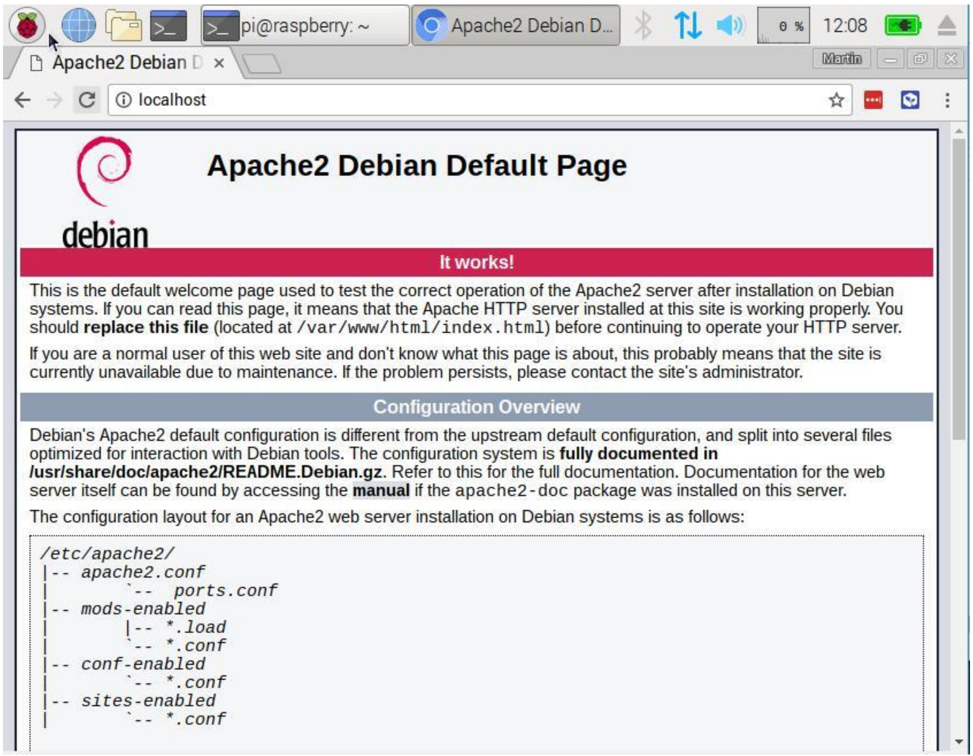



FIG 8.6 Apache 2 Debian default page

This means Apache is working.

2. Install PHP

PHP is a preprocessor: it‟s code that runs when the server receives a request for a web page via a web browser. It works out what needs to be shown on the page, and then sends that page to the browser. Unlike static HTML, PHP can show different content under different circumstances. Other languages are also capable of doing this, but since WordPress is written in PHP, that‟s what we need to use this time. PHP is a very popular language on the web: huge projects like Facebook and Wikipedia are written in PHP.

a) Install PHP and Apache packages with the following command: sudo apt-get install php –y
b) PHP is tested.
c) Create the file.: sudo leafpad index.php
d) Put some PHP content in it: <?php echo “hello world”:?>
e) Save the file.
f) Delete index.html because it takes precedence over index.php: sudo rm index.html
g) Refresh the browser. It shows “hello world”.

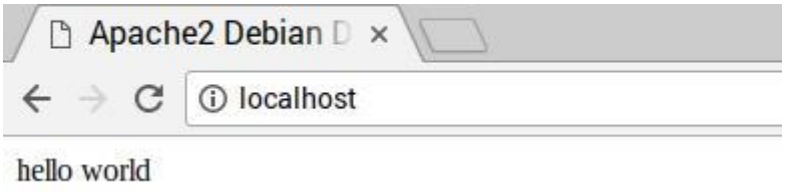



FIG 8.7 Apache browser page

If the raw PHP is displayed as shown above instead of “hello world”, reload and restart Apache like so: sudo service apache2 restart

3. Install MySQL

MySQL (is a popular database engine. Like PHP, it‟s widely used on web servers, which is why projects like WordPress use it, and why those projects are so popular.

a) Install the MySQL Server and PHP-MySQL packages by entering the following command into the terminal window: sudo apt-get install mysql-server php-mysql –y
b) Restart Apache: sudo service apache2 restart

4. Download Wordpress

Wordpress can easily be downloaded using the command wget.

Steps:

a) Change directory to /var/www/html/ and delete all the files in the folder.
   cd /var/www/html/
   sudo rm*
b) Download wordpress using wget: sudo wget http://wordpress.org/latest.tar.gz
c) Extract the Wordpress tarball to get at the Wordpress files: sudo tar xzf latest.tar.gz
d) Move the contents of the extracted wordpress directory to the cureent directory: sudo mv wordpress/*
e) Tidy up by removing the tarball and the now empty wordpress directory :sudo rm –rf wordpress latest.tar.gz
f) Running the ls or tree –L 1 command will show the contents of WordPress project
g) Now change the ownership of all these files to Apache user: sudo chown –R www_data:

5. Set up WordPress Database

a) Run the MySQL secure installation command in the terminal window.: sudo mysql_secure_installation

b) One will be asked Enter current password for root:- press Enter

c) Type in Y and press Enter to set root password.

d) Type in a password at the New password: prompt and press Enter

e) Type in Y Remove anonymous users

f) Type in Y to Disallow root login remotely

g) Type in Y to Remove test databases and access to it

h) Type in Y to Reload privilege tables now

when complete a message will be displayed saying All done! and Thanks for using MariaDB!

6. Create the Wordpress Database

Steps:

a) Run mysql in the terminal window: sudo mysql –uroot –p

b) Enter the root password created

c) Create the database for Wordpress installation at the MariaDB [(none)]> prompt using:create database wordpress;

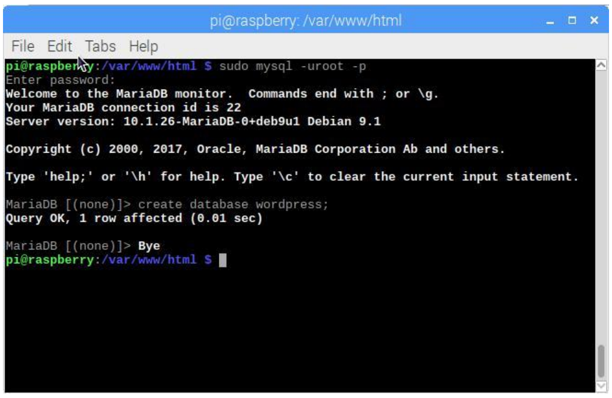



FIG 8.8 Installing MySQL

d) Now grant database privileges to the root user.

e) For the changes to take effect ,one needs to flush the database privileges: FLUSH PRIVILEGES;

f) Exit the MariaDB prompt with Ctrl+D

# CHAPTER 9

# MQTT(MESSAGE QUEUING TELEMETRY TRANSPORT)

MQTT was invented in 1999 by Dr. Andy Stanford-Clark and Arlen Nipper. MQTT is a Internet of Things connectivity protocol. It was designed as an extremely lightweight public messaging transport. It is useful for connections with remote locations where a small code is required. For example, it has been used in a range of home automation and small device scenarios. It is also ideal for mobile applications because of its small size, low power usage, minimised data packets and efficient distribution of information to one or many receivers.

## 9.1 WORKING OF MQTT:

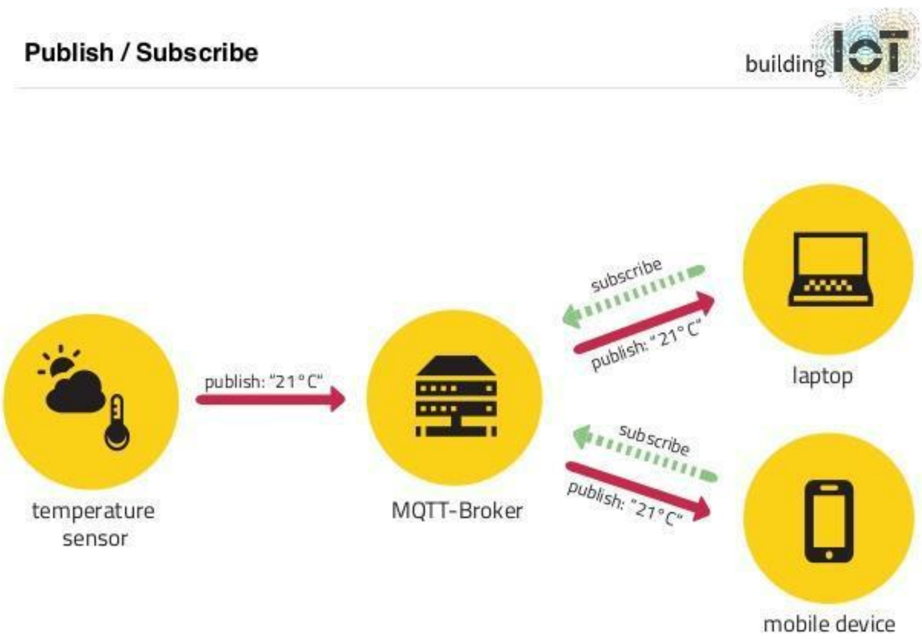



FIG 9.1 Working of MQTT

MQTT is a publish/subscribe protocol that allows devices to publish to a broker. Clients connect to this broker, which then mediates communication between the two devices. Each device can subscribe to particular topics.

MQTT is bidirectional and maintains stateful session awareness. The light weightness and efficiency of MQTT makes it possible to significantly increase the amount of data being monitored or controlled. MQTT makes it possible to collect, transmit and analyze the data being collected.

Unlike the usual poll/response model of many protocols, which tend to unnecessarily saturate data connections with unchanging data MQTT's publish/subscribe model maximizes the available bandwidth.

## 9.2 ADVANTAGES

- Distribute information more efficiently
- Increase scalability
- Reduce network bandwidth consumption dramatically
- Reduce update rates to seconds
- Very well-suited for remote sensing and control
- Maximize available bandwidth
- Extremely lightweight overhead
- Very secure with permission-based security
- Used by the oil-and-gas industry, Amazon, Facebook, and other major businesses
- Saves development time
- Publish/subscribe protocol collects more data with less bandwidth compared to polling protocols

# CHAPTER 10

# CADENCE OrCAD PCB Designer with PSpice

SPICE (Simulation Program for Integrated Circuits Emphasis) was developed at the University of California at Berkeley in the 1970s, and for many years has been the most widely used circuit simulator in the electronics industry. SPICE is a general purpose analog circuit simulator that is used to verify circuit designs and to predict the circuit behaviour. PSpice is a PC version of SPICE and HSpice is a version that runs on workstations and larger computers. PSpice has analog and digital libraries of standard components (such as NAND, NOR, flip-flops, and other digital gates, op amps, etc) which makes it a useful tool for a wide range of analog and digital applications. It is used for various analysis such as linear analysis, non- linear analysis etc.

## 10.1 APPLICATIONS

It comprises three main applications :

- Capture is used to drawn a circuit on the screen, known formally as schematic capture. It offers great flexibility compared with a traditional pencil and paper drawing, as design changes can be incorporated and errors corrected quickly and easily.

- PSpice simulates the captured circuit. One can analyse its behaviour in many ways and confirm that it performs as specified.
- PCB Editor is used to design printed circuit boards

## 10.2 STEPS TO DRAW CIRCUIT

1. Draw an electronic circuit on the computer using Capture.
2. Simulate it with PSpice using specific models for devices.
3. Analyse its behaviour with Probe, which can produce a range of plots. Historically this was a separate application but it is now integrated with PSpice.

## 10.3 CIRCUIT COMPONENTS AVAILABLE

- Independent and dependent voltage and current sources
- Resistors

- Capacitors
- Inductors
- Mutual inductors
- Transmission lines
- Operational amplifiers
- Bipolar transistors
- MOS transistors
- JFET
- MOSFET
- Digital gates

# CHAPTER 11

# HOME AUTOMATION

## 11.1 INTRODUCTION

Home automation gives you access to control devices in your home from a mobile device anywhere in the world. Home automation more accurately describes homes in which nearly everything -- lights, appliances, electrical outlets, heating and cooling systems -- are hooked up to a remotely controllable network. From a home security perspective, this also includes alarm system and all of the doors, windows, locks, smoke detectors, surveillance cameras and any other sensors that are linked to it.

Home automation is a step toward what is referred to as the "Internet of Things," in which everything has an assigned IP address, and can be monitored and accessed remotely.

The first and most obvious beneficiaries of this approach are "smart" devices and appliances that can be connected to a local area network via Ethernet or Wi-Fi. However, electrical systems and even individual points, like light switches and electrical outlets, were also integrated into home automation networks and businesses have even explored the potential of IP-based inventory tracking.

Automation is one of the two main characteristics of home automation. Automation refers to the ability to program and schedule events for the devices on the network. The programming may include time-related commands such as having your lights turn on or off at specific times each day. It can also include non-scheduled events such as turning on all the lights in the home when security system alarm is triggered.

The other main characteristic of cutting-edge home automation is remote monitoring and access. While a limited amount of one-way remote monitoring has been possible for some time it's only since the rise in smartphones and tablets that one has the ability to truly connect to home networks while away. With the right home automation system, one can use any Internet-connected device to view and control the system itself and any attached devices.

Monitoring apps can provide a wealth of information about home. One can check your security system's status, whether the lights are on, whether the doors are locked, what the current temperature of home.

Even simple notifications can be used to perform many important tasks. One can program system to send a text message or email whenever security system registers a potential problem from severe weather alerts to motion detector warnings to fire alarms.

The real hands-on control comes in when one start interacting with the home automation system from remote app. In addition to arming and disarming security system one can reprogram the scheduling lock and unlock doors, reset the thermostat and adjust the lights all from phone, from anywhere in the world

Ideally, anything that can be connected to a network can be automated and controlled remotely. In the real world home automation most commonly connects simple binary devices. This includes "on and off" devices such as lights, power outlets and electronic locks, but also devices such as security sensors which have only two states, open and closed.

### 11.2 ENERGY EFFICIENCY

One clear advantage of home automation is the unmatched potential for energy savings, and therefore cost savings. Your thermostat is already "smart" in the sense that it uses a temperature threshold to govern the home's heating and cooling system. In most cases, thermostats can also be programmed with different target temperatures in order to keep energy usage at a minimum during the hours when you're least likely to benefit from the heating and cooling.

At the most basic level, home automation extends that scheduled programmability to lighting, so that you can suit your energy usage to your usual daily schedule. With more flexible home automation systems, electrical outlets or even individual devices can also be automatically powered down during hours of the day when they're not needed. As with isolated devices like thermostats and sprinkler systems, the scheduling can be further broken down to distinguish between weekends and even seasons of the year, in some cases.

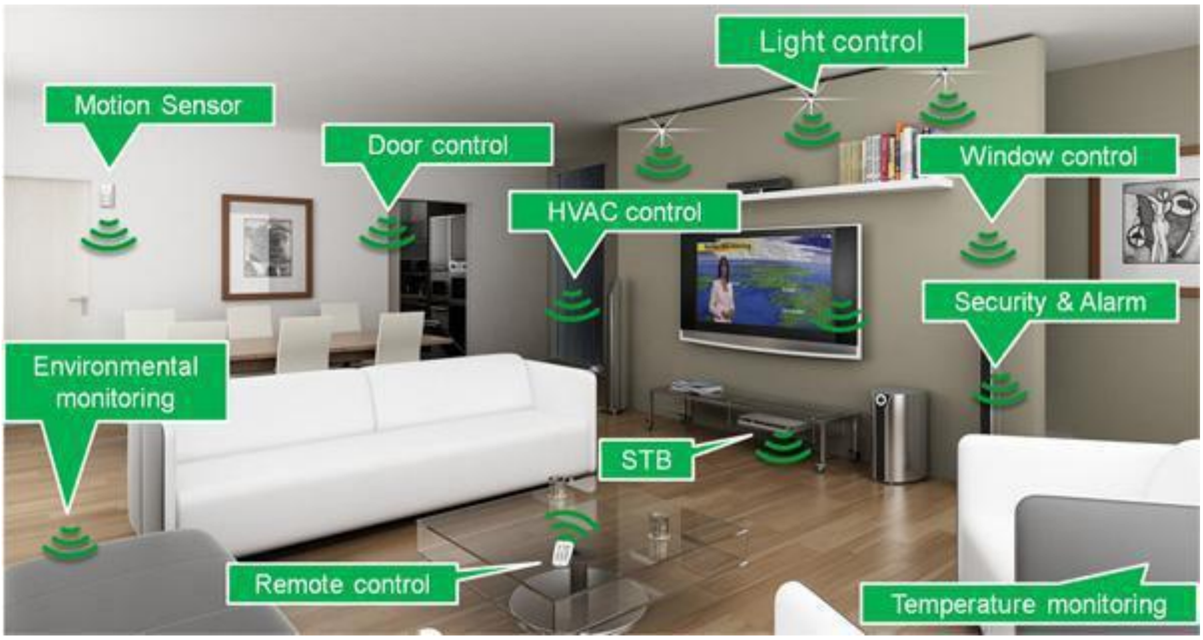



FIG 11.1 Working of MQTT

Home Automation system using IoT is a system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy. The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection.

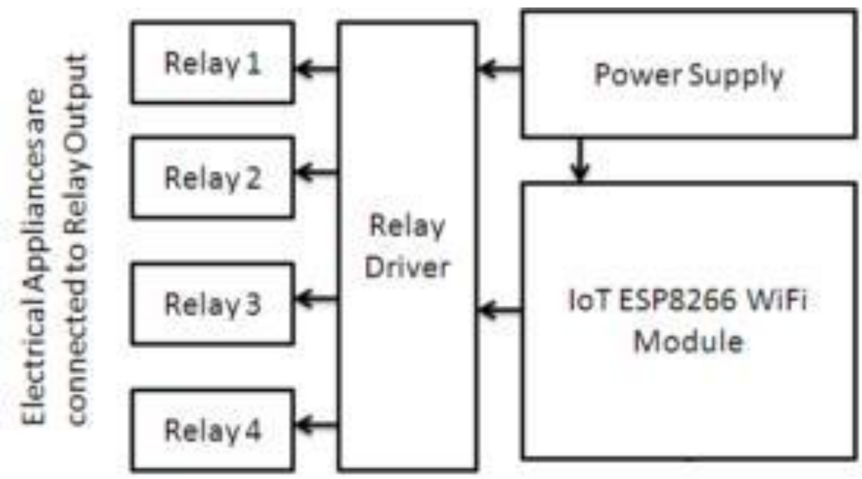



FIG 11.2 Block diagram – IoT Based Home automation

## 11.3 COMPONENTS USED

- Relays
- Esp8266 (wifi module)
- Power supply
- Connecting device (electrical appliance)
- Mqtt dashboard app( mqtt protocol)
- Transistor
- Flywheel diode
- Resistors
- Capacitors

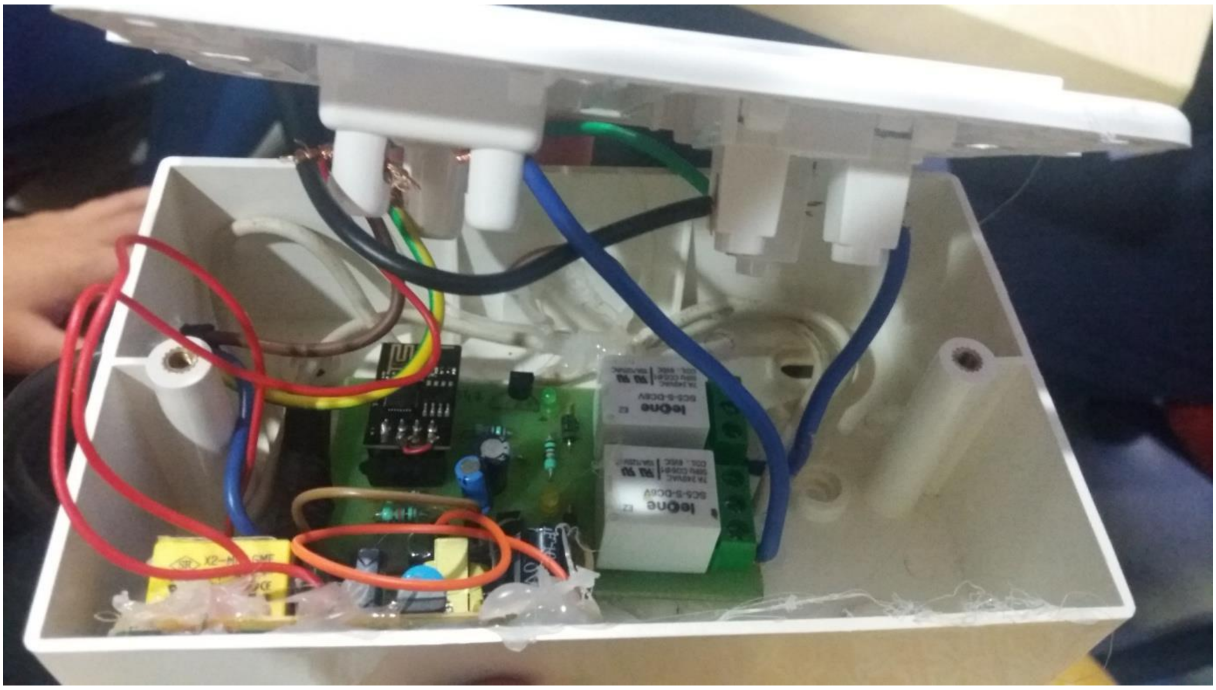


FIG 11.3 Project Image

## 11.4 CODE

```
#include <ESP8266WiFi.h>
#include <PubSubClient.h>
void setup_wifi();
void callback(char* topic, byte* payload, unsigned int length);
void reconnect();
const char* ssid = "demo";
```

```
const char* password = "12345678";
//const char* mqtt_server = "test.mosquitto.org";
const char* mqtt_server = "iot.eclipse.org";
//const char* mqtt_server = "broker.mqtt-dashboard.com";
int gpio2_pin = 2;
WiFiClient espClient;
PubSubClient client(espClient);

void setup() {
  pinMode(gpio2_pin, OUTPUT);

  //pinMode(0,OUTPUT);
    digitalWrite(gpio2_pin, HIGH);
    delay(1000);
    digitalWrite(gpio2_pin, LOW);
  Serial.begin(115200);
  setup_wifi();
  client.setServer(mqtt_server, 1883);
  client.setCallback(callback);
  reconnect();
}

void setup_wifi(){
  delay(10);
  // We start by connecting to a WiFi
  network Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
```

```
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}
void callback(char* topic, byte* payload, unsigned int length)
  { Serial.print("Message arrived [");
  Serial.print(topic);
  Serial.print("] ");
  for (int i = 0; i < length; i++) {
    Serial.print((char)payload[i]);
  }
  if((char)payload[0] == 'o' && (char)payload[1] == 'n') {
    //on
     digitalWrite(gpio2_pin, HIGH);
     Serial.print("pin high");
  }
  else if((char)payload[0] == 'o' && (char)payload[1] == 'f' && (char)payload[2] == 'f') //off
  { digitalWrite(gpio2_pin, LOW);
    Serial.print("pin low");
  }
  Serial.println();
}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
    Serial.print("Attempting MQTT connection...");
    // Attempt to connect
    if (client.connect("ESP8266ClientEkam")) {
      Serial.println("connected");
      // Once connected, publish an announcement...
      client.publish("ESP8266/connection1 status", "Connected!");
```

```
      // ... and resubscribe
      client.subscribe("ESP8266/LED1 status");
    } else {



      // Wait 5 seconds before retrying
      delay(5000);
    }
  }
}

void loop() {
  if (!client.connected()) {
    reconnect();
  }
  client.loop();
}
```

## 11.5 ADVANTAGES

1. Reduced installation costs: First and foremost, installation costs are significantly reduced since no cabling is necessary. Wired solutions require cabling, where material as well as the professional laying of cables (e.g. into walls) is expensive.
2. Easy deployment, installation, and coverage: Wireless nodes can be mounted almost anywhere. In adjacent or remote places, where cabling may not be feasible at all, e.g., a garden house or the patio, connection to the home network is accomplished instantly by simply mounting nodes in the area. Hence, wireless technology also helps to enlarge the covered area.
3. System scalability and easy extension: Deploying a wireless network is especially advantageous when, due to new or changed requirements, extension of the network is necessary. In contrast to wired installations, additional nodes do not require additional

cabling which makes extension rather trivial. This makes wireless installations a seminal investment.

4. Aesthetical benefits: As mentioned before, placement of wireless nodes is easy. Apart from covering a larger area, this attribute helps to full aesthetical requirements as well. Examples include representative buildings with all-glass architecture and historical buildings where design or conservatory reasons do not allow laying of cables.
5. Integration of mobile devices: With wireless networks, associating mobile devices such as PDAs and Smartphones with the automation system becomes possible everywhere and at any time, as a device's exact physical location is no longer crucial for a connection (as long as the device is in reach of the network).

# CHAPTER 12

# CONCLUSION AND FUTURE SCOPE

FIG 12.1 IoT future scope

Smartphones are a part of our daily lives. Having a miniature computer in our pocket has had a profound effect on our ability to access and assimilate information. Because of the powerful implications of this technology, it has become a ubiquitous part of our culture and is sweeping even the remotest, poorest regions of the planet. In recent years, mobile-integrated home automation has become a very big selling point of new homes. There are many different types of home automation that make modern living easier, more efficient and more convenient. The industry of home automation is growing by leaps and bounds every year. New advancements in home automation are very exciting to implement into our homes. Some of them are:

**Remote control of utilities**

Long past are the days of paying high utility bills due to forgetting to turn off the heater or lights. With new home automation technology, we will be able to see exactly what might have accidently left on. We will also easily be able to turn off your heater or switch off lights from your Smartphone while you are on-the-go. Present project can be enhanced to detect when the interior temperature gets too high for electronics and adjusts automatically.

**Utilizing alternative energy sources**

FIG 12.2 Utilising Solar energy

Alternative energy has become increasingly popular over the past decade due to the availability and increasing effectiveness of this technology. One of the most popular forms of alternative energy right now is solar energy. With advanced home automation, we will be able to effectively manage the energy intake and battery unit storage, and track how much energy our home is putting back into the grid, increasing our family‟s quality of life while making a difference to the environment.

**Smart appliances**

FIG 12.3 Smart appliances

We rely on our appliances daily. Without our appliances, we would not have clean clothes or a warm/cool home in which to sleep. With Smart appliances, we can set schedules for when certain tasks like dishwashing will be done. Much superior to mechanical timers, these timers can be set with a computer or Smartphone, and can easily be recalibrated. This can create a much more streamlined home.

**Advanced security systems**


FIG 12.4 Advanced security system

The best home security systems incorporate Smart home technologies to make safety and security more accessible. Doors and windows can be opened and closed, locked an unlocked remotely. Cameras can feed directly to the Smartphone or accessed from a tablet or laptop, preventing intrusions and providing the ability to check up children while elders are away.

With the use of home automation, we will find that our home is more relaxing that ever before.

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