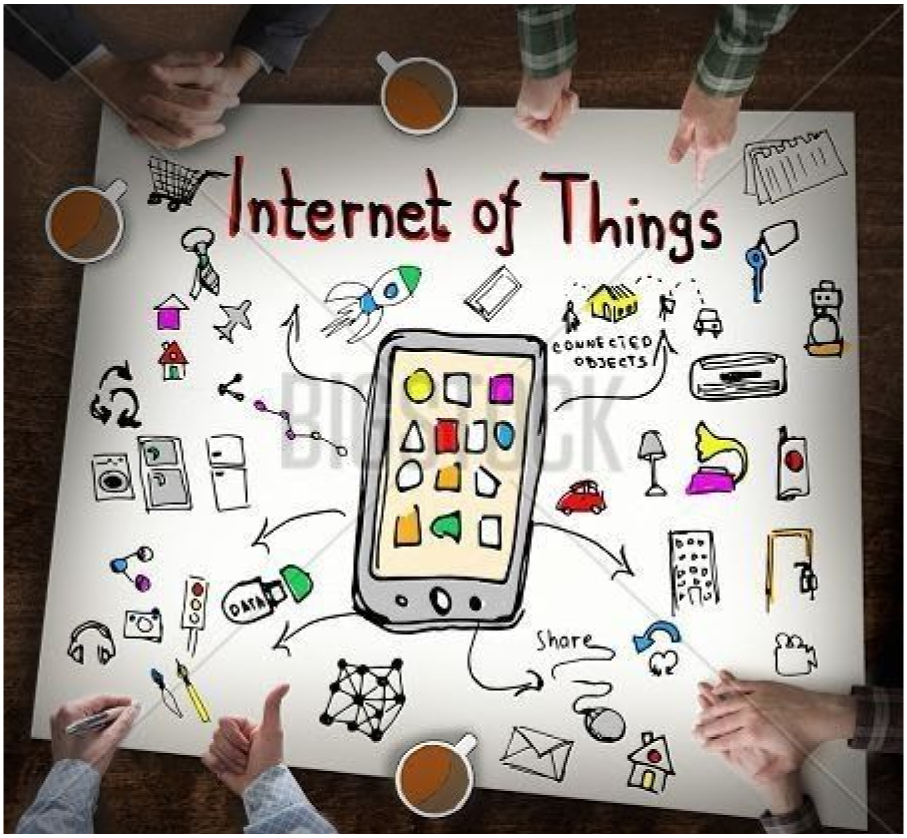
Summer Internship ‘19

Fruit of your own hard work is the sweetest



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13.05.2019 - 13.07.2019

Summer Internship

Supply Chain Innovations

Hindustan Coca-Cola Beverages Private Limited

CONTENTS

INTRODUCTION

In this work report, all the research and development work that has been done in a period of two months is well documented. In a world where the use of the latest technology has become a race in industries to reduce cost and increase convenience, IoT is going to be a major **breakthrough** in the **supply chain**.

What is the ‘Internet of Things-(IoT)’ ?and how will it help.

The idea that any object can be connected to the internet to fetch data and push new data for existing infrastructure is **IoT**.

Getting regular updates on the health of your machine and notifications when there is a need for maintenance will make your life convenient and reduce machine maintenance cost.

PHILOSOPHY

Suppose you bought a fan to keep your machines cool. Now the dust on wings of the fan needs to be cleaned regularly for a good life expectancy. Isn't it **adding** to **maintenance cost**? Don't you have to call people every month or two for fan cleaning? But do you really think the amount of dust will be the same every time and maintenance is really needed after every month? Means in some season dust is more so maintenance is required frequently and in some season dust is less so fans can run for 3-4 months without maintenance.

THEORY

When dust is gathered on the fan, its vibrations start increasing. The amount of dust on the wings can be calculated from the vibration of the wings. Using some algorithm (generally Machine Learning) vibrations are classified to Bad, Good and Moderate condition of health

Now, IoT helps you here. Let us see how

1. We will put a vibration sensor on fan wings
2. Connect Vibration sensor to Microcontroller (MCU) which will process vibrations into Health condition of the fan.
3. Now MCU will be connected to wifi to send health condition and maintenance

alarms to the maintenance team.

BENEFITS

1. You moved from regular maintenance to Predictive maintenance. It means you have to pay for maintenance only when it is actually needed. So if your fan is in good condition and can run for 2 more months there is no need for maintenance (but in the case of your regular maintenance method you will call the team in 2 months and pay them when it is actually not needed.
2. Think otherwise, if your fan is in bad condition and needs instant maintenance then you will be notified by the machine itself and thus you can prevent its damage (but in the case of regular maintenance, you won't know as your next maintenance date is after a few weeks.)

COMPONENTS

Component	Work	Analogy	Examples
Microcontroller (MCU)	Mathematical computations, Controlling action, making decision	Brain	ESP32, Arduino-Uno, Arduino Nano, ESP8266
Sensor	Gather data, like temperature, heat etc. and send to MCU which will process it further	Eyes, nose tongue: Eye collect light and send it to the brain (MCU) which process it into the scenery	DHT11: Temperature and humidity ACS712: Current sensor PIR: human proximity IR: infrared detector
Actuators	Do some actions when MCU give commands	Hands, legs etc: hand comes in action when the brain gives a command	Motors, relay circuit, bulbs

Introduction of a few components:

DHT11 Temp, humidity sensor

LM35 Temperature Sensor

HJ0500T02 Hall Effect Sensor Electrohms

ADXL35 Accelerometer sensor

Arduino UNO

ESP8266 Node MCU for logic and WiFi data transfer

Esp01 chip

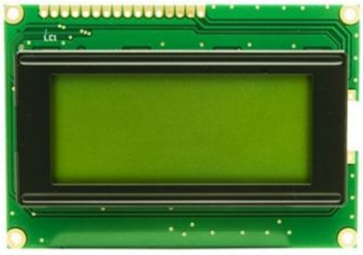
Hall effect Sensor

Ultrasonic Distance Sensor

IR Water Level Sensor

IR Proximity Sensor

BMP085 Pressure Sensor


LCD DISPLAY

CLOUD

1. Cloud computing is a type of computing that relies on shared computing resources rather than having local servers or personal devices to handle applications. In its most simple description, cloud computing is taking services ("cloud services") and moving them outside an organization's firewall.
2. Cloud computing and cloud storage give you seamless computation power as you will be connected to a distributed system where many processing units are connected. similarly, you will have access to large storage. Also, you can access this from anywhere as it is not on local computer or internet

EDGE COMPUTATION

1. Computing things near the edge of the network (where the data is generated) to get rid of any kind of delay.
2. Before sending data to the cloud, it is processed in microcontroller itself and only processed data which gives insight is sent to the cloud.

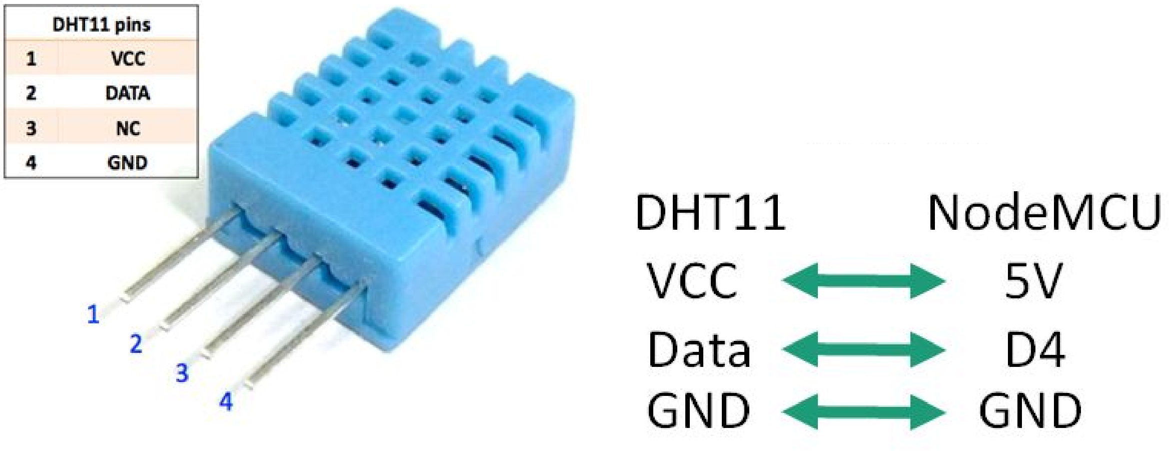
PROJECTS

Sr, No.	Title	Sensor, Power, MCU, Cloud Platform
1	*Forklift Battery Management System*	Hall effect Current sensor, Nodemcu, Wifi device, Power from forklift battery, 7805 ic, **Thingspeak platform**
2	*Health Monitoring of Electric Panel*	Esp01 chip, breakout board, adapter, Dht11, Blynk or Thingspeak any
3	*Forklift Order Management System*	IR Sensor, Adapter, Nodemcu, Blynk
4	*Rejected Bottles Bin Full Alert*	Ultrasonic sensor, adapter, Arduino (prefer), Blynk
5	*Tarpaulin Operator Fall SOS*	IMU or ADXL35, Arduino, Battery 9v, Thingspeak to implement machine learning

DHT11 Temperature and humidity sensor:

Download library from DHT-Library

1. https://www.brainy-bits.com/dht11-tutorial/
2. https://docs.google.com/presentation/d/1gLZs0lELJ76YG7GTkN-wA7rw7MV9WHyc5B2rIpmxzFo/edit#slide=id.g2cc48b3c66_1_10



DHT11 pins	
1	VCC
2	DATA
3	NC
4	GND

DHT11		NodeMCU
VCC	⟷	5V
Data	⟷	D4
GND	⟷	GND

LCD DISPLAY :

- For using the LCD display, you will need a potentiometer to contrast brightness (use voltage divider).
- https://www.arduino.cc/en/Tutorial/HelloWorld
- USE PWM analogWrite() INSTEAD OF POTENTIOMETER IN ARDUINO IT WORKS

  Note:- analogWrite() gives analogue values at pins using PWM
- https://www.instructables.com/id/Select-Color-Display-for-ESP32/

ESP01 Wifi module:

Few Words from me: You have to code ESP01 for serial communication only once. Separately code Arduino and add code to serially transmit data to esp. So add code for calculation part in Arduino and Internet (ex: Thingspeak part) in Esp01. Also, You can use ESP-01 standalone as I have used in Temperature sensors. It has two digital pins. So use then for sensing data and add calculation part too. So no serial communication needed now. But ESP has very few pins.

I would suggest using nodemcu 8266 or ESP32 because they have inbuilt wifi

1. https://www.geekstips.com/esp8266-arduino-tutorial-iot-code-example/
2. http://arduino.esp8266.com/Arduino/versions/2.0.0/doc/reference.html

These 3 links may help you to code esp8266-01 without UART to USB cable.I am using nodemcu-esp8266 and till now it worked great. You can code it with Arduino-Ide. Instead of taking nodemcu-esp8266, buy ESP32 microcontroller as it has inbuilt sensors for temperature etc.
Remember in this case your Arduino act as a communicator between esp8266 and computer

You might have seen some of the tutorials with UART to USB cable (use either) Also, you might have seen some AT-commands online. I think you may not need them.

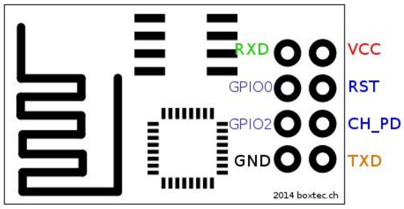
Use the second link

1. https://www.geekstips.com/esp8266-arduino-tutorial-iot-code-example/
2. →https://dzone.com/articles/programming-the-esp8266-with-the-arduino-ide-in-3
3. https://www.electronicshub.org/connect-esp8266-to-thingspeak/

Instructions: keep Arduino reset pin and gpio0 pin of esp8266 to ground while programming

1. Wire Up!

First, we'll need to identify the pinout of ESP8266.



To set the ESP8266 in programming mode you need to connect its wires like this:

ESP8266	Arduino UNO
RDX	RX
GPIO0	GND
GPIO2	3.3V
GND	GND
VCC	3.3V
RST	--------
CH_PD	3.3V
TXD	TX

Note: If you are using an Arduino UNO you +will need to set Arduino RST to GND. Please be careful with the VCC of the ESP8266, it works only with a 3.3V supply.

2. Setup the Arduino IDE

1. Download Arduino IDE.
2. Open your IDE and click on **"File -> Preferences".**
3. In "Aditional Boards Manager URLs" add this line and click on "OK":
4. **"*http://arduino.esp8266.com/stable/package_esp8266com_index.json"***
5. Go to **"Tools -> Board -> Boards Manager"**, type "ESP8266" and install it.
6. Go again to **"Tools -> Board"** and select "Generic ESP8266 Module".

3. Flash Your Code!

Now you're ready to use your ESP8266 as a stand-alone module without needing an external micro-controller. Check out more ESP8266 resources here to learn how to build IoT products and projects using this amazing module.

Serial Communication:

When ESP is used with Arduino

1. Code ESP to receive data from Arduino using RX and TX.
2. Code esp to send data on websites
3. Code Arduino to do the calculation
4. Code Arduino to send data serially to ESP using Rx and tx

   It used software serial library which makes any two pin rx and tx

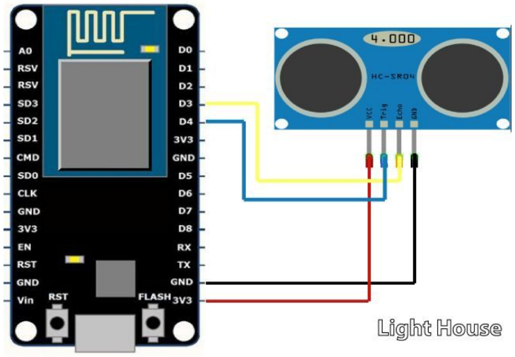
   Final code is also available in text format

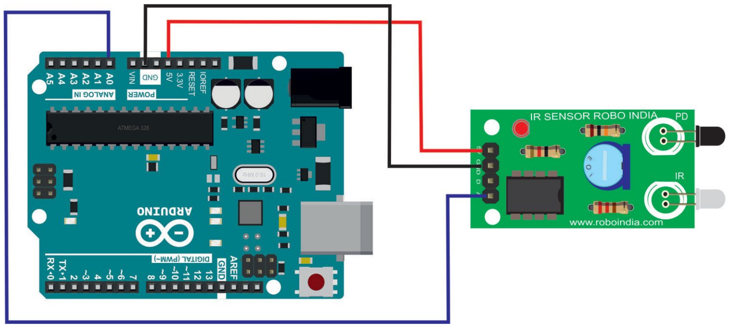
ULTRASONIC SENSOR:

For theory and code see: https://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/

The ultrasonic sensor has 4 pins: *Trigger, Echo, Ground, Vin*

1. It needs 5v for Vin, Using nodemcu 3.3v won't work, so power nodemcu using USB and use Vin pin to power ultrasonic or use Arduino 5v pin
2. For Arduino put Echo pin in 10 and trigger pin to 9
3. For nodemcu 10 and 9 **does not** correspond to D9 and D10. click here for pinout. See GPIO No.





INFRARED SENSOR:

1. This sensor has 3 pins. *Vin, Gnd, Vout*
2. *Vout* is output either High or Low based on obstacle presence
3. Put Vout in any of the Pin of MCU (Arduino or Nodemcu) then read digital value (high or low) from MCU. So most of the sensor has Vout high when there is an obstacle in front of IR led on the sensor. High can be mapped to obstacle
4. IR sensor sends Infrared rays and when there is an obstacle in front of it, those rays are reflected back to IR receiver on the sensor and it shows High at Vout.
5. Use simple digitalRead() command to read values

For reference and code:https://roboindia.com/tutorials/digital-analog-ir-pair-arduino/

INTRODUCTION TO NODEMCU:

A microcontroller like Arduino but with Wifi technology

Setup Arduino click here

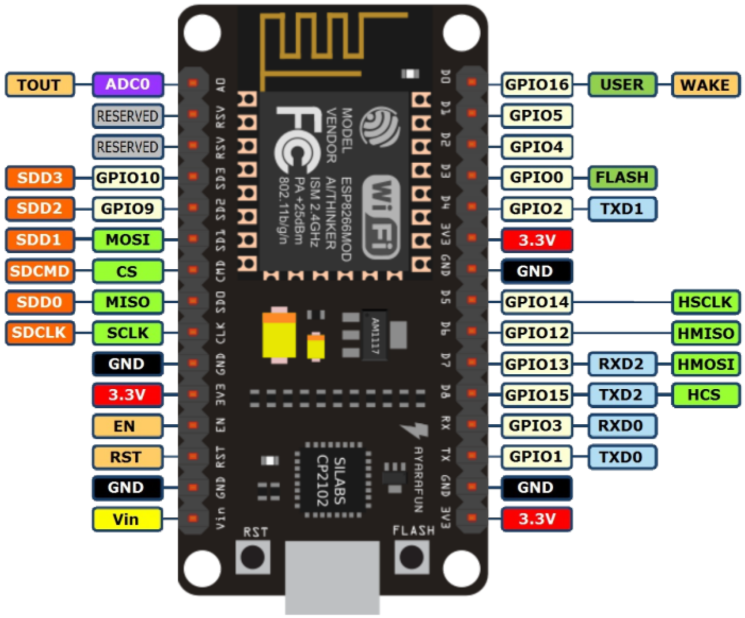
It's done, Use any Arduino code and replace pin no. using pinout

Nodemcu works with 3.3v, means high pin gives 3.3v so sensors which work on 5v has to be powered through a 5v battery

Select board in Arduino IDE and run flash code

1. Just put a line to on wifi. (given in codes).
2. Write code for computation.
3. Write code to push on the cloud.

Nodemcu Pinout: (you can google “nodemcu pinout”) or see below



DEEP SLEEP MODE

MCU consumes a lot of energy, so if we need data at an interval of let say 5 min. We can set up deep sleep where MCU will restart every 5 means read the data and send to the cloud. thus we can save energy if MCU is running on battery.

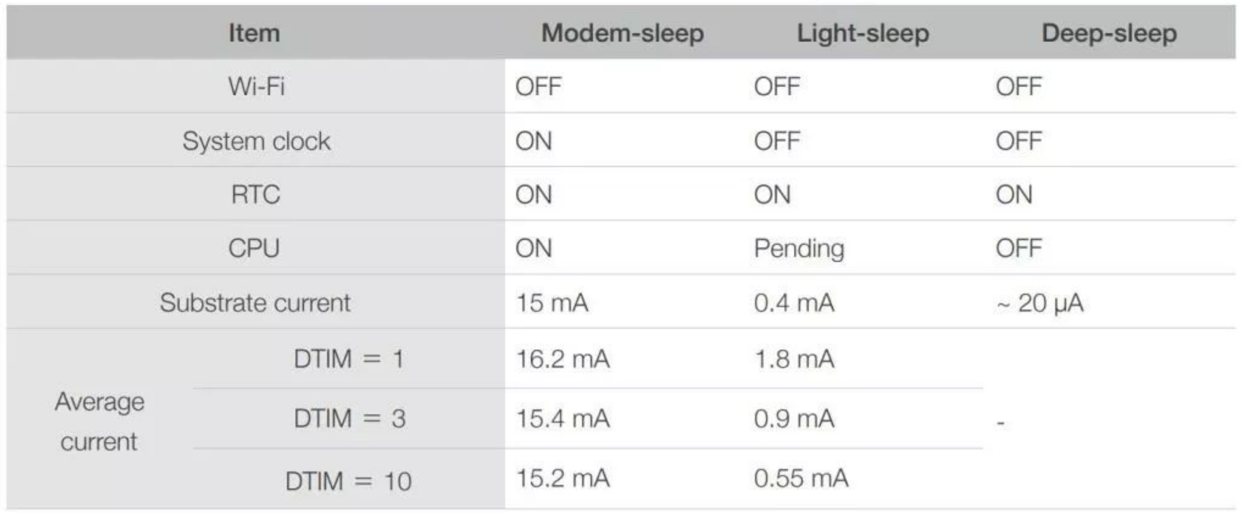
```
ESP.deepSleep(30e6);
```

Keep D0 connected to reset for deep sleep to work

Will set Arduino to deep sleep and it will restart after 30 sec.

Read:
http://embedded-lab.com/blog/esp8266-temperature-humidity-logger-deep-sleep-enabled/
https://randomnerdtutorials.com/esp8266-deep-sleep-with-arduino-ide/

Table 1-1. Differences between 3 Sleep Modes



Item		Modem-sleep	Light-sleep	Deep-sleep
Wi-Fi		OFF	OFF	OFF
System clock		ON	OFF	OFF
RTC		ON	ON	ON
CPU		ON	Pending	OFF
Substrate current		15 mA	0.4 mA	~ 20 μA
Average current	DTIM = 1	16.2 mA	1.8 mA	-
	DTIM = 3	15.4 mA	0.9 mA	
	DTIM = 10	15.2 mA	0.55 mA	

MISCELLANEOUS

How to use push button:

https://www.instructables.com/lesson/InputOutput/

The function of Pull-up pull-down resistor in your Arduino / esp8266 :

```
pinMode(pin, INPUT_PULLUP);
```

```
 pinMode(pin, INPUT_PULLDOWN);
```

1. When the button is not pressed pullup will keep pins voltage 5v/3.3v, if pullup not used then no connection of pin will be there and due to random noise you may get error
2. When the button is not pressed pulldown will keep pins voltage 0v/gnd, if pulldown not used then no connection of pin will be there and due to random noise you may get error

MAKING WEBPAGES

If you want Webpage updating only certain portion if ajax is used

https://circuits4you.com/2018/11/20/web-server-on-esp32-how-to-update-and-display-sensor-values/

JAVA, HTML AND CSS are used for making a display of data we collected.

Setting local web server to blink LEDs from buttons in your browsers

1. https://randomnerdtutorials.com/esp8266-web-server/
2. http://www.lucadentella.it/en/2017/07/08/esp32-20-webserver/
3. https://www.youtube.com/watch?v=6ZukQCWEDCM
4. https://www.youtube.com/watch?v=ROeT-gyYZfw

BLYNK

Blynk work with a mobile application for display. But data stored can be accessed on your webpage using GET API commands

Blynk app for pushing/reading sensor data online / also trying to set up a local server

Installing blynk library: https://github.com/blynkkk/blynk-library/releases/latest

Help: http://help.blynk.cc/en/articles/512105-how-to-install-blynk-library-for-arduino

1. https://examples.blynk.cc

2 .https://docs.blynk.cc/

3. Displaying sensor data in blynk app http://help.blynk.cc/getting-started-library-auth-token-code-examples/blynk-basics/how-to-display-any-sensor-data-in-blynk-app

4. https://www.youtube.com/watch?v=GOJkD1DeFBA

For blynk, there are two ways of data upload: Pushing or pulling:

Pushing: data pushed from MCU even if you are not displaying it

Pull: Data is pulled from MCU only when a Mobile application is ON.

So you cant have data history in last one (real-time data not available)

thingspeak

It is a cloud which gives you storage and computational facilities.

MATLAB is a platform for computation on thingspeak

One can read, process and write values into the thingspeak channel using Matlab commanD

1. Create Thingspeak account.
2. You can access 4 channels, each having 9 fields where you can store data
3. Push data to thingspeak fields and read them for use anytime
4. This can be done through MCU or online Matlab. But commands will be different

For Matlab: https://in.mathworks.com/help/thingspeak/thingspeakwrite.html

For MCU,

Install Thingspeak library from https://github.com/mathworks/thingspeak-arduino

Above link contains commands for read and write in a different manner

The common concept for all Clouds

1. Each cloud will have a library for simplified code for MCU.
2. You can read and write using those library commands.
3. Writing into the cloud will have limits per day or even per delay
4. You can access or display cloud data on websites using GET APIs and you can write data on the cloud using POST API.

   These APIs are kind of the address of cloud so that only you can access it.

   Some clouds give local server facilities. So you can set local cloud on your pc and data is stored in your facility

Selecting MCU

1. ESP8266, ESP32 and NODEMCU have wifi module but has lesser pins than Arduino.
2. Arduino has multiple analog pins whereas ESP has only one analog pin.

   In case you want to use a sensor which needs more than one analogue pin like using adxl35 with esp is troublesome. You can read only one axis' data because ESP has only one analogue pin

   Solution:

   ### MULTIPLEXER IC

If necessary use multiplexer circuit, which is a kind of switch which connects its own analog pin to different analog pin of the sensor on the basis of High or low values of its other pins (call them address pins). So on the basis of what pin we want to read, we can change voltages of its address pins and read required analog pin. The multiplexer has 3 address pin, means 2^3 =8 Analog can be read.

3. Arduino doesn't have wifi inbuilt so one has to use ESP-01 wifi module, which creates a lot of trouble in terms of serial communication and circuit for flashing code, but Arduino has more pins than esp
4. ESP works with 3.3v, all pins give 3.3 when they are high and can widthstand 3.3 only. So sensor which works on 5v like an ultrasonic sensor doesn't work with ESP.

   Solution: Power ESP via USB cable and use Vin pin as Vout for a 5v sensor.

DISCUSSIONS OF PROJECT SPECIFIC PROBLEMS

Health Monitoring of Electric Panels:

1. Used only ESP-01 as both Wifi module and MCU
2. A breakout board was used which gives access to pins properly also convert 5v to 3.3v, so 5v can also be used to power the MCU.
3. ESP-01 Was coded using Arduino as a programmer. Click here
4. Simple code containing the esp8266 library, with board selection "esp standalone" was flashed.
5. Chip has only 2 Pins, I used one for Temperature sensor and other free.
6. This system is powered through an adapter which gives 12v from 220V Mains and adapter is connected to the Breadboard power supply which gives 5v and 3.3v output. 5v was used to power ESP breakout board

   Code is in Text format is available in files: Temperature sensor standalone.txt

Tarpaulin Operator Fall SOS :

1.