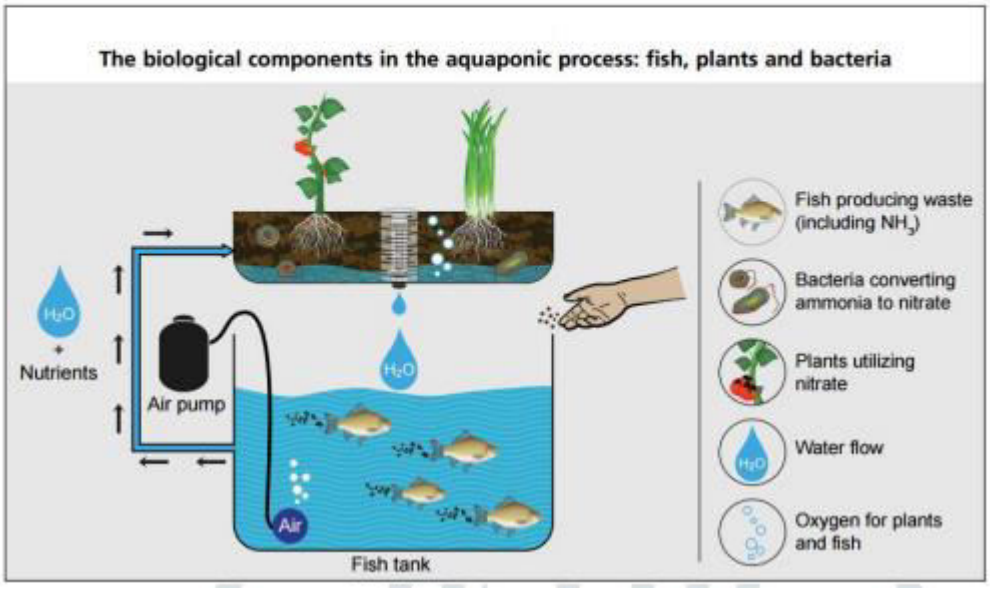
CHAPTER 1
INTRODUCTION

Aquaponics refers to the system that supports the dual combination of the aquaculture (fish rearing) and the hydroponics (production of the plants without soil). The excretions of the fish containing ammonia are converted by the nitrifying bacteria into nitrites and then to nitrates which can be used as nutrients for the plants. As compared to the traditional methods of farming, aquaponics is favorable for the place where there is no fertile soil, or lack of water or even lack of free land/soil. The main objective of this system is to develop an Internet of Things based aquaponics monitoring system which measures and displays parameters like pH level, water level, humidity, temperature, etc. on continuously to the user. Sensors are the hardware components that are used for acquiring information to and from Internet of Things technology. With the application of Internet of Things in Aquaponics system, remarkable changes can be brought in the field of agriculture by simply monitoring and maintaining the system parameters for effective growth of the plants. The use of Wi-Fi of Raspberry helped to connect the system to the web where in the data server stored the values of system parameters like pH value, temperature and humidity in the database and provided the information to the web server where the user can access the data in JavaScript Object Notation format and in graphical format as well. With the application of Internet of Things in the Aquaponics Monitoring system, the values of the system parameters and information can be displayed on the web server continuously.

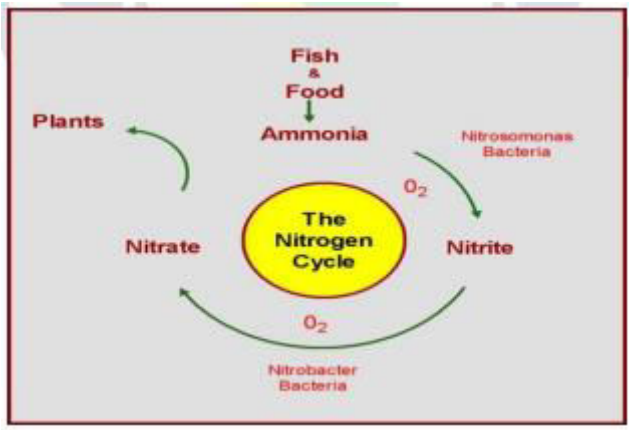
Aquaponics is a combination of aquaculture and hydroponic (soil-less plant culture) plant growth techniques. It doesn't require soil or any chemicals to produce a large amount of fish and vegetables in a small space. In aquaponics, the nutrient-rich water that results from raising fish provides a source of nutrients (Urea) for the nitrogen-consuming bacteria, which helps to clean the water where the fish live in by breaking down these compounds into nitrates, which then feed the plants and keeps them healthy. Water consumption is lower and plant density is usually at least twice that of soil based methods. As such the combination of aquaculture and hydroponics help to sustain an environment in which they both can thrive.

Aquaculture + Hydroponics → Aquaponics



THE NITROGEN CYCLE:

The most important biological process in aquaponics is the nitrification process, which is an essential component of the overall nitrogen cycle seen in nature. Nitrogen (N) is a chemical element and an essential building block for all life forms. Nitrogen is the most important inorganic nutrient for all plants. Nitrogen fixation is facilitated by bacteria that chemically alter the N2 by adding other elements such as hydrogen or oxygen, thereby creating new chemical compounds such as ammonia (NH3) and nitrate (NO3-) that plants can easily use. The ammonia is metabolized by a specific group of bacteria, which is very important for aquaponics, called nitrifying bacteria. These bacteria first convert the ammonia into nitrite compounds (NO2 -) and then finally into nitrate compounds (NO3-). Plants are able to use both ammonia and nitrates to perform their growth processes, but nitrates are more easily assimilated by their roots.



Aquaponics is a system that is a combination of aquaculture (breeding, raising, and harvesting fish, shellfish, and aquatic plants) & hydroponics (a part of hydroculture that revolves around the cultivation of plants, usually crops, without the soil, making use of nutrient solution in an aqueous solvent) in one aquaponic system. The aquaponic model should consist of water filtration systems, water storage tanks, fish tanks, sensors for regulating various parameters, and an adequate piping system to facilitate the transfer of water from one section to the another. It uses Fish's which contains nitrogen and minerals to provide important nutrients for the growth of the plants and in return, the plants will absorb the minerals, nutrients & nitrogen and purify the water, and give it back to the fishes. The nutrients will further aid the water purification process, since this liquid will be fed into the plants section of the aquaponic model. We have installed filtration tanks in other parts of the system too to make sure water is constantly filtered. The ultimate goal of this project is to make an steadfast system by creating an aquaponics system using the concept of IoT (Internet of Things). By creating an automatic system of aquaponics with the use of interface sensors with the Arduino board.

1.1 EMBEDDED SYSTEMS

An Embedded System can be portrayed as dealing with contraption that makes a particular centered showing up concerning. Gadgets, for example, the ventilation system, VCD player, DVD player, printer, fax machine, cell phone and whatnot are occurrences of installed structures. Each of these machines will have a processor and remarkable equipment to meet the particular fundamental of the application near to the installed programming that is executed by the processor for meeting that particular need. The presented composing PC programs are in like way called "firm thing". The desktop/flexible workstation phone a widely profitable PC.

Embedded Systems do a particular errand; they can't be acclimated to do grouped things. Preoccupations, word managing, bookkeeping, programming movement et cetera. In contains Embedded systems have unfathomably kept assets, especially You can utilize it for an assortment of vocations, for example, playing structures need to strife with two or three due dates. A particular occupation must be done inside a particular time. In some installed systems, called relentless structures, the due dates are stringent. Missing a due date may understand a calamity death toll or harm to property. Implanted frameworks are obliged for control. A comparative number of introduced systems work through a battery, the power utilize must be astoundingly low. Some implanted frameworks need to work in outstanding organic conditions, for example, high temperatures and Humidity.

1.3 OVERVIEW OF EMBEDDED SYSTEM ARCHITECTURE

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Figure.

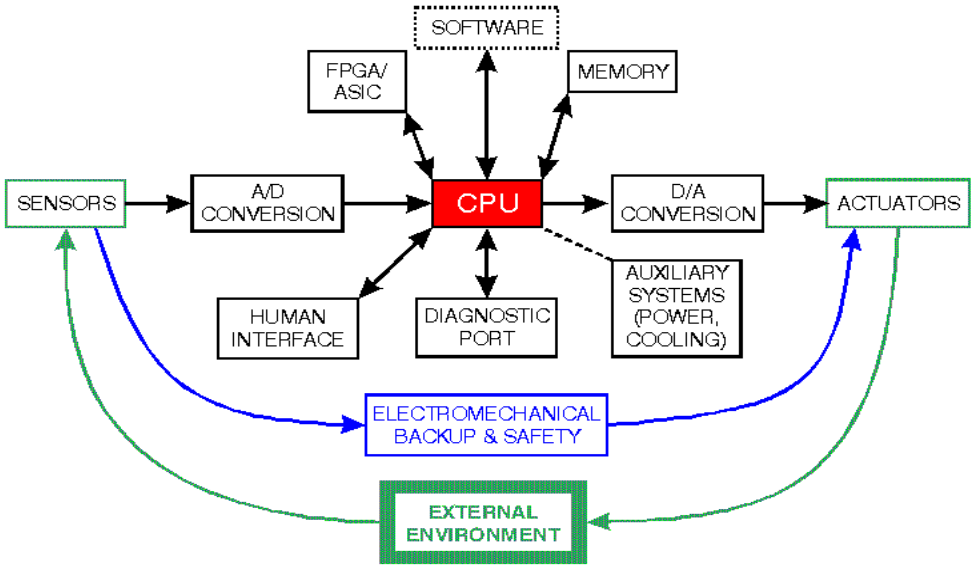


Figure 1.1: Overview diagram of Embedded system

The working system keeps running over the equipment, and the application programming keeps running over the working framework. A similar design is material to any PC including a desktop PC. Be that as it may, there are huge contrasts. It is not

necessary to have a working framework in each installed framework. For little machines, for example, remote control units, aeration and cooling systems, toys and so forth. There is no requirement for a working framework and you can compose just the product particular to that application. For applications including complex handling, it is fitting to have a working framework. In such a case, you have to incorporate the application programming with the working System and after that exchange the whole programming on to the memory chip.This may be seen as an adjustment in the lifestyles of people.

CHAPTER 2
LITERATURE SURVEY

The first aquaponics research was held in Canada. It was a small scale system added on to existing aquaculture research at a research station in Lethbridge, Alberta. Aquaponics naturally evolved from aquaculture in an effort to eliminate fish waste. The research made in Alberta has largely been driven by the industry itself as those in the greenhouse strive to perfect models and methods. In the mid-1990s, a number of fish growers in Alberta began the transition into aquaponics by building greenhouses and growing vegetables. The development of modern Aquaponics is often attributed to the various works of the New Alchemy Institute and the works of Dr. Mark McMurtry at the North Carolina State University. Dr. James Rakocy and his colleagues started researches in 1979 at the University of the Virgin Islands and developed the use of deep water culture hydroponic grow beds in a large-scale Aquaponics system. A set up was developed in a greenhouse at Brooks, Alberta where they made findings on rapid root growth in Aquaponics systems and also the system run well at a low PH level favored by the plants [1].

But the developed systems till then were not found to be informative type. The design is based on software and hardware part. The software is required to simulate the circuit using Multisim software, Microchip MPLAB IDE software used to perform the interface to Peripheral Interface Controller (PIC18F4550) and develop the layout of a printed board circuit using the Proteus software. Large amounts of Random Access Memory for buffering and enhanced flash program memory make it ideal for embedded control and monitoring applications that require periodic connection with a personal computer via Universal Serial Bus for data upload or download and/or firmware updates [2].

Globally, there are now hundreds of small scale aquaponics initiatives and several larger scale commercial or near commercial enterprises – the latter mainly in the USA and in particular Hawaii. In parallel with research on aquaponics there has also been substantial research on integrated multi-trophic aquaculture in which fish and plants are grown in more open systems. The classic examples here are of growing caged salmon in close association with mussel and seaweed cultivation. Despite substantial pilot scale research for well over a decade however, these systems have not been adopted on a significant commercial scale, mainly because of the large

quantity and low value of seaweed produced, reduced water circulation around the fish cages, and a range of other management issues[3].

One of researcher named Rik Kretzinger designed an aquaponics garden based on Arduino microcontroller. A simple timer performs all functions needed for a standalone aquaponics garden. An Arduino Uno microcontroller provides precise control of cycle times, and collects sensor data to show you what's taking place in the growing environment. An Arduino microcontroller lets you control your garden anywhere in the world. Receive text messages, do data streaming and logging, and more through the implementation of Internet of Things [4].

The use of Internet of Things technology to configure and deploy smart water-quality sensors that provide remote, continuous, and real-time information of indicators related to water quality, on a graphical user interface (GUI) was done in Seattle University by Shiny Abraham, Armand Shahbazian, Kevin Dao, Han Tran. A sensing system comprising of a Raspberry Pi and commercial sensor circuits and probes that measure Dissolved Oxygen, pH, and water temperature was deployed in an aquaponics facility in a town called Manchay, near Lima, Peru. Data acquired from the sensor system is uploaded to ThingSpeak, an Internet of Things analytics platform service that provides real-time data visualization and analysis. Continuous monitoring of this data, and making necessary adjustments, will facilitate the maintenance of a healthy ecosystem that is conducive to the growth of fish and plants, while utilizing about 90% less water than traditional farming [5].

This task incorporates numerous highlights like temperature detection. And also controlling utilizing a heat source and cooling fan. Along with that the discovery of pH in water utilizing a pH sensor. And a siphon for cleaning and also re-coursing the water. The proposed system initially differentiates the parameters of water by making use of multiple sensors. We were utilizing a PIC 16F877A microcontroller. Where the information will be contrasted and an ideal scope of the particular parameters. At that point, if the features are lower or upper than the ideal range then required tasks will be done in a similar manner. Another approach called the Internet of Things (IoT) jumps over any barrier between the physical world and the computerized world. In this aquaponics observing framework, with the utilization of IoT, the webserver persistently shows the estimations of the parameters and data [6].

Traditional farming and fishkeeping have enabled human populations to produce foods, but as communities grow though, less and less agricultural and

farmland is available. Also, due to change in climate, producing crops continuously is a difficult thing to do. Aquaponics addresses these concerns. Aquaponics is the mix of aquaculture along with hydroponics in a single system. The purpose of this study is to create an automatic aquaponics system using Nile Tilapia, Romaine Lettuce with access and control of pH level and temperature using the concept of IoT. Intel Edison is used as the microprocessor which continuously sends information about the aquaponics' status and adjusts them if the parameters fall below their optimal levels. The whole system can be checked with the use of an Internet Protocol camera. Weekly comparison of the growth of the plant and fish in automated aquaponics, and traditional fish keeping and hydroponics are done and growth in the automated aquaponics is significantly greater than its traditional alternative[7].

Aquaponics is a technique which mixes aquaculture along with hydroponics, growing fish and plants each in a single system. It uses fish excreta to give important nutrients to plants, hence, in exchange, the plants will purify the water and give it back to the fishes. The scope of this paper is to make an steadfast system by creating an aquaponics environment by using the concept of IoT . By creating an automatic environment of aquaponics with the use of sensors interfaced with the Arduino, it is necessary to make an automatic fish feeder and supply of water to the plants at regular intervals. Present system combines these technologies and must overcome fundamental issues like cost of plants, food's quality, and growth being limited. In this paper, we have intended to create a kit that has all the features we have told above, and is useful to give the vegetation for the house [8].

The ideated smart, sustainable house aquaponic environment has lots of sensors, actuator, and a microcontroller with stable internet connection to monitor and limit, to keep track of tank water and air quality. Growth of fish, plants is made sure by sending a warning beforehand to a person in the erratic conditions by phone notification in a feature-rich internet of the things mobile application[9].

In this paper, we have projected aquaponics in a new light that would require only very minimal manual intervention and yield great results with the help of technology. Here they have made use of wireless sensors to identify and monitor the parts of the ecosystem that would require manual intervention, automate the process thereby resulting in a sustainable system. Using various techniques and to propose a novel automated aquaponics system with all [10].

An agricultural irrigation technological development that is worth saying is the aquaponic process that is their ideation in this report. With ample amount of light and temperature along with humidity changes of the plant, it will be well suited to be put into indoor areas. Agricultural concept ideation with aquaponics is using the knowledge of the IoT since the data from sensors and limit actuator readings can be seen by softwares installed on phones from remote areas with just an active Internet. Agricultural concept ideation with inhouse aquaponic irrigation technology gives an option for someone who has no area for farming but still conducts business transactions which can give the farmer a source of livelihood. The irrigation processes applied to aquaponics are very averse from traditional farming processes. Hence, using this concept of the Internet of Things has more pros as opposed to traditional farming [11].

The goal of this research paper is to show how we can build an steadfast Internet of Things model in aquaponics to make an autonomous and independent system with the use of an Wireless Sensor Network. The standard of WSN which is called 6LoWPAN is preferred in this model that helps us to make an all round aquaponic model which is systematic in nature [12].

Goal of this paper is to understand the existing aquaponics systems implementing the necessary requirements and very less human intervention with the system. The technique for this project used is IoT which has automated fish feeding at regular intervals of time, automated water supply to the plants is done by using GSM [13].

Its principle is to utilize the excreta (ammonia) from the raised aquatic animals, transport the aquaculture water from the submerged motor to the filtration system, and discharge the aquaculture water to the nitrification system via the filtration system [14].

The nitrification system contains a large number of nitrite bacteria, which can decompose and oxidize ammonia. Oxidized nitrate can be converted to nitrate, which is an almost non-toxic substance. In an anaerobic environment, it can be decomposed into nitrogen and oxygen by anaerobic bacteria. Subsequent to the entire nitrification, the aquaculture water is drained into the plant bed. As the plant roots absorb nitrogen fertilizer, the water is simultaneously purified [15].

CHAPTER 3
PROPOSED SYSTEM

3.1PROPOSED SYSTEM

The existing problems seen in the traditional aquaponics system can be detached by the introduction of electronic approach in the system. And this can encourage people to produce organic and healthy plants for daily use or consumption in their own household. For this project, the setup of an aquaponics system consisting of fish tank and grow bed for plants was done. Then, a monitoring section was established in order to detect the water quality, temperature and humidity of aquaponics system by the use of Temperature sensor respectively. All these sensors were interfaced to the Arduino Mega microcontroller. Relay has been used for pump controlling feature. Arduino Mega has allowed the system to be Internet of Things based by using Wi-Fi Module. By the application of Internet of Things in this system, it has been possible to view the readings from anywhere in the world and also it provided the graphical and analytical view of the system parameters which define the IoT Based Aquaponics Monitoring System. Thus the block diagram of the proposed system in shown in figure 4.1.

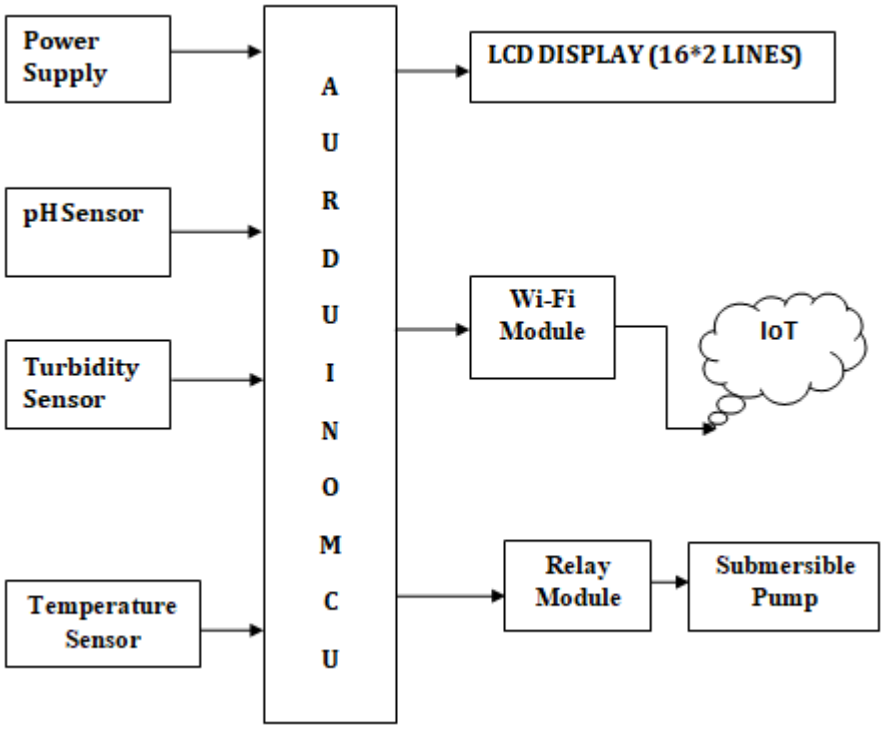


Figure 4.1 Proposed System Block diagram

CHAPTER 4
HARDWARE DESCRIPTION

4.1 HARDWARE COMPONENTS

These are the following components we used to design our Project "**Iot BASED ORGANIC FARMING USING AQUAPONICS METHOD":**

- Arduino UNO
- Power supply
- LCD Display
- Float Sensor
- pH Sensor
- Wi-Fi Module
- Relay Module
- Motor
- Temperature Sensor
- LED Strip

4.2ARDUINO UNO

Overview:

The Arduino Uno is a microcontroller board in context of the ATmega328. It has 14 electronic data/yield pins (of which 6 can be utilized as PWM yields), 6 clear data sources, a 16 MHz stylish resonator, a USB association, a power jack, an ICSP header, and a reset get. It contains everything foreseen that would help the microcontroller; just interface it to a PC with a USB association or power it with an AC-to-DC connector or battery to begin.

The Uno contrasts from every last going before board in that it doesn't utilize the FTDI USB-to-serial driver chip. Or on the other hand perhaps, it consolidates the Atmega16U2 (Atmega8U2 up to change R2) modified as a USB to-serial converter. Revision3 of the board has the running with new parts:

Arduino board:

Arduino is a model stage (open-source) in light of an easy to-use hardware and programming. It incorporates a circuit board, which can be modified (suggested as a microcontroller) and a possible programming called Arduino IDE (Integrated

Development Environment), which is worn to casing and exchange the PC code to the physical board. The key sections are: Arduino sheets can read fundamental or pushed data signals from different sensors and change it into a yield, for instance, starting a motor, turning LED on/off, join to the dull and diverse obvious exercises.

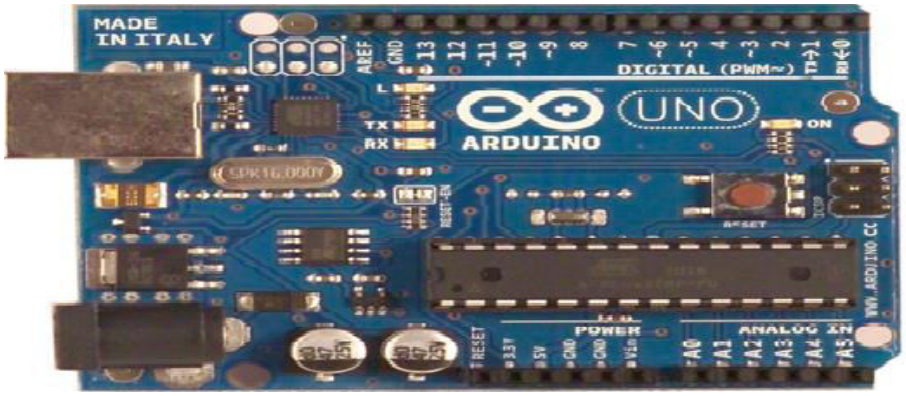


Figure 4.1: Arduino Board

ATmega328P-PU with Arduino Boot loader

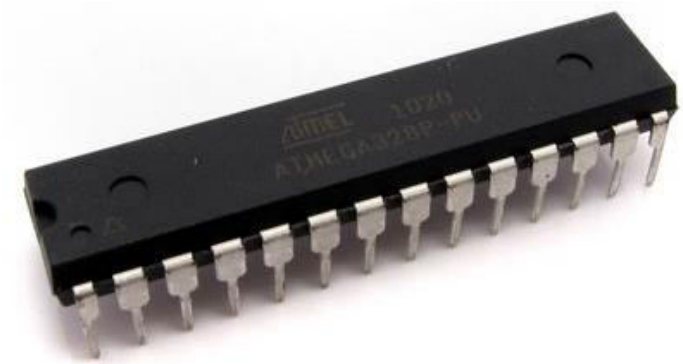


Figure 4.2: ATmega328P-PU

Description:

The name says everything on this one. An Atmega328 in DIP bundle, pre-stacked with the Arduino (16MHz) Boot loader. This will engage you to utilize Arduino code in your especially presented connects without using a genuine Arduino board.

To get this chip working with Arduino IDE, you will require an outside 16MHz significant stone or resonator, a 5V supply, and a serial association. On the off chance that you are not content with doing this, we propose acquiring the Arduino Duemilanove board that has these merged with the board.

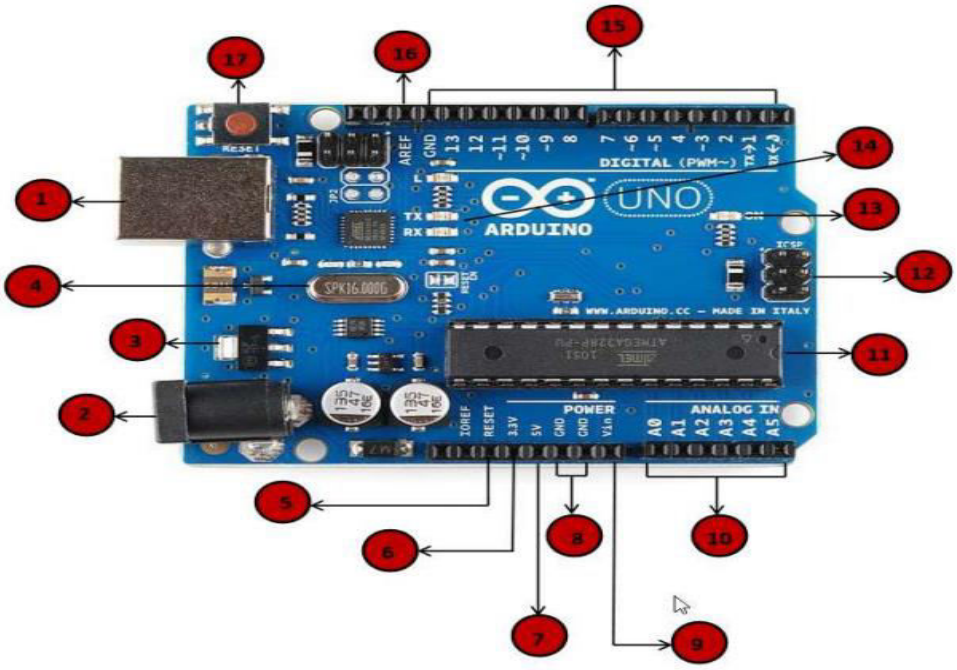


Figure 4.3: Pin Description of Arduino

1. **Power USB:** Arduino board can be engaged by using the USB interface from your PC. You should basically relate the USB interface with the USB union (1).
2. **Power (Barrel Jack):** Arduino sheets can be filled particularly from the AC mains control supply by assistant it to the Barrel Jack (2).
3. **Voltage Regulator:** The most distant purpose of the voltage controller is to control the voltage given to the Arduino board and parity the DC voltages used by the processor and diverse areas.
4. **Gem Oscillator:** The gainful stone oscillator helps Arduino in overseeing time issues. How does Arduino discover time? The most ideal reaction is, by using the noteworthy stone oscillator. The number engraved over the Arduino critical stone is 16.000H9H. It reveals to us that the repeat is 16,000,000 Hertz or 16 MHz.
5. **Arduino Reset:** You can reset your Arduino board, i.e., start your program from the most reliable beginning stage. You can reset the UNO board in two different ways. Regardless, by using the reset get (17) on the board. Second, you would interface have the ability to an outside reset catch to the Arduino stick named RESET (5).

   6,7,8,9 Pins (3.3, 5, GND, Vin) 3.3V (6): Supply 3.3 yield volt

   - 5V (7): Supply 5 yield volt

- Most of the parts used with Arduino board works fine with 3.3-volt5-volt GND (8) (Ground): There are a few GND sticks on the Arduino, any of which it tends to be used to ground your circuit. Vin (9): This stick in like way can be used to control the Arduino board from an outside power source, like AC mains control supply.

6. **Direct sticks:** The Arduino UNO board has five clear data pins A0 through A5. These pins can read the flag from a reasonable sensor like the moisture sensor or temperature sensor and change over it into an electronic regard that can be broke down by the chip.
7. **Primary Controller:** Each Arduino board has its own specific microcontroller (11). You can remember it as the cerebrum of your board. The essential IC (joined circuit) on the Arduino is somewhat not definitely the equivalent as board to board. The microcontrollers are generally of the ATMEL Company. You ought to perceive what IC your ban has before stacking another program from the Arduino IDE. This information is open on the most astounding explanation behind the IC. For more bits of finding out about the IC movement and purposes of restriction, you can propose the data sheet.
8. **ICSP stick:** For the most part, ICSP (12) is an AVR, an unassuming programming header for the Arduino containing MOSI, MISO, SCK, RESET, VCC, and GND. It is as frequently as conceivable proposed as a SPI (Serial Peripheral Interface), which could be considered as an "extension" of the yield. If all else fails, you are slaving the yield contraption to the expert of the SPI transport.
9. **Power LED pointer:** This LED ought to light up when you relate your Arduino to a power source to demonstrate that your blockade is empowered certainly. If this light does not turn on, by then there is a vital issue with the affiliation.
10. **TX and RX LEDs:** On your board, you will find two names: TX (transmit) and RX (get). They appear in two places on the Arduino UNO board. Regardless, at the robotized pins 0 and 1 display the pins accountable for sequential correspondence. Second, the TX and RX drove (13). The TX drove flashes with different speed while sending the sequential data. The speed of

shooting depends on the baud rate used by the board. RX flashes in the midst of the getting method.

11. **Computerized I/O:** The Arduino UNO board has 14 electronic I/O pins (15) (of which 6 give PWM) (Pulse Width Modulation) yield. These pins can be dealt with to fill in as data electronic pins to look at procedure for speculation regards (0 or 1) or as forefront yield pins to drive particular modules like LEDs, exchanges, et cetera. The pins stamped "~" can be used to make PWM.
12. **AREF:** Remain for Analog Reference. It is on occasion, used to set an external reference voltage (in the region of 0 and 5 Volts) past what many would consider attainable for the reasonable data stick.

SpecializedSpecifications:

Microcontroller	ATmega328
Working Voltage	5V
Information Voltage(recommended)	7-12V
Info Voltage (limits)	6-20V
Computerized I/O Pins	14 (of which 6 give PWM yield)
Simple Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Streak Memory	32 KB (ATmega328) of which 0.5
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Specifications

- 802.11 b/g/n.
- Integrated low power 32bit MCU.
- Integrated 10bit ADC.
- Integrated TCP/IP protocol stack.
- Operating temperature range: -40 ° C ~ 125 ° C.
- Frequency range: 2.4GHz - 2.5GHZ.
- Operating voltage: 3.0v~3.6v.
- Operating current: Average value 80mA.

Programming NodeMCU ESP8266 with Arduino IDE:

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use.

Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself.

Uploading your first program:

Once Arduino IDE is installed on the computer, connect the board with the computer using the USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>NodeMCU1.0 (ESP-12E Module), and choose the correct Port by selecting Tools>Port. To get it started with the NodeMCU board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the built-in LED of the board blinking.

4.3 POWER SUPPLY

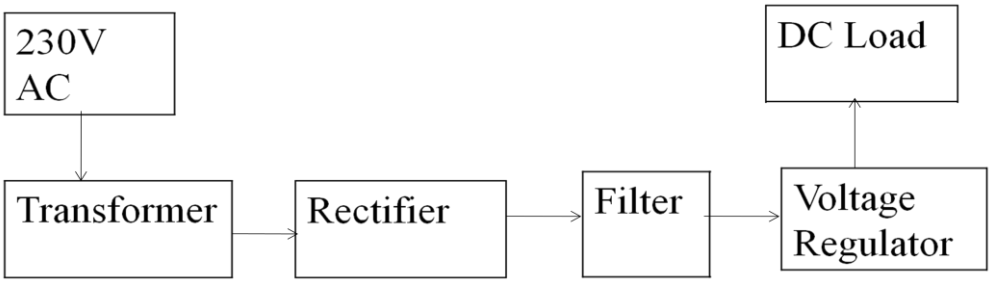


Figure 4.4: Power Supply

The information to the circuit is related from the arranged power supply. The AC information i.e., 230v from the mains give is wind around the transformer to 12v and is lively to a rectifier. The yield grabbed from the rectifier is a sore DC voltage. Remembering the true objective to get an unmodified DC voltage, the yield voltage from the rectifier is supported to a channel to leave any AC parts introduce widely after refresh. Inevitably, this voltage is given to a voltage controller to get an immaculate unfaltering dc voltage.

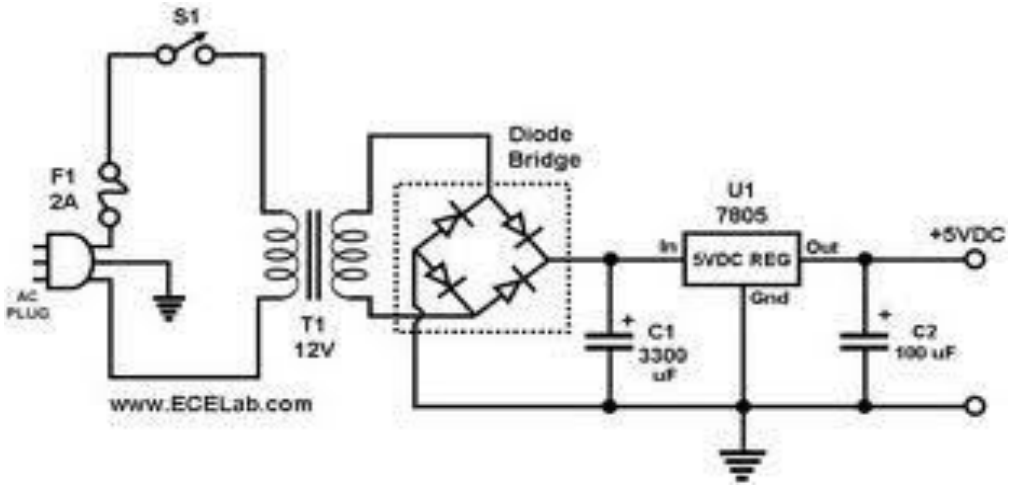


Figure 4.5: Circuit diagram of LPC2148

The Arduino Uno can be filled by techniques for the USB association or with an outside power supply. The power source is picked consequently. Outside (non-USB) power can come either from an AC-to-DC connector (divider wart) or battery. The connector can be connected by ending a 2.1mm focus positive interface with the board's essentialness jack. Leads from a battery can be embedded in the Gnd and V_{in} stick headers of the POWER connector.

The board can wear down an outer supply of 6 to 20 volts. In the event that gave under 7V, regardless, the 5V stick may supply under five volts and the board might be unsafe. In the event that utilizing more than 12V, the voltage controller may overheat and hurt the board. The prescribed run is 7 to 12 volts.

The power pins are as per the going with

- V_{IN}: The information voltage to the Arduino board when it's utilizing an outside power source (instead of 5 volts from the USB association or other supervised control source). You can supply voltage through this stick, or, if giving voltage by techniques for the power jack, get to it through this stick.
- 5V: The facilitated control supply used to control the microcontroller and differing parts on the board. This can come either from VIN by techniques for an on-board controller, or be given by USB or another planned 5V supply.
- 3.3V: A 3.3 volts supply conveyed by the on-board controller. Most ludicrous current draw is 50 mA.
- GND: Ground pins.

4.4 LIQUID CRYSTAL DISPLAY (LCD)

LCD stays for Liquid Crystal Display. LCD is finding extensive utilize supplanting LEDs (seven-piece LEDs or other multi segment LEDs) because of the going with reasons:

- The declining expenses of LCDs.
- The ability to indicate numbers, characters and plan. This is instead of LEDs, which are obliged to numbers and a few characters.
- Consolidation of a fortifying controller into the LCD, in this way easing the CPU of the task of resuscitating the LCD. Strikingly, the LED must be restored by the CPU to keep demonstrating the data.
- Simplicity of programming for characters and outline. These are used for arraigning specific messages on a little scale LCD.

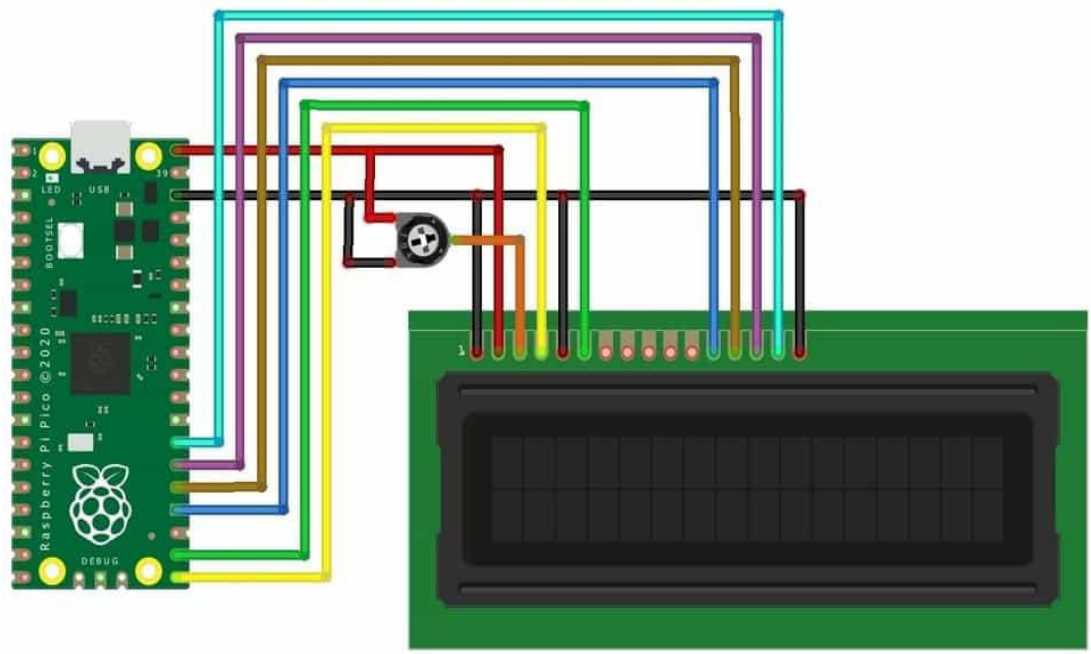


Figure 4.6: LCD Module

Passage mode set order

These gather sets cursor move bearing and show proceed onward/OFF. There are 4 possible limit set commands;04, 05, 06, and 07. This request modifies the course the cursor moves by setting the convey counter to expansion or decrement. This request is basic

The support relies upon a 74C922 chip and my circuit to change over the 4-bit data yield of the 74C922 to 8-bit information. It moreover has 3 distinct gets on it. This makes it exceptional to investigate diverse roads in regards to LCDs by entering

charges/data physically. To show the effect of every limit set charge it is normal that the LCDs underneath are 2*16 LC Displays with DD RAM convey set to 8 and underline cursor ON. Observe that when the convey counter is set to DECREMENT, strings sent to the LCD will be engraved in reverse demand. A comparable thing applies to the CG RAM, moreover.

- Clear Display.
- Cursor Home. RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 0 1 * Returns the cursor to the home position (Address 0). Returns show to its unique state on the off chance that it was moved.
- Entry Mode Set.
- Display ON/OFF.
- Cursor and Display Shift.
- Function Set.
- Set CG RAM Address.
- Set DDRAM Address.

LCD Connection:

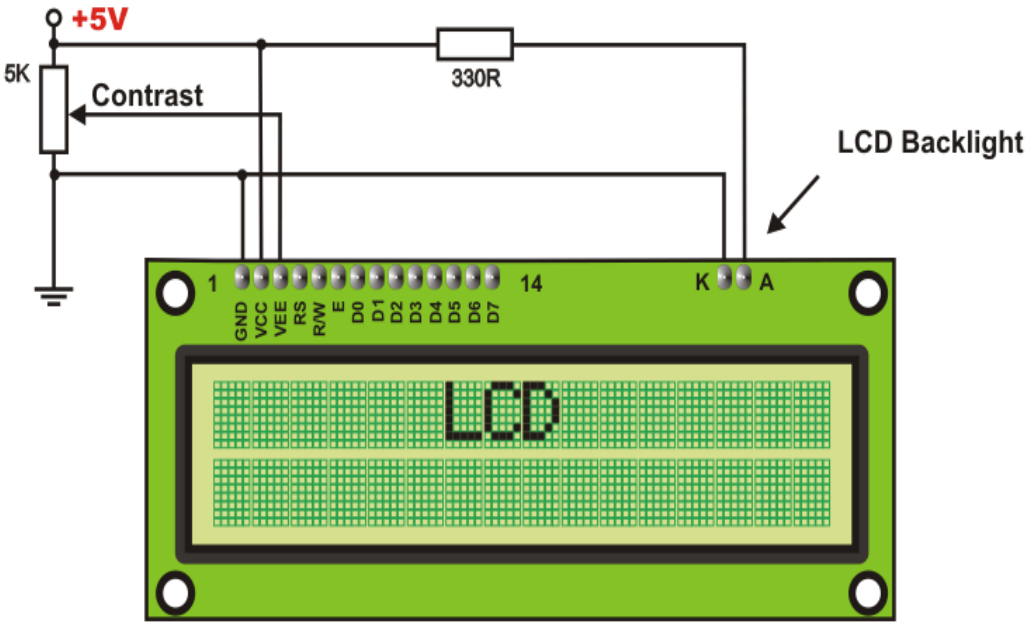


Figure 4.7: LCD Connections

LCD Initialization

- To instate LCD to the microcontroller the accompanying guideline and orders are to be insert into the capacities

- 0×38 is utilized for 8-bit information instatement.
- 0xFH for making LCD on and instating the cursor
- 0x6H for augmenting the cursor which will show another character in the LCD
- 0x1H for clearing the LCD.
- Sending information to the LCD: E=1; empower stick ought to be high
- RS=1; Register select ought to be high to write the information
- Placing the information on the information registers
- R/W=0; Read/Write stick ought to be low to write the information.

5.6ELECTROMECHANICAL RELAY

An electromechanical relay is a type of relay which function using a magnetic field produced by an electromagnetic coil when a control signal is applied to it. It is called as electromechanical since it has moving contacts in the output circuit which are operated by applying an electrical signal.

Working Principle

An electromechanical relay transfers signals between its contacts through a mechanical movement.It has three sections viz. *input section, control section*and *output section*.

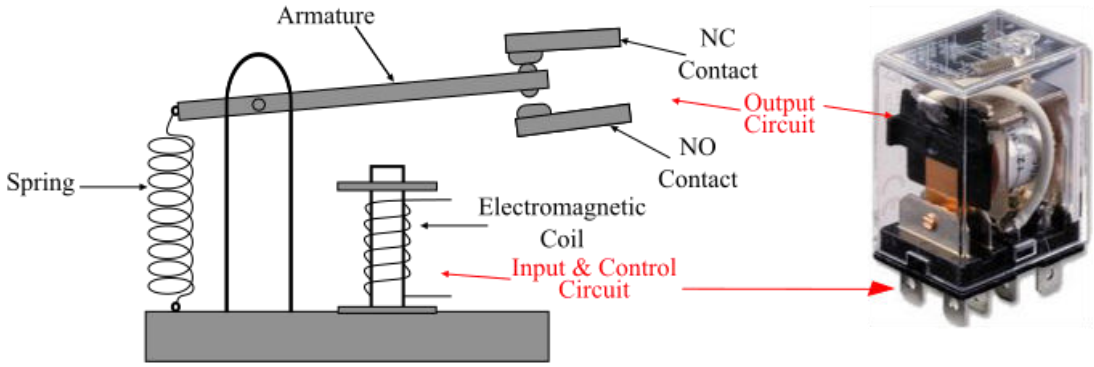


Figure4.8: Electromechanical Relay

The *input section consists* of input terminals where a small control signal is to be applied. The *control section* has an electromagnetic coil which gets energised when control input signal is applied to the input terminals and the *output*

section consists of an movable armature and mechanical contacts – movable and stationary, the movement of the armature makes or breaks the electrical circuit.

When an input control voltage is applied to the electromagnetic coil, it gets magnetized and the armature is attracted by the magnetic field produced by the coil. The movable mechanical contacts are attached to the armature, thus when the armature moves towards the electromagnet, the contacts close, making the output circuit switched on. When the control signal is removed, the armature comes back to its original position by the force of spring, making output circuit off.

The relay is the device that open or closes the contacts to cause the operation of the other electric control. It detects the undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area through ON or OFF.

LDR SENSOR

The controlling of lights and home appliances is generally operated and maintained manually on several occasions. But the process of appliances controlling may cause wastage of power due to the carelessness of human beings or unusual circumstances. To overcome this problem we can use the light-dependent resistor circuit for controlling the loads based on the intensity of light. An LDR or a photo resistor is a device that is made up of high resistance semiconductor material. This article gives an overview of what is LDR or light-dependent resistor circuit and its working.

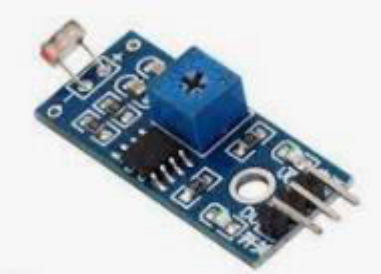


Figure 4.9 LDR Sensor

In electronic circuits, the LDR symbol is used that mainly depends on the resistor symbol; however, it illustrates the light rays in the arrows form. In this way, it follows the same principle which is used for phototransistor & photodiode circuit symbols wherever arrows are utilized to demonstrate the light dropping on these types of components.

Working Principle of Light Dependent Resistor

The working principle of an LDR is photoconductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the LDR, then the electrons in the valence band of the material are eager to the conduction band. But, the photons in the incident light must have energy superior to the bandgap of the material to make the electrons jump from one band to another band (valance to conduction).

Hence, when light having ample energy, more electrons are excited to the conduction band which grades in a large number of charge carriers. When the effect of this process and the flow of the current starts flowing more, the resistance of the device decreases.

4.8SUBMERSIBLE WATER PUMP

Most commonly,a submersible water pump is used as the heart of an aquaponics units submersible pump of its capacity would consume 25-50 W/h. A helpful approximation to calculate energy efficiency for submersible pumps is that a pump can move40 liters of water per hour for every watt per hour consumed, although some models claim twice this efficiency.

Figure 4.10:Submersible Water Pump

When designing the plumbing for the pump, it is important to realize that pumping per is reduced at every pipe.

Fitting: up to 5% of the total flow rate can be losses at each pipe connection when water is forced through.Thus, use the minimal number of connections between the pump and the fish tanks. It is also important to note that the smaller the diameter of the pipes,the larger the water flow loss.A 30mm pipe has twice the flow of a 20mm pipe even if served from pumps with same.

Motor Specifications

- Standard 130 Type DC motor.
- Operating Voltage: 4.5V to 9V.
- Recommended/Rated Voltage: 6V.
- Current at No load: 70mA (max)
- No-load Speed: 9000 rpm.
- Loaded current: 250mA (approx)
- Rated Load: 10g*cm.
- Motor Size: 27.5mm x 20mm x 15mm.

4.9 TEMPARTURE AND HUMIDITY SENSOR (DHT11)

Temperature sensor measures the temperature of the solar panel as we know the power generated by solar panel is directly related to temperature at the panel i.e if temperature is high at panel, then the voltage current generated is also more or vice versa. Therefore, measurement of temperature is necessary which is done by temperature sensor module dht11.

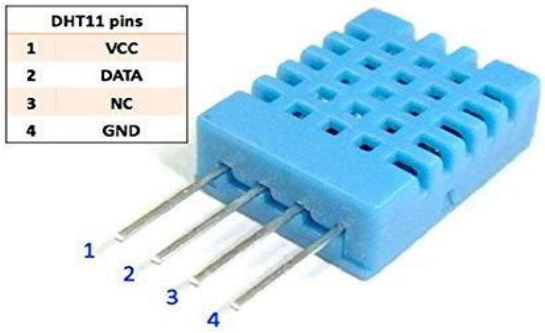


Figure 4.11: Temperature & Humidity Sensor

DHT11 Temperature and Humidity Sensor include a temperature and stickiness sensor complex with an adjusted computerized flag yield. By utilizing the selective advanced flag securing strategy and temperature and dampness detecting innovation, it guarantees high unwavering quality and astounding long haul soundness. This sensor incorporates a resistive-type moistness estimation part and a NTC temperature estimation segment, and interfaces with an elite 8-bit microcontroller, offering amazing quality, quick reaction, hostile to impedance capacity and cost-viability.

This unit is made up of temperature sensor. It is a linear sensor with sensitivity of 10mV per degree Celsius. Its voltage output is directly proportional to temperature.

The two parameters are related by the formula:

$$T = 100 \times V_{out}$$

Where, T = temperature in degree Celsius and V_{out} = Voltage in volts

For Measuring Temperature here, we have used temperature sensor that is gives 10 mV for every 1 degree Celsius. Circuitry is simple for this.

DHT11 Sensor Interfacing with NodeMCU

DHT11 sensor measures and provides humidity and temperature values serially over a single wire.It can measure the relative humidity in percentage (20 to 90% RH) and temperature in degree Celsius in the range of 0 to 50°C.It has 4 pins; one of which is used for data communication in serial form.

Pulses of different T_{ON} and T_{OFF} are decoded as logic 1 or logic 0 or start pulse or end of the frame. For more information about the DHT11 sensor and how to use it, refer to the topic DHT11 sensorin the sensors and modules topic.

Specifications

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

pH SENSOR:

pH measurements are predominantly conducted with pH-sensitive glass electrodes, which have, in general, proven satisfactory in measurements of pH. However, the behaviour of pH-sensitive glass electrodes often falls short of what precision is required. Even with the most careful treatment, the potential of cells containing glass electrodes often drifts slowly with time after such cells were placed in a new solution. Drift of cell potentials is an especially severe problem in investigations dependent on precise observation of small pH differences. Measurements involving cells with liquid junctions are subject to further uncertainties due to the dependence of liquid junction potentials upon medium concentration and composition and due to pressure changes in the system.

Figure 4.12: pH Sensor

Specifications of pH Sensor

Items	Values
Operating voltage	3.3V/5V
Range	0-14PH
Resolution	±0.15PH（STP）
Response time	＜1min
Probe Interface	BNC
Measure temperature	0-60℃
Internal resistance	≤250MΩ（25℃）
Alkali error	0.2PH（1mol/L）Na+，PH14）（25℃）

LED

LEDs are used in many places. They are the colored indicator lights on many electronic devices, they can be used to make bright advertising signs, brake lights on some newer cars, in TVs, and more recently, light bulbs for the home. White LEDs bright enough to illuminate rooms are usually more expensive than regular lightbulbs but they last longer and burn less electricity.

LEDs, which make their own light, should not be confused with LCDs, which block light. Some displays, however, mix the two technologies, using LEDs to backlight the LCD.

Today, some LEDs are surface-mount devices (SMD), so they can be very small.

CHAPTER 6
SOFTWARE DESCRIPTION

6.1 SOFTWARE REQUIREMENTS

Arduino 1.0.6 software tools used to program microcontroller. The working of software tool is explained below in detail.

Programming Microcontroller

A compiler for an abnormal state dialect decreases generation time. To program the Arduino UNO microcontroller the Arduino is utilized. The writing computer programs is done entirely in the installed C dialect. Arduino is a suite of executable, open-source programming advancement devices for the microcontrollers facilitated on the Windows stage.

Arduino is a device for appearing well and good and control a greater amount of the physical world than your desktop PC. It's an open-source physical registering stage in view of a straightforward microcontroller board, and an improvement domain for composing programming for the board.

One of the challenges of programming microcontrollers is the restricted measure of assets the developer needs to manage. In PCs assets, for example, RAM and preparing speed are essentially boundless when contrasted with microcontrollers. Conversely, the code on microcontrollers ought to be as low on assets as could reasonably be expected

Arduino Compiler

Get an Arduino board and USB cable:

You additionally require a standard USB link (An attachment to B plug): the kind you would associate with a USB printer, for instance. (For the Arduino Nano, you'll require an A to Mini-B link.)

Figure6.1: Arduino Board and USB Cable

Connect the board:

The Arduino Uno, Mega, Duemilanove and Arduino Nano consequently draw control from either the USB association with the PC or an outer power supply. In case you're utilizing an Arduino Diecimila, you'll have to ensure that the board is configured to draw control from the USB association.

The power source is chosen with a jumper, a little bit of plastic that fits onto two of the three sticks between the USB and power jacks. Watch that it's on the two sticks nearest to the USB port. Associate the Arduino board to your PC utilizing the USB link. The green power LED (named PWR) ought to go on.

Open the blink example

Open the LED blink example sketch: File > Examples >1.Basics> Blink**.**

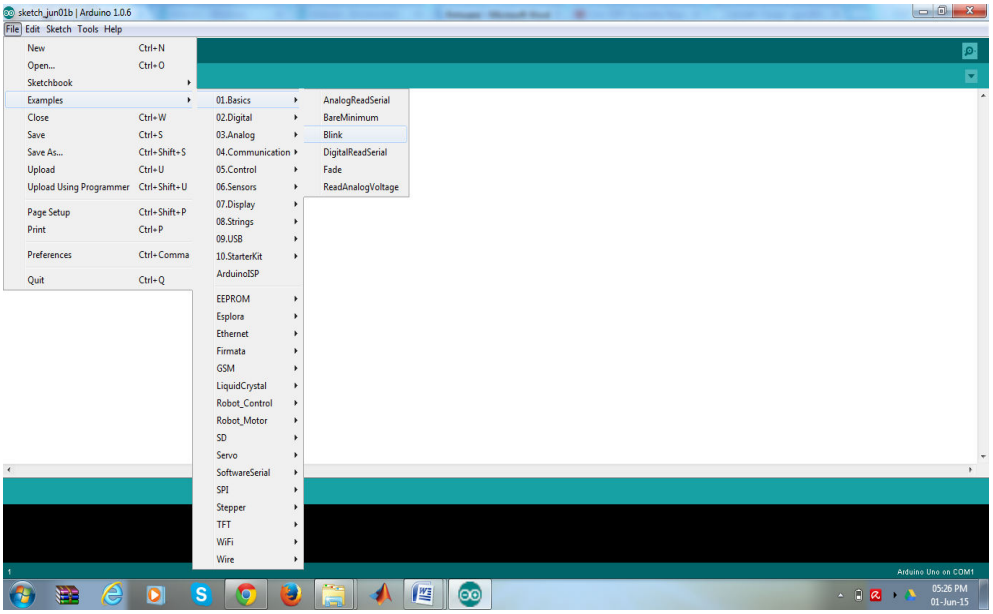


Figure6.2: Opening Blink Example

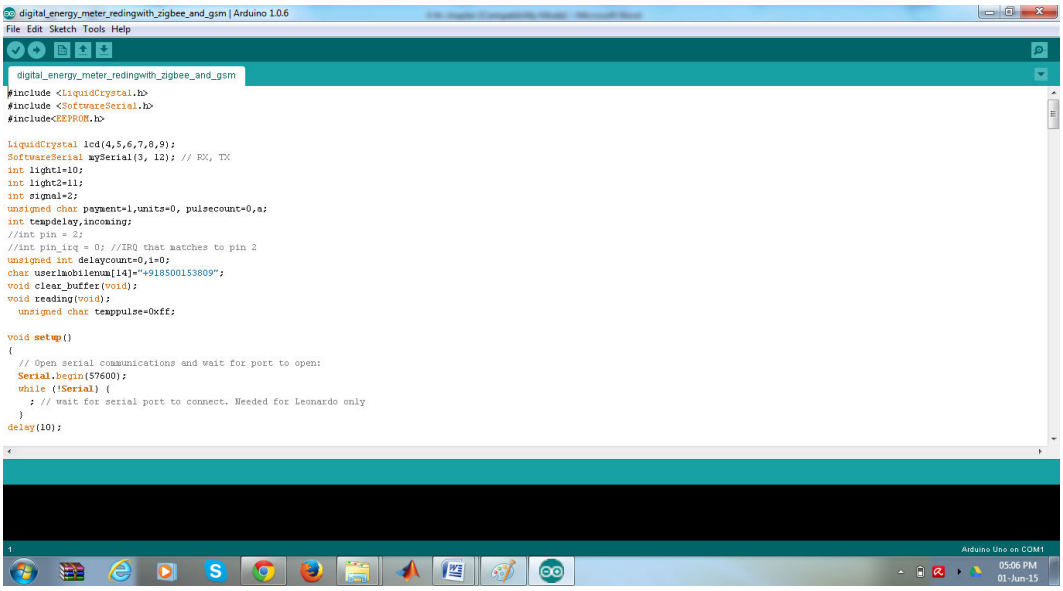


Figure6.3: Source Code Written in Arduino Compiler

Select your board:

You'll need to select the entry in the Tools > Board menu that corresponds to your Arduino.

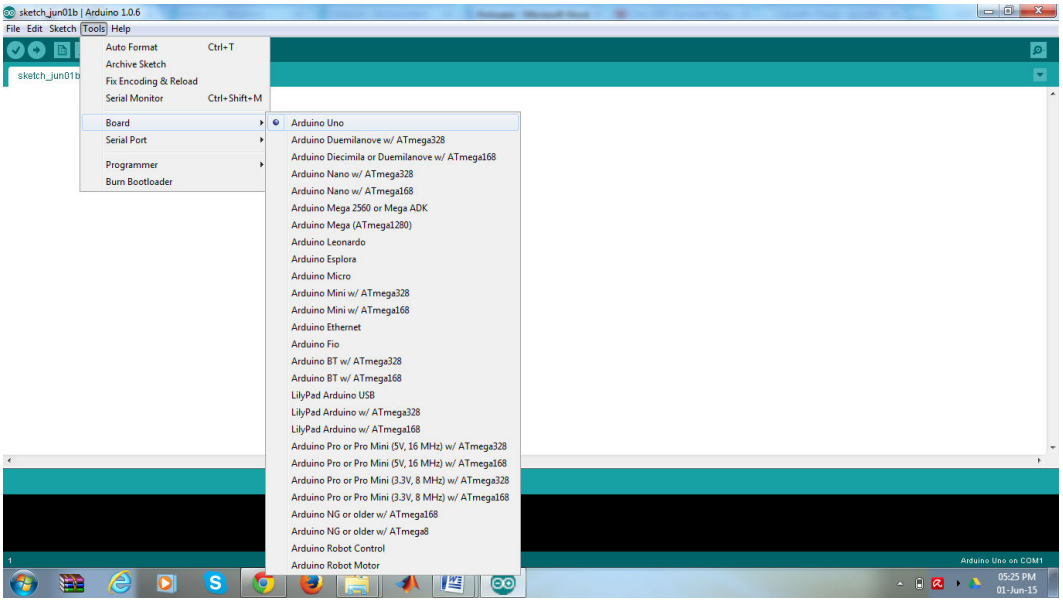


Figure6.4: Selecting an Arduino Uno

Writing Sketches:

Software written using Arduino are called sketches. These sketches are written in the text editor. Sketches are saved with the file extension.ino. It has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino environment including complete error messages and other information. The bottom right-hand corner of the window displays the current board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

NB: Versions of the IDE prior to 1.0 saved sketches with the extension.pde. It is possible to open these files with version 1.0, you will be prompted to save the sketch with the.ino extension on save.

	Check Checks your code for mistakes.
	Transfer Assembles your code and transfers it to the Arduino I/O board. See transferring beneath for subtle elements. Note: If you are utilizing an outer software engineer, you can hold down

	the "move" key on your PC when utilizing this symbol. The content will change to "Transfer utilizing Programmer"
	New Makes another draw.
	Open Presents a menu of all the representations in your sketchbook. Clicking one will open it inside the present window. Note: because of a bug in Java, this menu doesn't scroll; on the off chance that you have to open a portray late in the rundown, utilize the File | Sketchbook menu.
	Spare Recoveries your outline.
	SerialMonitor Opens the serial screen.

Table6.1: Writing Sketches

Extra charges are found inside the five menus: File, Edit, Sketch, Tools, Help. The menus are setting delicate which implies just those things applicable to the work as of now being done are accessible.

Select your serial port:

Select the serial gadget of the Arduino board from the Tools | Serial Port menu. This is probably going to be COM3 or higher (COM1and COM2 are typically saved for equipment serial ports). To discover, you can disengage your Arduino board and re-open the menu; the section that vanishes ought to be the Arduino board. Reconnect the board and select that serial port.

Upload the program:

Before transferring your portray, you have to choose the right things from the Tools > Board and Tools > Serial Port menus. The sheets are depicted beneath. On the Mac, the serial port is most likely something like/dev/tty.usbmodem241 On Windows, it's presumably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher

(for a USB board) - to discover, you search for USB serial gadget in the ports segment of the Windows Device Manager.

On Linux, it ought to be/dev/ttyUSB0,/dev/ttyUSB1 or comparable.

Once you've chosen the right serial port and board, press the transfer catch in the toolbar or select the Upload thing from the File menu. Current Arduino sheets will reset naturally and start the transfer. With more established sheets (pre-Diecimila) that need auto-reset, you'll have to press the reset catch on the board just before beginning the transfer. On most sheets, you'll see the RX and TX LEDs flicker as the portray is transferred. The Arduino condition will show a message when the transfer is finished, or demonstrate a blunder.

When you transfer a portray, you're utilizing the Arduino bootloader, a little program that has been stacked on to the microcontroller on your board. It enables you to transfer code without utilizing any extra equipment. The bootloader is dynamic for a couple of moments when the board resets; at that point it begins whichever outline was most as of late transferred to the microcontroller. The bootloader will squint the on-board (stick 13) LED when it begins (i.e., at the point when the board resets).

Presently, just tap the "Transfer" catch in the earth. Hold up a couple of moments - you should see the RX and TX leds on the board blazing. In the event that the transfer is fruitful, the message "Done transferring." will show up in the status bar. (Note: If you have an Arduino Mini, NG, or other board, you'll have to physically exhibit the reset catch on the board promptly before squeezing the transfer catch.)

Figure6.6: Compilation under Process

A couple of moments after the transfer completes, you should see the stick 13 (L) LED on the board begin to flicker (in orange). In the event that it does, congrats! You've gotten Arduino up-and-running.

6.2 UBI DOTS CLOUD:

The basics components of any Internet of Things application powered by Ubidots are: Devices, Variables, Synthetic Variables Engine, Dashboards, and Events.

Once your devices, variables, and general Application is assembled, give your App some layers with Ubidots Device Management to learn more about Ubidots internal architecture and how you can use Apps, Organizations, and Users to efficiently connect your data with those who should be using it.

1. Devices

A Ubidots' device is a virtual representation of a data-source or simply, an asset taking sensor data and transmitting said data through a connection protocol to Ubidots' cloud.

For current firmware examples and tutorials for connecting your device to Ubidots.

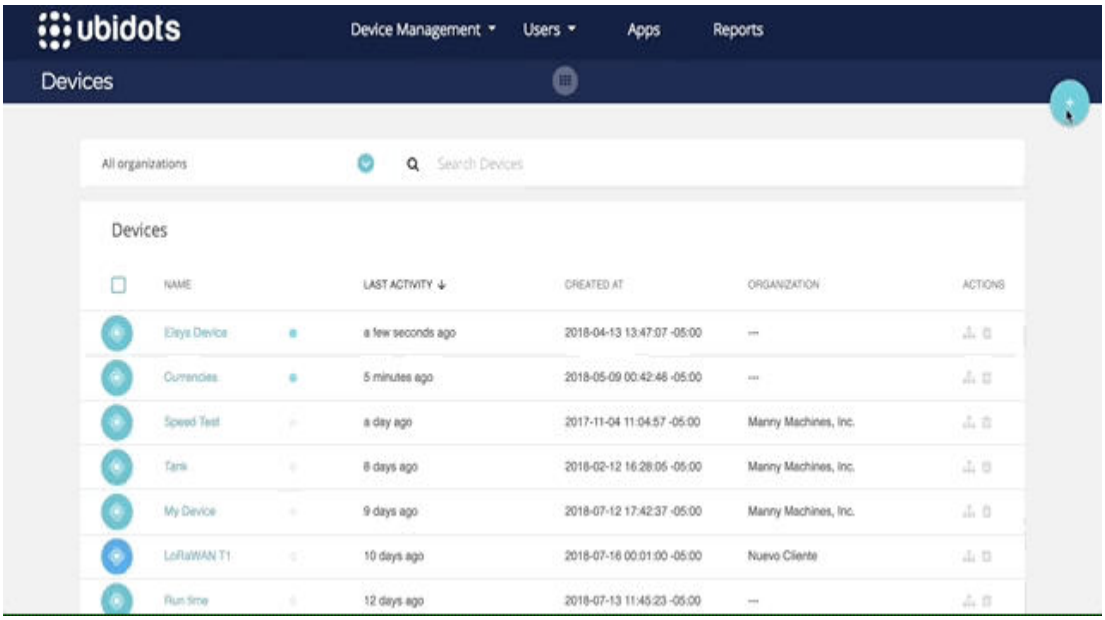
All devices are different, but the standard setup on any device entails:

- A library that should be installed in the device's IDE. (Not required)
- Filling parameters for authentication and connection such as a TOKEN (i.e. the unique ID for each account or user), device and variable labels (i.e. devices and variables unique identifiers in Ubidots), Wi-Fi SSID and Password, depending on the device and the requirements.
- Making API request (i.e., a call from a device to the web server). Ubidots' libraries spare the need to manually make these requests. However, if you're working with a device not currently in the list of supported hardware, you can choose a connectivity protocol such as MQTT or HTTP and make a request using the API accordingly.

Creating devices: There are three ways to create devices:

1. Devices are created automatically in Ubidots the first time a dot is received to a user's private TOKEN or an Organizational TOKEN.
2. Clicking the "+" icon in the top right corner of any single device's screen.

3. Creating a Device Type which then creates a new device with pre-determined device properties, appearance, and variables and automate the on-boarding of thousands of devices.



2. Variables

Once a device is created and receiving data from your hardware or another 3rd party data-source, the data will be presented in its raw or calculated form as a variable.

Types of Variables:

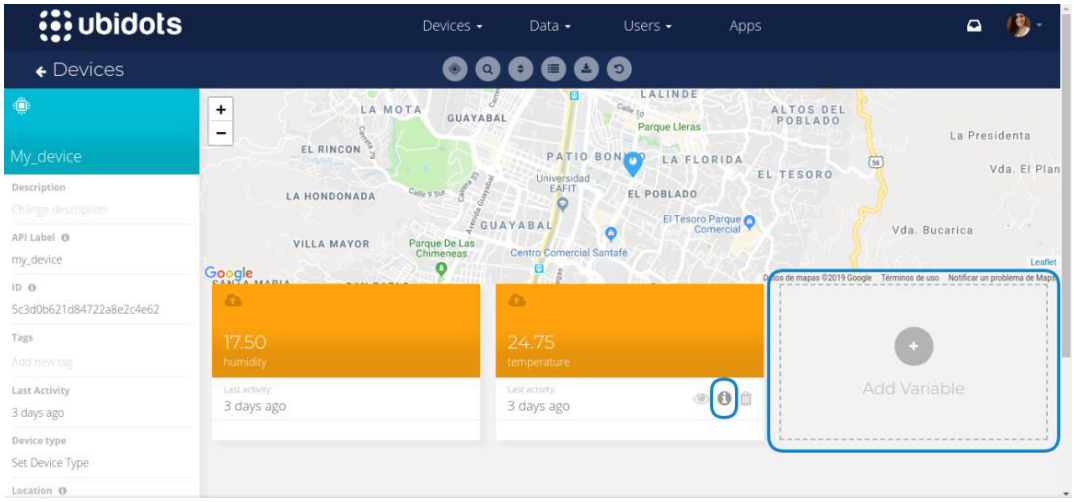
Default - raw data coming from devices (people counted).

Synthetic - correspond to statistical or arithmetical operations of default variables in a determined time-frame (e.g., average daily traffic this month).

Below you can read more about synthetic variable setups.

Creating variables: there are two ways to create variables.

1. Assigning a label as a variable within your hardware's code.
2. Clicking the "+" icon found in any single device screen and assign a name which will also correspond to the variable's label. By default, Ubidots assigns an additional unique identifier to the variable called Variable ID. To find both the variable's ID and variable's label, select the "i" icon form the variables card.

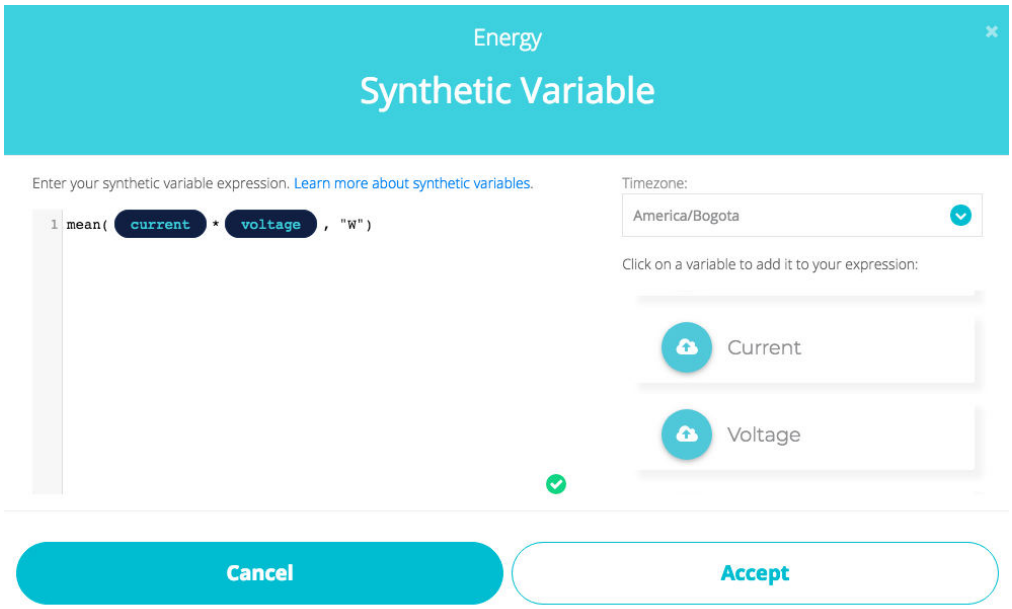


3. Synthetic Variables Engine

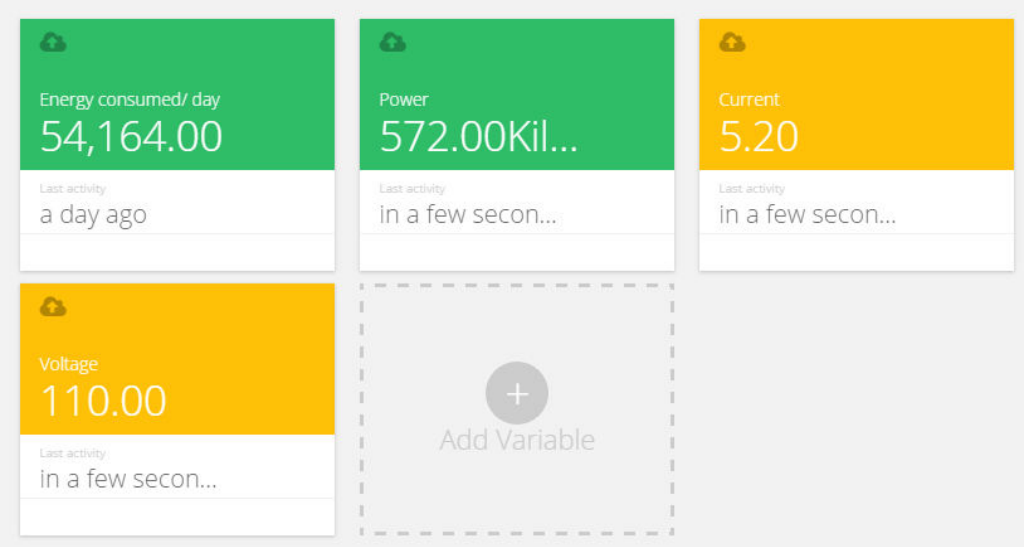
Ubidots Synthetic Variables (SV) Engine is a simple and effective way to create insights from the raw data stored in Ubidots' Cloud. Using Ubidots SV Engine, users can create Synthetic Variables that calculate and enhance data to give data-driven decision to user of an Ubidots powered application.

For example, to calculate Average (mean) Energy consumed this week, we will need to create a synthetic variable called Energy to calculate the product of Current and Voltage (P=C*V): the default variable Current is multiplied by Voltage. Then average the product every week with built-in function *mean()*.

Synthetic Variables Analytics



Here is a complete list of available functions, such as cos(x) or ceil(x) functions, and more!



Note that default variables are yellow, and Synthetic Variables are green.

4. Dashboards and Visualizations

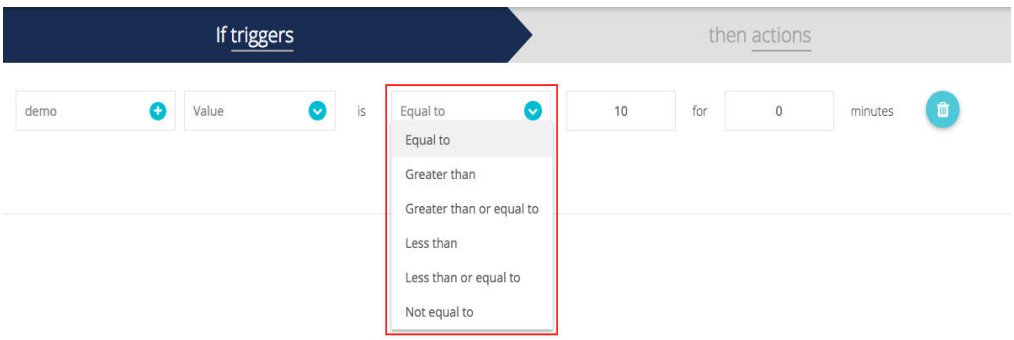
Dashboards are the human-machine interfaces where data is easily visualized. Your Ubidots account will let you create as many dashboards as needed, containing widgets and data-visualizations to comprehend your data at a glance. For additional details on your dashboard's construction, check out this tutorial.

5. Events

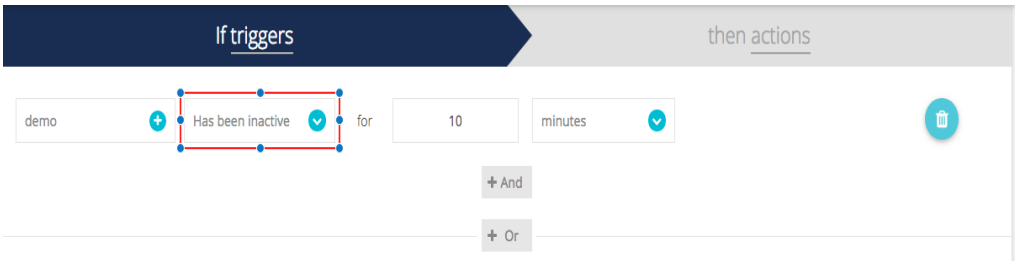
In Ubidots, Events are messages triggered and delivered through Email, SMS, Telegrams, Slack, Voice Call or webhook messages based on a customized design rule created in the application. If you wish to create alerts for your IoT application, check out this tutorial for additional support.

Three Event types:

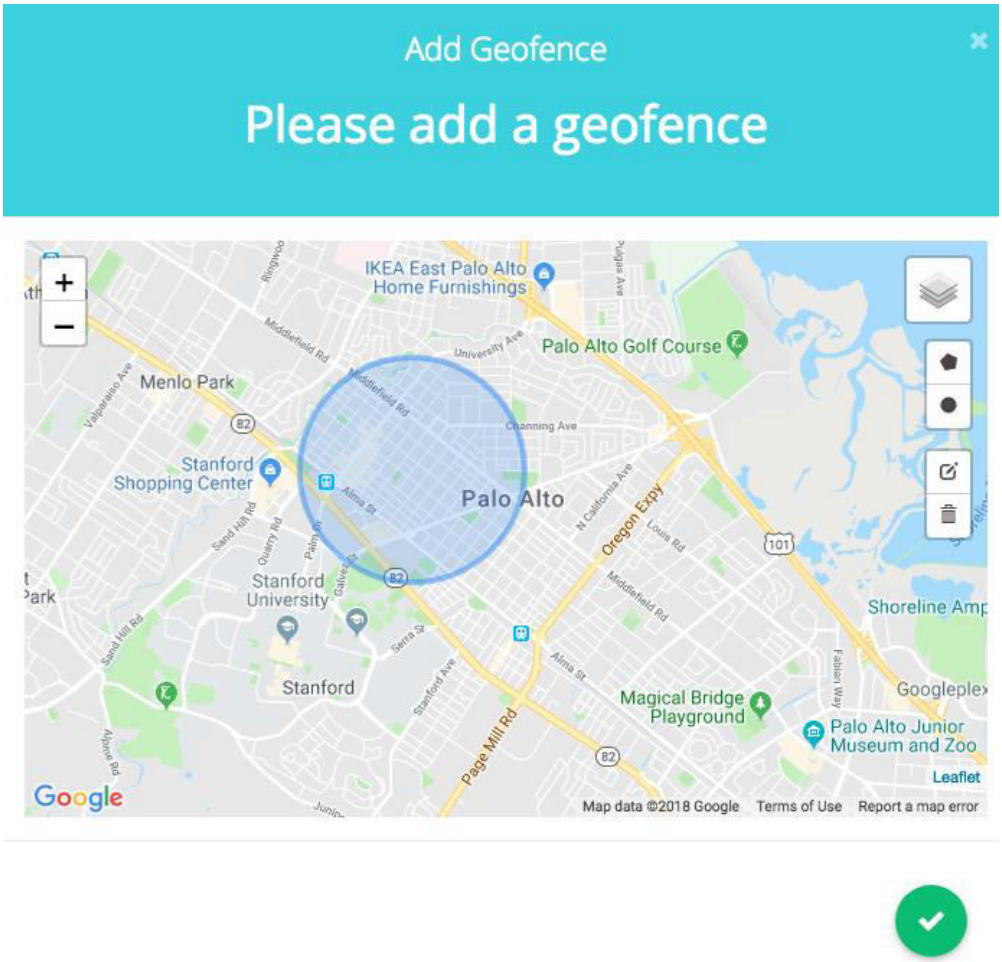
- When sensor readings reach a specific value:



- Variable is inactive during a specific amount of time:



- When a device enters or exits a specific area (geofence):



CHAPTER 6

ADVANTAGES AND APPLICATIONS

6.1 ADVANTAGES

- All natural fertilizer source from fish waste.
- Efficient, sustainable and high productive.
- Produces both protein and nutritious vegetable crop.
- Eliminating soil eliminates soil borne diseases.

6.2 APPLICATIONS

- Farming Technique
- Environmental Technique
- Health & Nutrition:

CHAPTER 7

RESULTS & DISCUSSION

The existing problems seen in the traditional aquaponics system can be detached by the introduction of electronic approach in the system. And this can encourage people to produce organic and healthy plants for daily use or consumption in their own household. For this project, the setup of an aquaponics system consisting of fish tank and grow bed for plants was done. Then, a monitoring section was established in order to detect the water level, pH value, temperature and humidity of aquaponics system by the use of Ultrasonic sensor, pH sensor module and Temperature and Humidity sensor (DHT11) respectively. All these sensors were interfaced to the Raspberry Pi microcontroller. Then finally the system parameters were displayed through Liquid Crystal Display and Internet of Things successfully. Also, a relay has been used for light controlling feature. Raspberry Pi has allowed the system to be Internet of Things based. By the application of Internet of Things in this system, it has been possible to view the readings from anywhere in the world and also it provided the graphical and analytical view of the system parameters which define the IoT Based Aquaponics Monitoring System.

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