iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** X **Month of publication:** October 2020

DOI: https://doi.org/10.22214/ijraset.2020.31969

A Fully Autonomous Industrial Automation by Edge Computing using Raspberry pi

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Abstract: The autonomous industrial automation using Edge computing describes the collection and processing of machinery data from the sensors attached to the huge industrial plants without the need of cloud or remote computers involved. The collected sensor data will be processed on board at the device itself and the decision will be taken based on the prewritten algorithms without waiting for any human interventions in the emergency situation without wasting time on human involved analysis for the betterment and improvement of security and safety at the highly hazardous manufacturing plants. The hardware platform to implement the project consists of a different sensors and Raspberry Pi 3 Model B equipped in a way to communicate with a centralized gateway through the Hybrid connectivity. In the recent years though the IoT devices and usage is increasing yet the cost of implementation and maintenance in cloud is hefty and still it needs some human interventions at some point to take any critical decisions based on any custom alerts or by monitoring a customized dashboard on 24x7. That is due to the separation of the data collection and data processing in the current model. The data will be transmitted from the device to a local gateway at some remote place and from there it needs to be sent to a cloud server and there the processing needs to be done and based on the outputs certain decisions has to be made. Even though these all were done in few seconds still it is not real time and there will be some latency issues in it. Thus, it might cause a lot of issues or lose of human life as well when working in some hazardous places like chemical manufacturing or something which involves lots of temperature or explosive based things. Since we have lot of computation power in the IoT boards which were attached to the machines but we are not utilizing it. The edge computing will utilize the on-board processing capabilities wisely and will take decisions on time without any human interventions.

Keywords: Edge Computing, Raspberry PI, Industry 4.0, Internet of Things (IOT), Aws Green Grass

I. INTRODUCTION

The Internet of Things is a rising topic of social, economic and technical significance. Internet of Thing using sensors, Processors and Microcontrollers with accessories used for communication through the internet and becoming the constitutive part of the Internet, it is built with a suitable protocol which helps the interacting and communicating with each other and with the users respectively. This communication through the internet helps to find many applications which are developed based on IoT technology in which every physical object like sensor devices are connected to the internet. Industrial automation plays a major role in the Internet of things which reduces the risk and wastages faced by industries and employees.

There are some highly toxic or explosive chemicals will be used in the manufacturing or industries which needs to be maintained under a specific temperature or vice versa. Using the current IoT methods we can detect a gas leak or temperature rise using certain sensors but which needs to be transmitted to a cloud or remote server and processed there and then only we can see that it has been reached a dangerous level and then some human has to go and make necessary changes to cool than the situation. Whereas in the edge computing method the data will be processed on the device it self and simple logic would trigger a message or alert to another device which is attached to a power or control unit and immediately it starts the cool down process which might save a lot of time and lives

II. LITERATURE SURVEY

1) *Edge Computing from Hype to Reality:* In[1] M. Abu Sharkh *et al.*, proposed Industry 4.0 can be conceptually viewed as embracing and infusing the core ideas of mist computing in the factory with the goal of gaining operational and performance efficiencies through rapid and precise decision-making for automated devices in the factory environment.it is based on cyber-physical systems achieved through complete and seamless digitalization of the manufacturing industry
2) *Fog and Edge Computing Principles and Paradigms:* In[2] Albert Y. Zomaya et al., proposes the notion of having computational resources near the data sources. Thus, the large supply chain industry can be benefited very highly where lots of possibilities for error prune to human interventions and the edge could resolve almost 90% of them in real time.

3) *Industry 4.0 – A Glimpse:* Saurabh Vaidya et al proposed the discovery of new technologies has made industry development from the early adoption of mechanical systems, to today's highly automated assembly lines, in order to be responsive and adaptive to current dynamic market requirements and demands. Challenges like embedment, predictability, flexibility and robustness to unexpected conditions. There are some challenges and fundamental issues occurs during the implementation of industry 4.0 in the current manufacturing industries are given as Intelligent Decision-Making and Negotiation Mechanism: In smart manufacturing system needs more autonomy and sociality capabilities as key factors of self-organized systems whereas the today's system has 3C Capabilities i.e. lack of autonomy in the systems. Manufacturing Specific Big Data and Analytics: It is a challenge to ensure high quality and integrity of the data recorded from manufacturing system. The annotations of the data entities are very diverse and it is an increasing challenge to incorporate diverse data repositories with different semantics for advanced data analytics grouped and worked together for distributed decision making.
4) *Combining Edge Computing and Blockchains for Flexibility and Performance in Industrial Automation:* In[4] Mauro Isaja *et al.*, presents the vision of future manufacturing foresees flexible and hyper-efficient plants that will enable manufacturers to support the transition from conventional "made-to-stock" production models, to the emerging customized ones such as "made-to-order", "configure-to-order" and "engineering-toorder". Flexibility in automation is a key prerequisite to supporting the latter production models, as it facilitates manufacturers to change automation configurations and rapidly adopt new automation technologies, as a means of supporting variation in production without any essential increase in production costs.
5) *Edge Computing Applied to Industrial Machines:* In[5] Anderson Carvalho *et al*., presents the many advanced segments like the self-driving cars industry, artificial intelligence and neural networks are becoming present in more common places like farms and industrial plants. This in association with the increasing adoption of small computational units for edge computing enables new solutions to control machinery, robots or to perform data analysis as presented earlier on. The presented findings point that the conversion of existing machines to smart machines are feasible running some of the presented techniques on edge devices. Future works will be more specific regarding the ideal architecture for this solution and will present some practical examples to help the reader to understand the research targets.
6) *Influence of Industrial Internet of Things on Mechatronics:* In[6] Stevan Stankovski *et al.*, presents the paper IIoT has different interaction between things and a variety of levels. Industrial communication is much more complex then office communication. It is not only one type of network and one type of protocol that is used. It can be very simple like an AS-i network which needs only one cable to connect to the sensors and actuators, the input and output modules from any manufacturer.
7) *Edge Computing for Fault Detection in Smart Systems:* Increasing the performance of all computing components enables the development of new architectures and platforms for data processing, sharing, distribution and storage of data. Speed, security and reliability of data transmission are essential parameters in industrial automation In[7] Gordana Ostojić present the Speed, security and reliability of data transmission are essential parameters in industrial automation and therefore only those architectures/concepts that successfully meet these parameters have a chance to succeed in an industrial environment, especially in the concept of Industry 4.0. The term Industry 4.0 symbolizes the concept of a Fourth Industrial Revolution.
8) *Heating Circulation Pump Disassembly Process Improved With Augmented Reality:* In[8] Srñan S. TEGELTIJA presents disassembly sequences are different for each type of product it is essential to supply disassembly workers with relevant information as efficiently as possible at the corresponding location and at the right time. Several methods and technologies have been used to achieve this goal like: Petri net, Monte Carlo method, barcode, RFID and others. Augmented Reality (AR) is a new concept that can also help in supplying workers with relevant information in real time.

A. Survey Of The Existing Work

The machinery will be fitted with a sensor or IoT device which will transmit the data to a local gateway and then the gateway will transmit the data to a cloud or remote system where the actual processing, cleaning and storage will be happening.

There are numerous issues in these methods.

If the device fails to communicate to the local gateway or the gateway fails to transmit the records to the remote server due to network or power outages that happens frequently in industrial places Since they were isolated in outer places. This situation might be a cumbersome process for a remote processing model where the accuracy and latency is always traded off.

The Existing system can be successfully deployed to collect and store the data for a future processing and

For historical maintenance but it lacks the efficiency to act as a real time monitoring system. There has to be someone monitoring the reports always and alert the respective team or people to rectify an error or correction in any system manually.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue X Oct 2020- Available at www.ijraset.com

B. Survey of Proposed Systems/Technologies

The new system will utilize the processing capacity of the on board IoT devices to take decisions without any human interventions. This model doesn't need an internet or any kind of network connectivity. The IoT boards were preconfigured to monitor a sensor reading and the actions needed to be performed in case of the low- or high-level reading from respective sensors. This method will be very useful for a quick and autonomous activity of the IoT devices known as edge computing.

III. REQUIREMENT ANALYSIS

The connected things can be managed from a centralized console like aws green grass core. Where we can add and deploy new devices or change the functions and trigger it. Whenever the devices come in contact with internet they will sync with the latest updates and changes done in cloud and follow new instructions. Thus, the devices can act independently without any dependencies or can form a group of devices to communicate with the use of LAN to exchange information between them.

A. Hardware And Software Requirements

1) Hardware Requirements

Processor	x64 Compliant Processor
RAM	4 GB RAM is Recommended
Storage (HDD/SSD)	500 MB Minimum
Network	Any standard, Gigabit Ethernet NIC

2) Software Requirements

Operating System	Raspian Os
Framework	Raspberry pi
Device Version	Raspberry pi 3 B
Language	Shell script, Python 3

3) AWS Green Grass

Service	IoT Greengrass core
Cloud Resources	Security Group for SSH, S3, lambda

B. Users And Use Case Descriptions

1) *Cloud Console:* The devices can be created and mapped in AWS green grass core and can be controlled and deploy new changes using the lambda functions from the cloud which will be downloaded to device when it comes in contact with the cloud console.
2) *IoT Device:* The device will keep on monitoring the sensors and perform the current programmed tasks and also keeps checking the cloud server for a new rules or changes to pull from there and update in OTA.

IV. SYSTEM DESIGN

A. Proposed System Architecture On Cloud

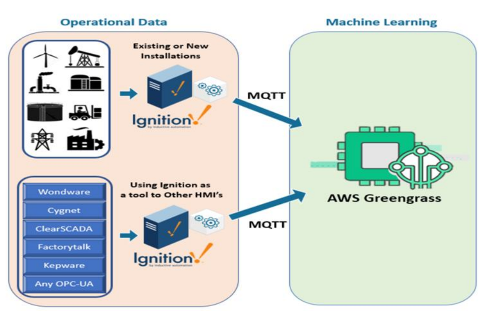

Fig 4.1 Proposed System Architecture On Aws

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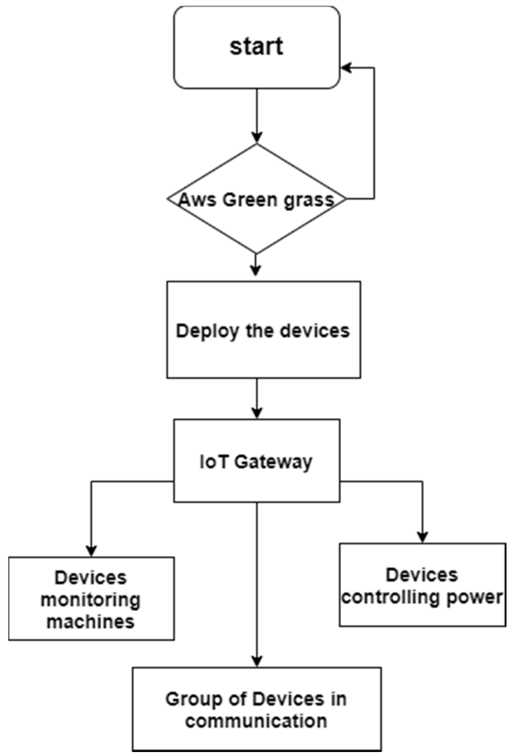
B. *Procedure Design*

Dataflow Diagram



V. IMPLEMENTATION AND TESTING

A. *Implementation Environment*

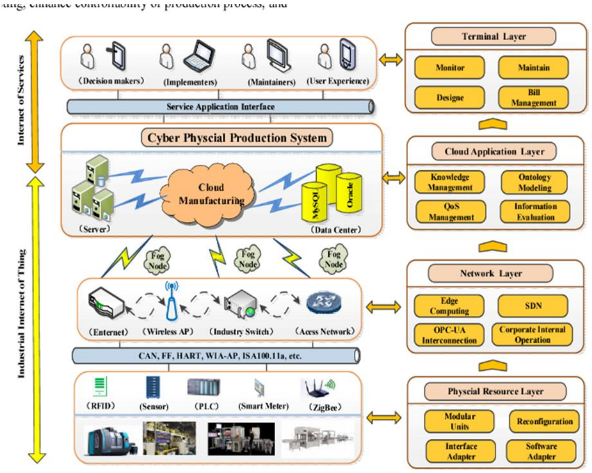


Fig. 1 Hierarchical architecture of smart factory

The 'Thing' in IoT can be any device with any kind of built-in-sensors with the ability to collect and transfer data over a network without manual intervention. The embedded technology in the object helps them to interact with internal states and the external environment, which in turn helps in decisions making process.

In a nutshell, IoT is a concept that connects all the devices to the internet and let them communicate with each other over the internet. IoT is a giant network of connected devices – all of which gather and share data about how they are used and the environments in which they are operated.

A developer submits the application with a document containing the standards, logic, errors & exceptions handled by him to the tester. Again, if there are any issues Tester communicates it back to the Developer. It takes multiple iterations & in this manner a smart application is created.

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Similarly, a room temperature sensor gathers the data and send it across the network, which is then used by multiple device sensors to adjust their temperatures accordingly. For example, refrigerator's sensor can gather the data regarding the outside temperature and accordingly adjust the refrigerator's temperature. Similarly, your air conditioners can also adjust its temperature accordingly. This is how devices can interact, contribute & collaborate.

B. Module Description

1) *Cloud Stage:* The sensors system is used to obtain the information or readings from the machinery and the reading which is read is converted into signals. These signals are provided for processing to Raspberry Pi, which is the IoT module. The Pi then displays the information on a Monitoring dashboard and also stores the information over the cloud. This information can be accessed by the engineers on his phone/computer and get the information. If any emergencies, the workers are sent an alert automatically through the Alarm and shutdown the faulty machine. The sensors value is read and displayed on the monitor and stored in the cloud for future use. It also shows graphical use of the sensors so we can predict for the further problems.
2) *Client Stage:* FULL devices suite will be attached to a manufacturing machines and configured to control them in case of any emergency. So, A device monitoring system consists of several sensors connected to a machine and they communicate the data through the processing unit. In the project, Raspberry Pi is used as a data aggregator as well as a processor. The cloud and local centers with trained professionals are used for monitoring.

VI. FRONTENDCONFIGURATION

A. Raspberry PI SBC

The Raspberry Pi is known as a single- board computer, which means exactly what it sounds like: it's a computer, just like a desktop, laptop, or smartphone, but built on a single printed circuit board. Like most single-board computers, the Raspberry Pi is small – roughly the same footprint as a credit card – but that doesn't mean it's not powerful: a Raspberry Pi can do anything a bigger and more power-hungry computer can do, though not necessarily as quickly.

All Raspberry Pi models have one thing in common thing. they're compatible, meaning that software written for one model will run on any other model. It's even possible to take the very latest version of the Raspberry Pi's operating system and run it on an original pre-launch Model B prototype. It will run more slowly, it's true, but it will still run.

Fig 6.1.1 Raspberry Pi kit

Fig 6.1.2 Raspberry pi's system-on-chip

Raspberry Pi is made up of various different components, each of which has a role to play in making it work. The first, and arguably most important, of these can be found just above the center point on the top side of the board (Figure 1-2), covered in a metal cap: the system-on-chip (SoC).

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The name system-on-chip is a great indicator of what you would find if you pressed the metal cover off: a silicon chip, known as an integrated circuit, which contains the bulk of the Raspberry Pi's system. This includes the central processing unit (CPU), commonly thought of as the 'brain' of a computer, and the graphics processing unit (GPU), which handles the visual side of things.

Fig 6.1.3 Random Access Memory (RAM)

A brain is no good without memory, however, and on the underside of the Raspberry Pi you'll find exactly that: another chip, which looks like a small, black, plastic square (Figure 1-3). This is the Pi's random-access memory (RAM). When you're working on the Pi, it's the RAM that holds what you're doing; only when you save your work will it be written to the microSD card. Together, these components form the Pi's volatile and non- volatile memories: the volatile RAM loses its contents whenever the Pi is powered off, while the non-volatile microSD card keeps its contents.

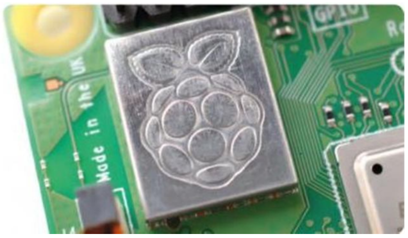
Fig 6.1.4 WIFI & Radio module

Turning the board over again you'll find another metal lid to the upper-right, this one featuring an etched Raspberry Pi logo (Figure 1-4, overleaf). This covers the radio, the component which gives the Raspberry Pi the ability to communicate with devices wirelessly. The radio itself acts as two main components, in fact: a WiFi radio, for connecting to computer networks; and a Bluetooth radio, for connecting to peripherals like mice and for sending data to or receiving data from nearby smart devices like sensors or smartphones.

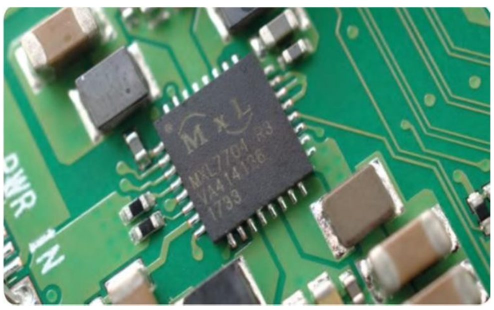

Fig 6.1.5 power management integrated circuit (PMIC)

Another black, plastic-covered chip can be seen to the bottom edge of the board, just behind the middle set of USB ports. This is the network and USB controller, and is responsible for running the Ethernet port and the four USB ports. A final black chip, much smaller than the rest, can be found a little bit above the micro USB power connector to the upper-left of the board (Figure 1-5); this is known as a power management integrated circuit (PMIC), and handles turning the power that comes in from the micro USB port into the power the Pi needs to run.

Fig 6.1.6 Raspberry pi's USB ports

The Raspberry Pi has a range of ports, starting with four Universal Serial Bus (USB) ports (Figure 1-6) to the middle and right-hand side of the bottom edge. These ports let you connect any USB- compatible peripheral, from keyboards and mice to digital cameras and flash drives, to the Pi. Speaking technically, these are known as USB 2.0 ports, which means they are based on version two of the Universal Serial Bus standard

Fig 6.1.7 Ethernet port

To the left of the USB ports is an Ethernet port, also known as a network port (Figure 1-7). You can use this port to connect the Raspberry Pi to a wired computer network using a cable with what is known as an RJ45 connector on its end. If you look closely at the Ethernet port, you'll see two light- emitting diodes (LEDs) at the bottom; these are status LEDs, and let you know that the connection is working.

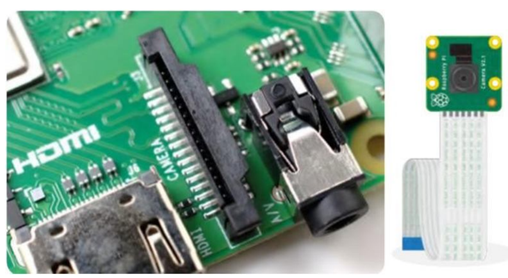

Fig 6.1.8 Camera Connector

Directly above the 3.5 mm AV jack is a strange-looking connector with a plastic flap which can be pulled up; this is the camera connector, also known as the Camera Serial Interface (CSI) (Figure 1-9). This allows you to use the specially designed Raspberry Pi Camera Module (about which you'll learn more in Chapter 8, The Raspberry Pi Camera Module.)

Fig 6.1.9 Micro USB power port

Above the HDMI port is a micro USB power port (Figure 1-11), which you'll use to connect the Raspberry Pi to a power source. The micro USB port is a common sight on smartphones, tablets, and other portable devices. So you could use a standard mobile charger to power the Pi, but for best results you should use the official Raspberry Pi USB Power Supply.

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Fig 6.1.10 HDMI port

Above that, still on the left-hand edge of the board, is the High-Definition Multimedia Interface (HDMI) port (Figure 1-10), which is the same type of connector you'll find on a games console, set-top box, and TV. The multimedia part of its name tells you that it carries both audio and video signals, while high-definition tells you that you can expect excellent quality. You'll use this to connect the Raspberry Pi to your display device, whether that's a computer monitor, TV, or projector.

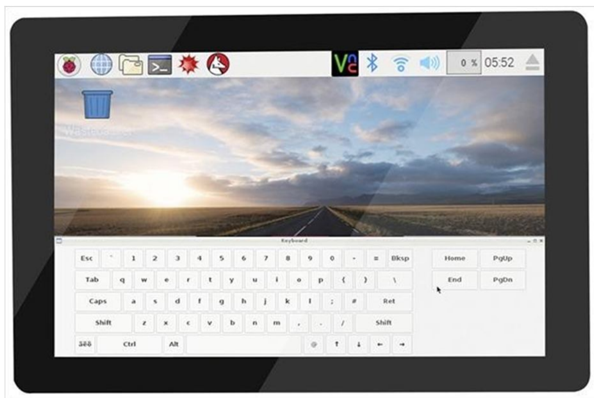

Fig 6.1.11The Raspberry Pi Touch Display

B. PIC Microcontroller Based Heat and Temperature sensor Suite

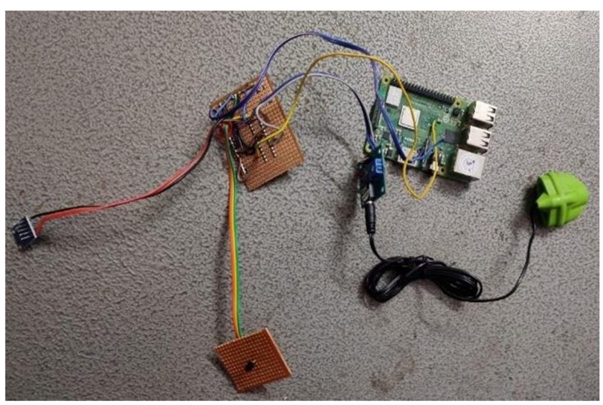

Fig 6.2.1 Kit Implementation based Heat and temperature monitoring

The kit implementation for Heat and temperature Monitoring System is shown in the figure 6.2.1.The Mouse and Keyboard The kit implementation for Heat and Temperature Monitoring System is shown in the figure.

The Mouse and Keyboard connected to the USB port of Pi and the Monitor connected to the HDMI video port. The sensors connected to the GPIO pin through which the data from the Pi is transferred to the server and the team can monitor the data on the monitor.

The device is connected to the required machine using the heat and temperature sensors and continuously monitors the readings for the safe level and for any anomaly. If the readings reaches any significant level of spikes then immediately the IoT device will shut down it or take proper action to save any accident or fire in the manufacturing.

1) *Heat Sensor – Working & Application*

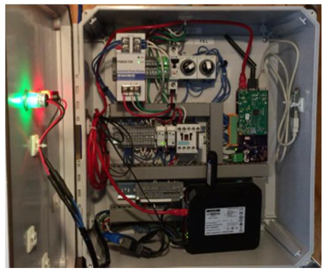

Fig 6.2.2 Heat and temperature Sensor

The main purpose of this automatic heat and temperature monitoring system is to monitor the gas and chemical temperature, room and certain machineries to prevent from fire accidents.

In all industries certain highly volatile chemical and gases were used for various purposes. These devices observe the temperature and heat waves. The engineers and other people from management staff keep a record of the historical temperature and readings of every plant and machines. Let us understand about its primary application by considering a project as a practical example with the help of a temperature sensor. Ammonium nitrate is a commonly used one and also highly flammable and can explode when introduced a heat and tightly closed area. By the proposed heat monitoring which is implemented to check the temperature of the pipes. The Zig Bee mesh protocol is used where the machine 24-hour reading records are being monitored and also looking for anomalies and maintained in the cloud. IoT empowered devices at the same time enrich the safety with regular monitoring and collection of data actively and moderate the cost of maintenance of the same.

2) *DHT11–Temperature and Humidity Sensor*

Pin Identification and Configuration: DHT11 Specifications

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

3) *DHT11 Equivalent Temperature Sensors:* DHT22, AM2302, SHT71
4) *Other Temperature Sensors:* Thermocouple, TMP100, LM75, DS18820, SHT15, LM35DZ, TPA81, D6T
5) *Difference between DHT11 Sensor and Module:* The DHT11 sensor can either be purchased as a sensor or as a module. Either way, the performance of the sensor is same. The sensor will come as a 4- pin package out of which only three pins will be used whereas the module will come with three pins as shown above. The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required.
6) *Where to use DHT11:* The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. So if you are looking to measure in this range then this sensor might be the right choice for you.
7) *How to use DHT11 Sensor:* The DHT11 Sensor is factory calibrated and outputs serial data and hence it is highly easy to set it up. As you can see the data pin is connected to an I/O pin of the MCU and a 5K pull-up resistor is used. This data pin outputs the value of both temperature and humidity as serial data. If you are trying to interface DHT11 with Arduino then there are ready-made libraries for it which will give you a quick start. If you are trying to interface it with some other MCU then the datasheet given below will come inhandy. The output given out by the data pin will be in the order of 8bit humidity integer data + 8bit the Humidity decimal data +8 bit temperature integer data + 8bit fractional temperature data +8 bit parity bit. To request the DHT11 module to send these data the I/O pin has to be momentarily made low and then held high as shown in the timing

8) *Applications*
a) Measure temperature and humidity
b) Local Weather station
c) Automatic climate control
d) Environment monitoring

9) *LM 35 Temperature Sensors:* The LM35 series are precision integrated- circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35D is rated to operate over a 0° to +100°C temperature range. Outputs 10mV per Degree that can also be read directly on multimeter or read in to microcontroller. For example at 30 degree celcius it will output 300mV at linear scale.

10) *Features*
a) Calibrated directly in Celsius (Centigrade)
b) Linear + 10.0 mV/ C scale factor
c) 0.5 C accuracy guaranteeable (at +25 C)
d) Rated for full -55 to +150 C range
e) Suitable for remote applications
f) Low cost due to wafer-level trimming
g) Less than 60 A current drain
h) Low self-heating, 0.08 C in still air
i) Nonlinearity only 1/4 C typical

C. Power Supply Definition

A power supply (sometimes known as a power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

1) *Power Supply Unit Block:* All digital circuits work only with low DC voltage. A power supply unit is required to provide the appropriate voltage supply. This unit consists of transformer, rectifier, filter and a regulator. AC voltage typically of 230Vrms is connected to a transformer which steps that AC voltage down to the desired AC voltage level. A diode rectifier then provides a full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a DC voltage. This resulting DC voltage usually has some ripple or AC voltage variations. Regulator circuit can use this DC input to provide DC voltage that not only has much less ripple voltage but also remains in the same DC value, even when the DC voltage varies, or the load connected to the output DC voltage changes. The required DC supply is obtained from the available AC supply after rectification, filtration and regulation. The main components used in the power supply unit are Transformer, Rectifier, Filter and Regulator. The 230V AC supply is converted into 9V AC supply through the transformer. The output of the transformer has the same frequency as in the input AC power. This AC power is converted into DC power through diodes. Here the bridge diode is used to convert AC supply to the DC power supply. This converted DC power supply has the ripple content and for normal operation of the circuit, the ripple content of the DC power supply should be as low as possible. Because the ripple content of the power supply will reduce the life of the circuit. So to reduce the ripple content of the DC power supply, the large value of capacitance filter is used. This filtered output will not be the regulated voltage. For this purpose IC7805 regulator IC is used in the circuit.
2) *Transformer:* Transformer is a device used either for stepping-up or stepping-down the AC supply voltage with a corresponding decreases or increases in the current. Here, a transformer is used for stepping-down the voltage so as to get a voltage that can be regulated to get a constant 5V.

3) *Rectifier:* A rectifier is a device like semiconductor, capable of converting sinusoidal input waveform units into a unidirectional waveform, with a nonzero average component.
4) *Filters:* Capacitors are used as filters in the power supply unit. The action of the system depend upon the fact, that the capacitors stores energy during the conduction period and delivers this energy to the load during the inverse or non-conducting period. In this way, time during which the current passes through the load is prolonged and ripple is considerably reduced.
5) *Voltage Regulator:* The LM78XX is three terminal regulator available with several fixed output voltages making them useful in a wide range of applications. IC7805 is a fixed voltage regulators used in this circuit.

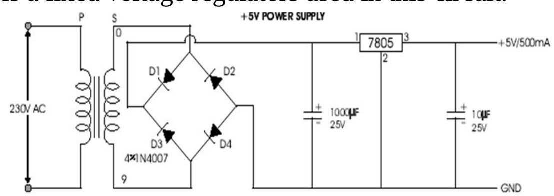

Figure 6.2.3 Five Volts Power Supply AWS Green Grass

AWS is the top most cloud provider of the modern era. AWS is not only providing the computations but also provides a wide array of services in the platform. The IoT core is one of it where the edge computing framework is name as a Green Grass Core. Which is the one controls the devices deployed in the on-premise manufacturing plants. It needs internet to deploy and only make change to device when it comes to contact using internet and when necessary. It also offers enormous features like device shadow, rules engine, ssl based security to make the life easier on the console to manage the devices. But it all were billed based on the usage hours.

6) *Purpose, Context And History:* The term “Internet of Things” (IoT), coined by Kevin Ashton in 1999 , has been in use for several years and continues to be of interest, specifically when it comes to technological progress. But what exactly is the IoT? Essentially, it refers to giving objects representation in the digital realm through giving them a unique ID and connecting them in a network . In other words, these things are connected to the internet and are able to automatically transfer data without relying on human interaction - hence being “Machine to Machine” (M2M) interaction. Essentially, M2M interaction enables networked devices to exchange data and perform actions without the input or assistance of humans, for instance in remote monitoring. Indeed, the lack of necessity for human intervention seems to conjure dystopian images of the future. But this is not necessarily the case. For instance, one can envision the IoT to become an important feature of the ‘home of the future’, where one can begin pre-heating the oven just before they get home from work via a (mobile) application. Or perhaps, automatically turning on the washing machine when the power grid has less load, as communicated by a remote power plant. Or, businesses can anticipate when a popular item is running low on stock due to notification from the shelves that they sit on. Hence, the IoT has many interesting applications that can be applied to both individuals and corporations. According to Dr. Lara Sristava, advisor to the European Commission, the IoT is predicted to become pervasive and as ubiquitous as the Internet today. Increasingly embedded processing power in objects will lead to increased embeddedintelligence in objects, consequently giving rise to the popular term of referring to such objects as “smart” . Objects will create their own content and merge with society. So this content will merge with user content, creating a semantic world informed by key patterns. These patterns will help us better leverage our increasingly large amount of available data. So in the absolute most general sense, the IoT can be thought of as creating intelligent devices that are interconnected with people and other devices. The type of device that is connected is only limited by the imagination of its creator. History The concept of the IoT, although uncoined at the time, has been in discussion since the early 1990s [20]. The notion was popularized by using it for market analysis at MIT’s Auto-ID center. Originally, the network was based on items tagged with “Radio Frequency ID” (RFID) chips, a technology which has already existed for half a decade. The first applications were to use RFID chips in inventory management, from the facilitation of routing to loss prevention. Over time, technologies developed and other methods of networking objects emerged such as using bar- codes, “Quick Response” (QR) codes, digital watermarking and ”Near Field Communication” (NFC). As costs lowered for the technologies to make objects “smart”, an increased amount of applications for networking objects came to be. These applications included connecting objects for surveillance and security. It was also applied in other industrial uses such as transport, food safety and document management. As a relatively ‘new’ web technology, the timeline for the IoT looks quite sparse:

a) *1991:* Concept realized
b) *1999:* Term "Internet of Things" coined
c) *2002:* Popularization by MIT and use in businesses
d) *2005–2010:* Applications in surveillance, security, healthcare, transport, food safety and document management
e) *2011:* Green Grass API committed to GitHub
f) *2020:* 50 billion devices predicted to be connected to the devices

The European Commission has big plans for the use of the IoT by 2020, as noted in its digital agenda. It is predicted that in just 6 years time, there will be over 50 billion devices connected to the IoT. Overall, the IoT is still in its infancy and there are many promises for its application in the future, with seemingly endless possibilities.

VII. OPERATING PRINCIPLES

In order to connect an object to the IoT, several things are needed in the hardware and software realm. First of all, if one wishes to go beyond simply connecting data from a computer, objects to gather (sensors) or receive (actuators) data are necessary. For example, a digital thermometer can be used to measure temperature. In this case, the data needs to be uploaded to a network of connected servers which run applications. Such a network is commonly referred to as 'the cloud'. The cloud utilizes the process of visualization, meaning that several physical servers can be connected and used in tandem, but appear to the user as one machine (despite that at the physical level, the machines function independently). This method of computing thus allows changes to be made to the 'virtual' server (such as software updates or changes in storage space) much easier than before.

In this case, an object will connect to the cloud through a (possibly wireless) Internet connection to upload or receive data. Objects to be connected are typically augmented with either sensors or actuators. A sensor is something that tells us about our environment. Think of a temperature sensor, or even the GPS receiver on your mobile phone. Actuators are something that you want to control. Things like thermostats, lights, pumps, and outlets. The IoT brings everything together and allows us to interact with our things and, even more interestingly, allows things to interact with other things.

For the purpose of connecting an object to the IoT, we focus on the Green Grass API. The interface provides simple communication capabilities to objects within the IoT environment, as well as interesting additional applications (such as IoT core, which will be further discussed in a later section). Moreover, Green Grass allows you to build applications around data collected by sensors. It offers near real-time data collection, data processing, and also simple visualizations for its users. Data is stored in so-called channels, which provides the user with a list of features. Each channel allows you to store up to 8 fields of data, using up to 255 alphanumeric characters each. There are also 4 dedicated fields for positional data, consisting of: Description, Latitude, Longitude, and Elevation. All incoming data is time and date stamped and receives a sequential ID. Once a channel has been created, data can be published by accessing the Green Grass API with a 'write key', a randomly created unique alphanumeric string used for authentication. Consequently, a 'read key' is used to access channel data in case it is set to keep its data private (the default setting). Channels can also be made public in which case no read key is required.

According to the Green Grass website, the API works as noted in Figure 1. Essentially, 'things' are objects that are given sensors to collect data. Data is sent and received via simple "Hypertext Transfer Protocol" (HTTP) POSTs, much like going to a web page and filling out a form. This communication happens through plaintext, JSON or XML. The data is then uploaded to the cloud and from there can be used for a variety of purposes. In turn, data (such as commands or choosing certain options) can be gathered and communicated to the cloud, which in turn sends these messages to the object.

Fig 6.2.4 Green Grass representing itself as '

VIII. CONCLUSION

IoT Technology is an integration of various technologies which enables different devices and objects to interact with each other and use different network technologies. The proposed system gives better and effective industrial growth to team and the information collected is networked worldwide through internet and communication devices in turn connected to cloud services and engineers can use this data and provide a quick and effective solution. The proposed model is a well- equipped system where the person can check the machinery which is far away from his reach anywhere, anytime. Emergency alert e-mail is sent to the crew if the threshold value is reached automatically it will be shut down and respective team will be informed to check further. This system is helpful for both employer and employees. The aim of the proposed framework is to adopt a new autonomous production of industrial things and systems that can provide high safety and productivity without failures at a very low cost and by using this combination of large data analysis, cloud computing, and computing technologies. The enhancement for the designed system will connect more sensors and connect all the objects to the Internet for quick and easy access. Further enhancement of the existing model can also be deployed as a mobile application in order to become easy to access the model around the world. The mobile application can be enhanced with the emergency services, workers list, nearby hospitals. The workers who fail to follow certain rules like wearing masks and gloves also can be eliminated by using the Pi camera. The system is implemented for one-to-one access, which can be implemented for many by giving a unique id for each machine/divison in the home or the hospital.

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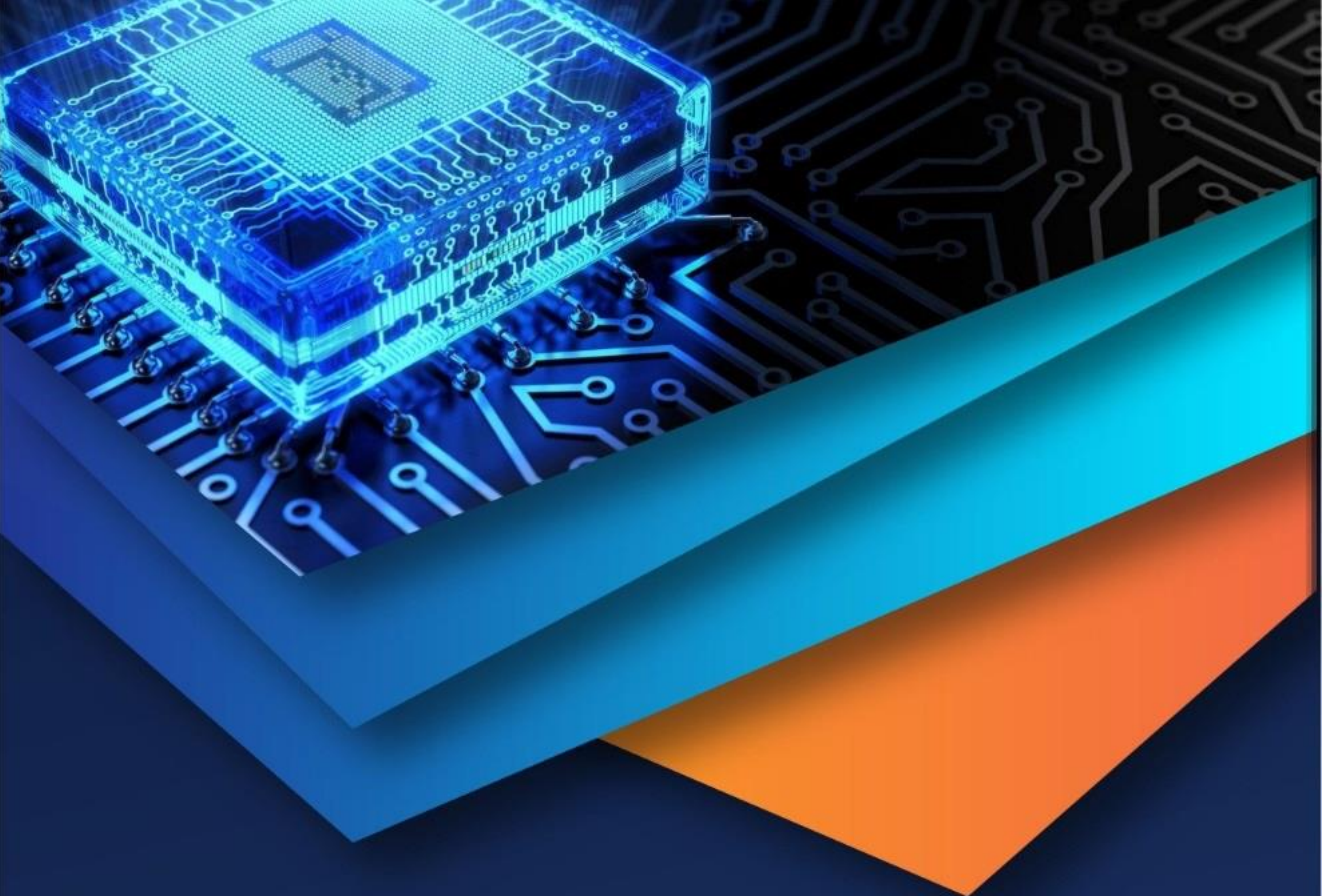

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