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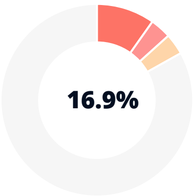

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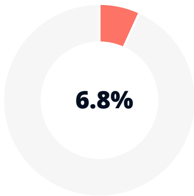

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IOT Based Smart Factory System with Sensor Integration and Cloud Connectivity

Submitted by

Gagan M Kakol (170EC20017)

Under the guidance of

Mr. Gopalkrishna BE, M.Tech (VLSI Design), MISTE

In partial fulfilment of the award of Diploma in Electronics and Communication Engineering

Department of Electronics and Communication Engineering

Government Polytechnic College,

Harihar -577601

2022-2023

Government Polytechnic College, Harihar

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CERTIFICATE

This is to certify that the project report entitled **"IOT BASED SMART FACTORY SYSTEM WITH SENSOR INTEGRATION AND CLOUD CONNECTIVITY"**, submitted by **GAGAN M KAKOL (170EC20017)** is the bonafied work completed under my supervision and guidance in partial fulfilment for the award of Diploma in Electronics and Communication Engineering Government Polytechnic College, Harihar during the academic year 2022-23.

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DECLARATION

I hereby declare that the thesis entitled, " IOT BASED SMART FACTORY SYSTEM WITH SENSOR INTEGRATION AND CLOUD CONNECTIVITY " is submitted to the Board of Technical Examination, Bangalore as an award of Diploma in Electronics and Communication Engineering carried out by me in the Department of Electronics and Communication Engineering Government Polytechnic Harihara under the supervision of Mr. Gopalkrishna, Lecturer E&C department, Government Polytechnic Harihara for the year 2022-23.

The primary data in the study of "IOT Based Smart Factory System with Sensor Integration and Cloud Connectivity" project is collected by me together with my project associates. I further declare that the study of the project as not formed the basis for award of Diploma in Electronics and Communication Engineering.

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ACKNOWLEDGEMENTS

The portion of success is brewed by the efforts put in by many individuals. It is constant support provided by people who give you the initiative, who inspire you at each step of your endeavour that eventually helps you in your goal.

I wish to express my deep gratitude and heartily appreciation for the invaluable guidance of our professors throughout the span of doing this project. We are indebted to our college Principal **Mr. H V Srinivasa**

I am also thankful to our Head of the Department **Smt. Sudha M**, Project Co-Ordinator and Project Guide **Mr. Gopalkrishna** and the credit of this project also goes to all our Teaching and Non-Teaching staffs for his invaluable and elaborate suggestions. Their excellent guidance made me to complete this task successfully.

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EXECUTIVE SUMMARY

The IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project uses the power of Internet of Things technologies. By combining various sensors and connecting them to the cloud connectivity, we create a smooth and seamless system, this system revolutionizes factory operations by enabling automation, optimization, and real-time monitoring. These sensors encompass temperature and humidity sensors, flame sensors, infrared (IR) sensors for product counting, and load cells for precise weight measurement. The data collected from these sensors serves as a valuable resource, offering deep insights into the factory environment and facilitating informed decision-making for enhanced operational efficiency. By implementing our IoT-based Smart Factory System, manufacturers gain unprecedented levels of efficiency, and productivity. The integration of sensors, cloud connectivity, and data analytics provides invaluable insight.

The IoT-based Smart Factory System provides a many number of advantages to manufacturers. It automates critical processes such as activating ventilation systems based on temperature and humidity readings, or triggering water pumps in response to flame detection. The system also offers real-time display of weight measurements, allowing precise monitoring of product quantities.

.

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ABBREVIATIONS & NOTATION

Table 1: Abbreviations

English Symbols	Meaning
IR	Infrared
MCU	Micro Controller Unit
Wi-Fi	Wireless Fidelity
BLE	Bluetooth Low Energy
LCD	Liquid Crystal Display
BO	Battery operated
IDE	Integrated Development Environment
WBS	Work Breakdown Structure
CBS	Cost Breakdown Structure
IOT	Internet Of Things
DTE	Department of Technical Examinations
PPT	Power Point Presentation
HVAC	Heat Ventilation and Air Conditioning
ESP	Event Stream Processing
VIA	Virtual Interface Architecture
UI	User Interface
SOC	Security Operational Center
CPU	Central Processing Unit
RISC	Reduced Instruction Set Computer
GPIO	General Purpose Input/ Output
SPI	Serial Peripheral Interface
I2C	Inter-Integrated Circuit

IC	Integrated circuit
PWM	Pulse With Modulation
MHz	Mega Hertz
VCC	Voltage Common Controller
NO	Normally Open
NC	Normally Close
Com	Common
AC	Alternate Current
DC	Direct Current
PCB	Printed Circuit board
NTC	Negative Temperature Coefficient
NM	Nano Meter
RPM	Rotation Per Minute
GNU	General Public License
USB	Universal Serial Bus
IOT	Internet of Things

CHAPTER 1

1.1 INTRODUCTION

The IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project makes use of the Internet of Things. By combining various sensors and connecting them to the cloud, a seamless and fluid system is produced. This technology enables automation, optimization, and real-time monitoring, revolutionising factory processes.

This category of sensors consists of temperature and humidity sensors, flame sensors, infrared (IR) sensors for product counting, and load cells for precise weight measurement. Data from these sensors is a valuable resource that offers in-depth perceptions into the industrial environment and aids in the formulation of well-informed decisions for improved operational efficiency.

An important success of our project is the seamless integration of cloud connectivity. By connecting the smart manufacturing system and the cloud, we make it possible for the safe transfer and archival of sensor data in online databases.

The IoT-based Smart Factory System offers manufacturers a wide range of benefits. It automates crucial procedures like triggering water pumps in response to flame detection or activating ventilation systems based on temperature and humidity sensors. Additionally, the system provides weight measurements in real-time, enabling accurate product quantity monitoring.

Implementing our IoT-based Smart Factory System helps manufacturers achieve previously unheard-of levels of production and efficiency. Data analytics, cloud connectivity, and sensor integration together offer priceless knowledge. In our project, we made use of the following hardware and software elements:

i. Node MCU ESP8266 with integrated Wi-Fi and BLE connectivity which is used in a wide range of applications.
ii. Arduino Uno
iii. LCD display
iv. Load cell sensor
v. HX711 amplifier

vi. IR sensor
vii. Flame sensor
viii. DHT11 sensor
ix. BO motor
x. Node MCU base connector
xi. Fan
xii. Motor pump
xiii. 2channel 5v Relay
xiv. Arduino IDE
xv. Thinger.io Cloud platform

1.2 SCOPE OF THE CAPSTONE PROJECT

- **Sensor Integration:** In order to monitor and manage the manufacturing system, the Smart Factory System project gathers data from sensors like IR, flame, DHT11, and load cells. The production line, the arriving area, the packaging line safety area, etc. all have sensors built in. This will facilitate the collection of additional data, real-time decision-making, and process improvement.

- **Wireless Communication and Cloud Integration:** The Project system is connected to the Wi-Fi using Microcontroller board Node MCU ESP8266 to interface with Thinger.io cloud platform. For remote monitoring and to control the system. This improves operational efficiency and responsiveness by giving real-time access to vital information.

- **Remote Monitoring and Notifications:** We are using Thinger.io cloud platform to enable operate remotely and collect data in data buckets, to track of system life, and get notifications alerts for any accidents or incidents. This makes easy for predictive maintenance, reducing downtime and increasing productivity.

- **User Interface and Data Visualization:** The LCD panel of the system displays real-time weight measurements as well as other essential data, enhancing user interaction and simplifying data interpretation. This intuitive interface enables operators to efficiently monitor processes and take choices.

- **Power Management and Scalability:** The concept employs energy-saving methods to cut down on power usage while also taking scalability into account for potential future growth or the incorporation of extra sensors. As a result, eco-friendly practices are promoted and the changing demands of the smart factory are satisfied.

- **Documentation and Support:** The project assures thorough documentation, which includes user manuals and instructions, to help users set up, configure, and troubleshoot systems. Continuous assistance is offered to address any technical problems or questions, fostering efficient functioning and user pleasure.

CHAPTER 2

2.1 CAPSTONE PROJECT PLANNING

We meticulously plan and organise our project throughout the crucial capstone project planning stage of the project management process. It supports our decision-making process and aids in our comprehension of the project's goal. Planning allows us to identify what has to be done, when it should be done, and who will be in charge of each activity. It makes sure that everyone is on the same page and striving to achieve the same goal. Overall, by offering a strategy for its implementation, capstone project planning creates the conditions for a project's success.

2.1.1 Work Breakdown Structure (WBS) for Smart Factory system

Work Breakdown Structure shows the project tasks level from beginning to end of the project, and objectives of smart factory system. It provides a roadmap to build a project with successful with co-ordination.

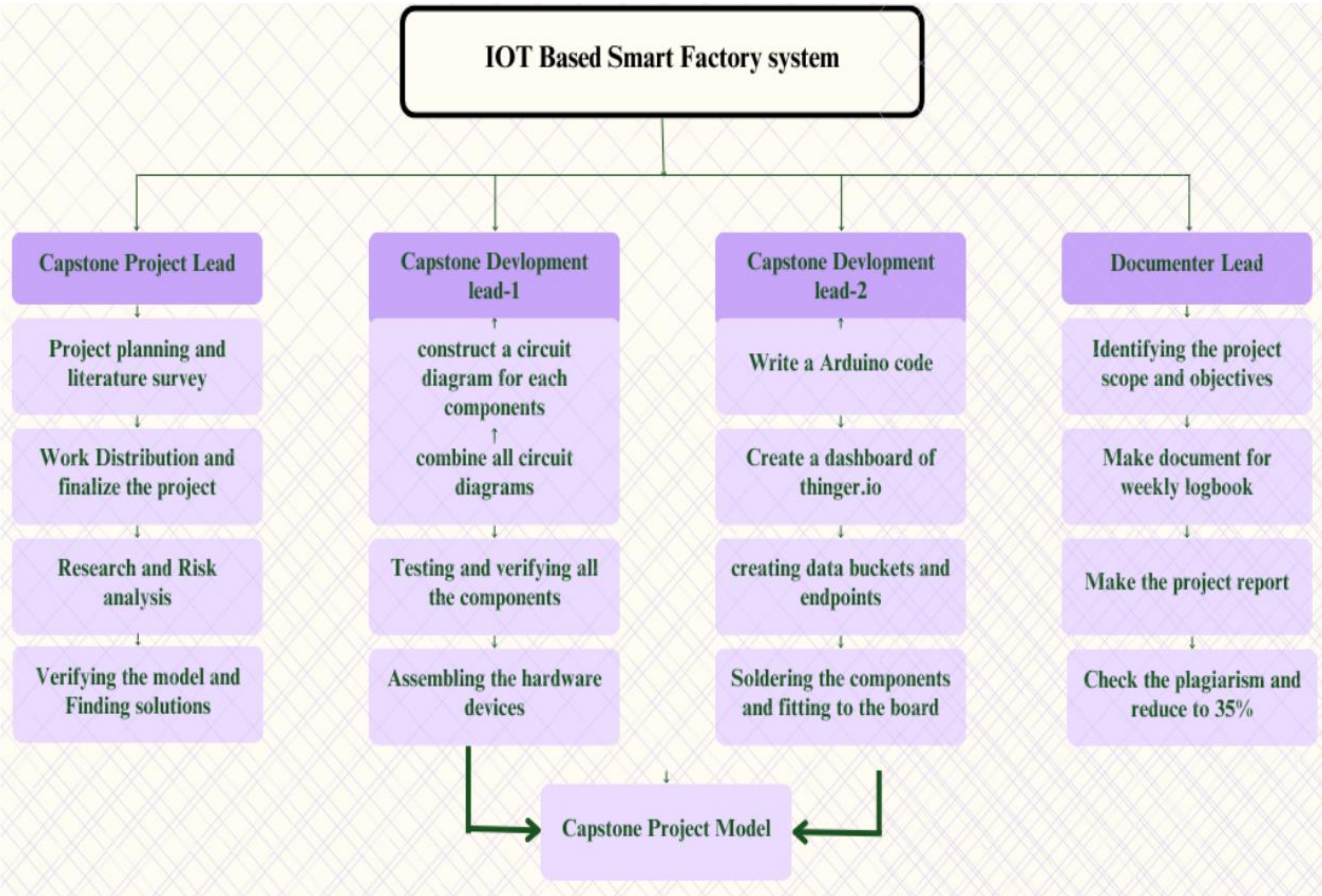


Figure 2.1 Flow chart of Work Breakdown structure (WBS)

2.1.2 Timeline Development – Schedule for Smart Factory system

Week-1: Discussing about our capstone project with the reference of marketing scope.

Week-2: Prepared a literature survey based on discussed with the group members.

Week-3: Planning & designing of our project "IOT Based Smart Factory with Sensor Integration and Cloud Connectivity" & collecting related document of our project

Week-4: To start basic requirement of project as per requirement & configuration.

Week-5: To buy the electronic interfacing modules like controller, sensors, and fabrication materials

Week-6: To start a programing for in our project we are using "ARDUINO IDE" software.

Week-7: As per programming to create as separate or individual components circuit diagram with reference of coding.

Week-8: Searched for perfect cloud platform and finalize the Thinger.io Cloud.

Week-9: To complete coding part then finish up necessity of a fabrication works.

Week-10: To connect the hardware components with the controller as per coding instruction then finalize our project.

Week-11: Integration of components as per required for capstone project.

Week-12: To start necessity document preparation for individual components and make a Report on chapter 1-3.

Week-13: Prepared a project banner for introduction and fitted to the wall.

Week-14: To check the report as per DTE plagiarism to check Plagiarism and reduce up to 35%.

Week-15: Finalize our Project designing, testing, and Plagiarism.

Week-16: Planning for PPT and demonstration.

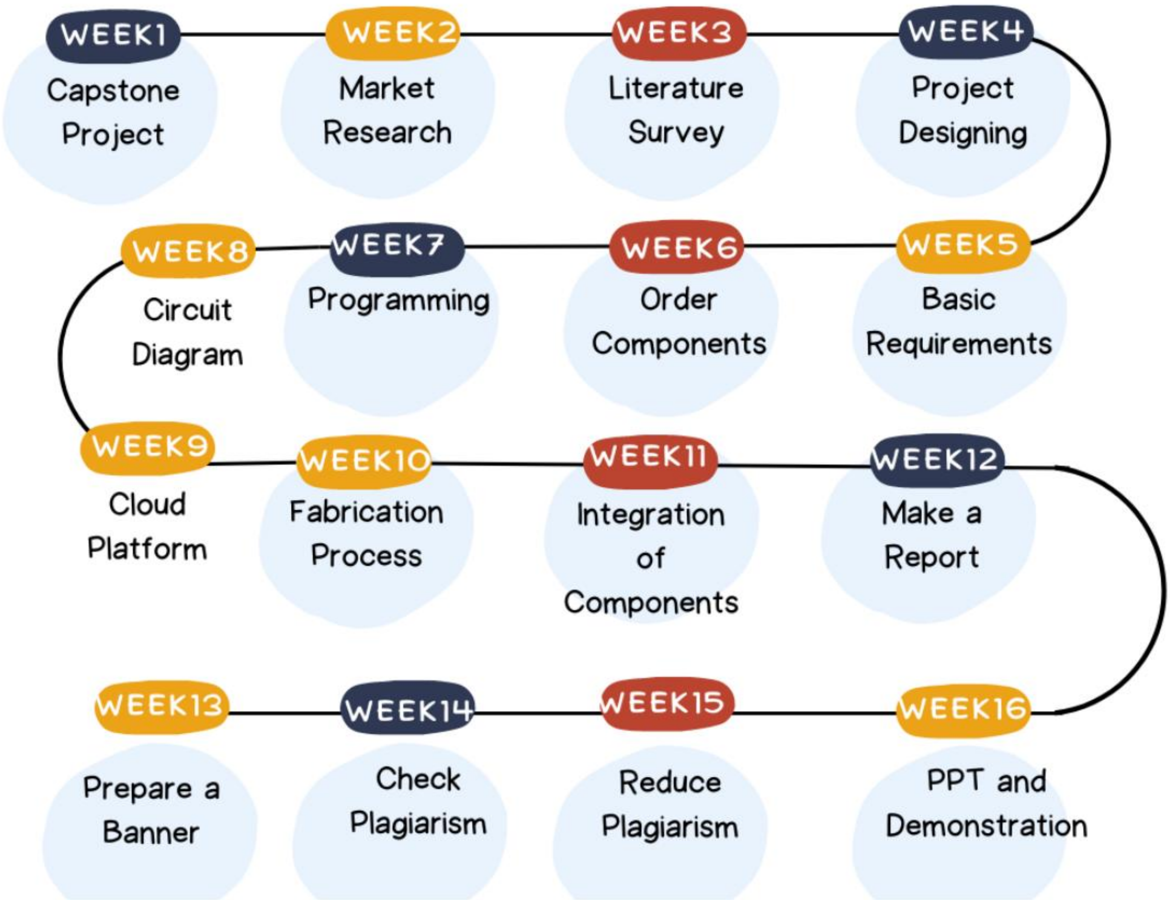


Figure 2.2 Flow chart of Time line schedule

2.1.3 Cost Breakdown Structure (CBS) for Smart Factory system

In our project we have used various components that are listed below with their cost.

Sl. No	Components	Quantity	Cost
1	NodeMCU	1	500
2	Load Cell	1	700
3	Flame Sensor	1	200
4	IR Sensor	1	200
5	DHT11	1	200
6	Mini Fan	1	200
7	Buzzer	1	100
8	Water Pump	1	200
9	DC Motor	2	300
10	jumpers	1set	250
11	Smoke Sensor	1	200
12	Wooden Board	1	200
13	Arduino Uno	1	750
Total			4000

Table 2.1 – Cost Breakdown Structure (CBS) Table

2.1.4 Capstone project risk analysis for Smart Factory system

Potential risks and uncertainties are recognised, evaluated, and managed during the critical process of risk analysis in project management. Understanding potential difficulties and how they could affect project goals is helpful. Proactive steps can be taken to mitigate risks and guarantee project success by undertaking a risk analysis.

- **Technical risks:** Incompatibility between the ESP8266 and Arduino Uno boards, leading to integration challenges.
- **Safety risks:** Insufficient protection measures for electrical components, leading to potential hazards.
- **Employee resistance:** The implementation of a smart not supportive for employees who are not familiar with new technologies.
- **High upfront costs:** Implementing a smart factory can be expensive, investment in advanced technologies and infrastructure.
- **Performance risks:** insufficient testing to software problems or inaccurate sensor readings.
- **Time risks:** Delays in the obtaining of required hardware components, causing a delay in project timeline.

2.2 REQUIREMENTS SPECIFICATION

2.2.1 Functional

- Automate turning on of ventilation through HVAC system according to the DHT11.
- Real-time display of the weight of products on the 16*2 LCD display.
- Ability to control the speed of the conveyor belt via ESP8266.
- Automatically turning on of water pump through flame sensor when flame detected.
- Storing the data of all sensors in the data buckets for easy retrieval and analysis.
- Maximum number of products per day was counted through IR sensor via conveyor belt.

2.2.2 Non-Functional (Quality Attributes)

- The system should be capable of handling an increasing workload or expanding requirements
- The UI and overall system design should be user-friendly
- The system should very Strong security measures to protect sensitive data and prevent unauthorized access.
- The system should be stable and operate continuously without any failures.
- The system should demonstrate high performance, with low latency and fast response times.
- The system should be implemented in a way to facilitates for easy to maintenance and to update or replace the components without disrupting the overall system.

2.2.3 User Input

- In this system user input is not needed.
- Only is to monitor the Factory Environment.
- Only you can control the speed of work through web dashboard.

2.2.4 Technical Constrains

- The Microcontrollers used in this, such as NodeMCU and Arduino, having processing capabilities and memory limitations.
- The range and stability of WiFi network could impose constraints on the system functionality.
- The components require a stable power supply to operate effectively.
- The accuracy and reliability of the sensors can impact the overall system.
- The system involves data transmission and remote access and malicious activities is crucial
- The project should consider environmental factors, such temperature and dust that may impact the performance of the hardware components.

2.3 Software and Hardware Details

2.3.1 ESP8266

The open-source NodeMCU firmware and development board are designed specifically for Internet of Things (IoT) applications. Hardware based on the ESP-12 module is used along with firmware that is powered by Espressif Systems' ESP8266 Wi-Fi SoC.

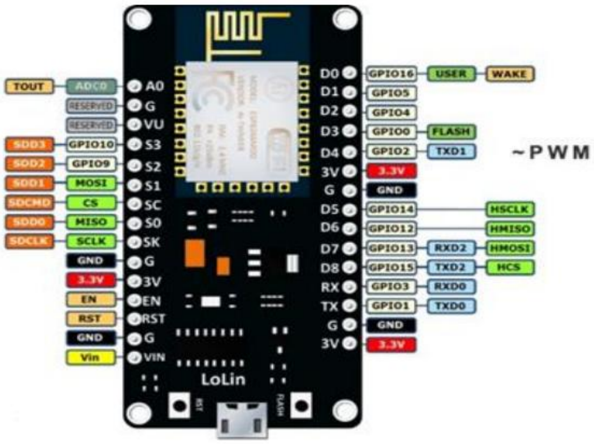


Figure 2.3 Pinout Diagram of Nodemcu ESP8266

CPU	L106 32-bit RISC microprocessor
GPIO	16 Pins
UART	4
SPI	4
I^2C	1
Input Voltage	7-12 Volts
Output Voltage	3.3 volts
Wi-Fi	802.11 b/g/n
Bluetooth	BLE (shares the radio with Wi-Fi)
Clock Speed	80 MHz

Table 2.2 Nodemcu ESP8266 Specification Table

In our project we have used the ESP8266 Development Board to get the data from all sensors and sends to the actuators and analyze it and send the data to Cloud and check it and get back the corresponding output from the server and collected in different data buckets.

2.3.2 Arduino Uno

Using an 8-bit ATmega328P microprocessor as its foundation, the popular Arduino Uno development board. A crystal oscillator, serial communication, a voltage regulator, and other supporting parts are included with the ATmega328P MCU IC to help the microcontroller function.

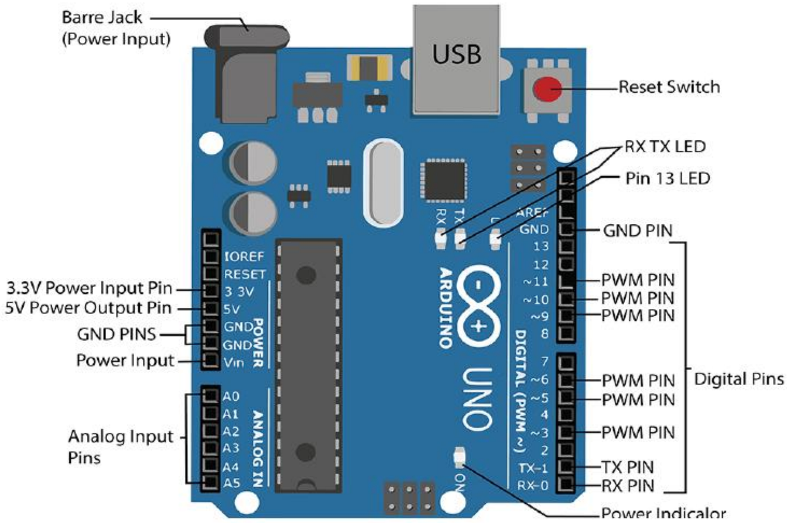


Figure 2.4 Pinout Diagram of Arduino Uno

CPU	ATmega328P – 8 bit AVR family microcontroller
Analog pins	6 Pins
Digital pins	14 Pins
Serial pins	Rx, Tx
PWM	5 Pins
Input Voltage	6 to 12 volts
Output Voltage	5 volts
SPI	4 Pins
Flash memory	ATmega328P – 8 bit AVR family microcontroller
Clock Speed	16 MHz

Table 2.3 Arduino Uno Specification Table

In our project we have used the Arduino Uno Development Board to get the Weight Measure data from Load cell and analyze it and send the data to HX711 amplifier and check it and get back the corresponding output from the Arduino and LCD display.

2.3.3 Relay

With a few additional capabilities, such optical isolation, the dual-channel relay module is essentially identical to a single-channel relay module. A microcontroller's pins can be utilised to switch mains powered loads using the dual-channel relay module.

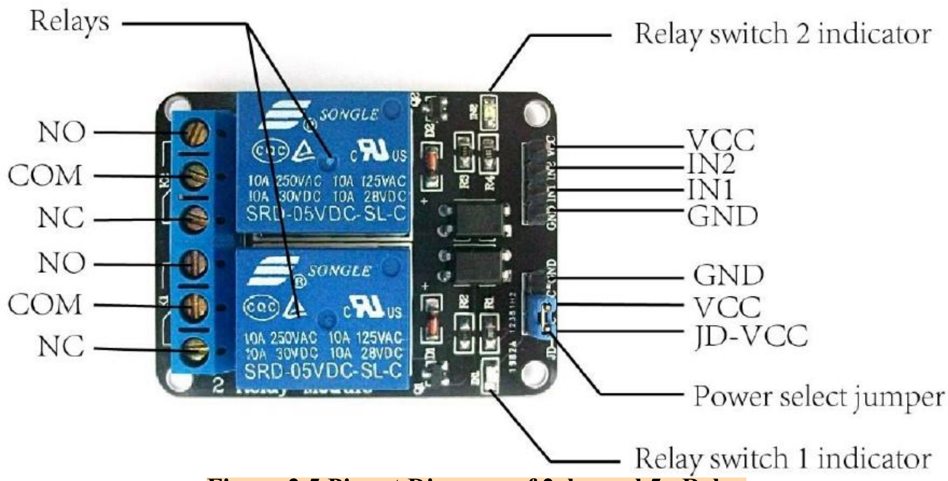


Figure 2.5 Pinout Diagram of 2channel 5v Relay

Current when relay is active	~70mA (single), ~140mA (both)
GND	Input ground reference
IN1	Input to activate the first relay
IN2	Input to activate the second relay
VCC	Input for directly powering the relay coils
Supply Voltage	3.75V to 6V
Trigger current	5mA
maximum current	10A
maximum contact voltage	250VAC, 30VDC
Clock Speed	240MHz

Table 2.4 2channel 5v Relay Specification Table

In our project we have used the 2channel 5v Relay used for fan and water pump for external supply when esp8266 triggered these two will turn on through relay module.

2.3.4 LCD Display

16x2 LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability, programmer friendly and available educational resources.

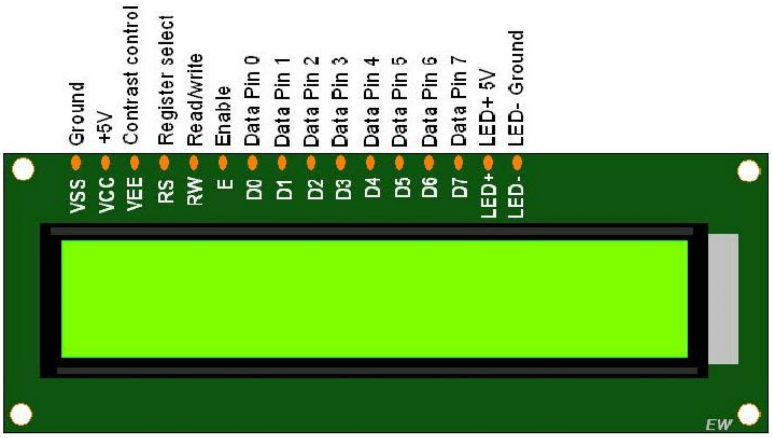


Figure 2.6 Pinout Diagram of LCD display

Vss (Ground)	Ground pin connected to system ground
Data pins	8 Pins
Vdd	Powers the LCD with +5V (4.7V – 5.3V)
VE (Contrast V)	Decides the contrast level of display. Grounded to get maximum contrast.
Register Select	Connected to Microcontroller to shift between command/data register
Input Voltage	4.7V to 5.3V
Current consumption	1mA
Read/Write	Used to read or write data. Normally grounded to write data to LCD
Enable	Connected to Microcontroller Pin and toggled between 1 and 0 for data acknowledgement
LED Positive	Backlight LED pin positive terminal

Table 2.5 16*2 LCD Display Specification Table

In our project we have used the 16*2 LCD Display to get the weight measured data from load cell through HX711 amplifier and Arduino Uno microcontroller.

2.3.5 ESP8266 Base connector

ESP8266 Base connector is a used for Nodemcu Esp8266 for external supply.

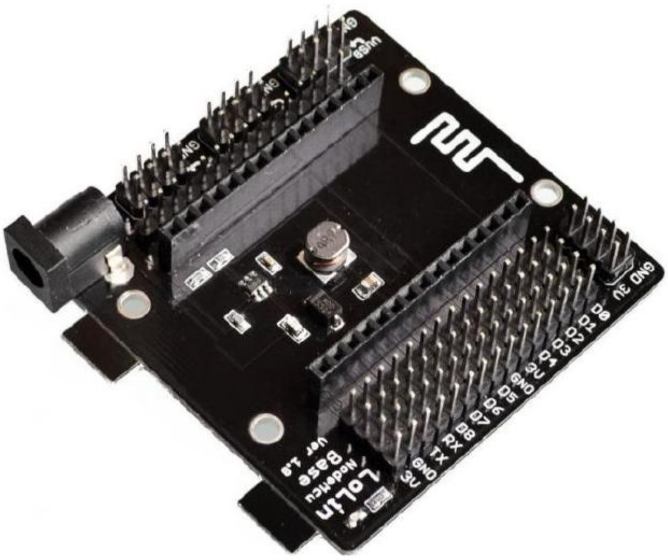


Figure 2.7 Pinout Diagram of ESP8266 Base connector

PCB Thickness	1.6mm
Pin Pitch:	2.54mm (0.1in)
UART	3
SPI	4
I^2C	2
Input Voltage	6V – 24V DC
Output Voltage	5 volts
NodeMCU Pin Distance between sides	~28.0mm
Board Dimensions	60.0mm x 60.0mm x 15.0mm (L x W x H)
Weight:	22.5 g

Table 2.6 ESP8266 Base connector Specification Table

Pins for Extra connections for microcontroller ESP8266, it will powered by adaptor.

2.3.6 IR Sensor

The IR sensor module consists mainly of the IR Transmitter and Receiver, Op-amp, Variable Resistor (Trimmer pot), output LED along with few resistors

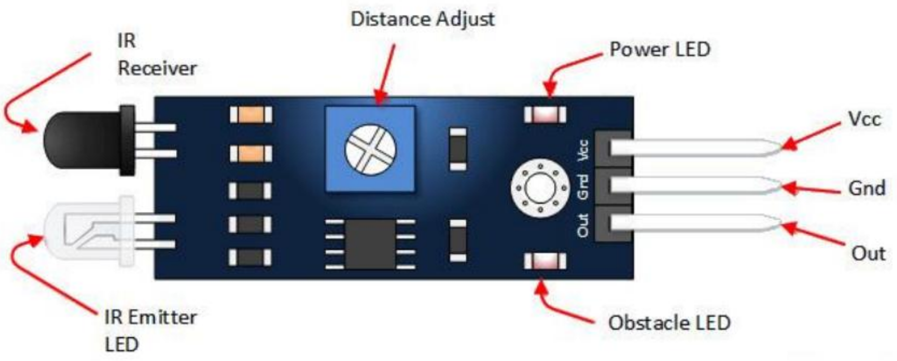


Figure 2.8 Pinout Diagram of IR sensor

VCC	Power Supply Input
GND	Power Supply Ground
OUT	Active High Output
Range	Up to 20cm
supply current	20mA
Input Voltage	3.3 to 5 volts

Table 2.7 IR sensor Specification Table

In our project we have used the IR Sensor for product counting in was installed in the conveyor belt, it counted data was send to cloud thinger.io and stored in the different data buckets.

2.3.7 DHT11 Sensor

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

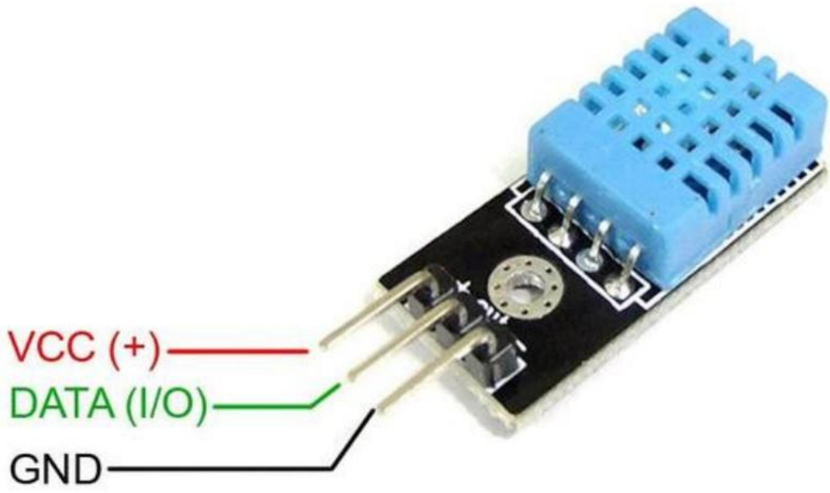


Figure 2.9 Pinout Diagram of DHT11 sensor

Vcc	Power supply
Data	Outputs both Temperature and Humidity through serial Data
Ground	Connected to the ground of the circuit
Operating Voltage	3.5V to 5.5V
Operating current	0.3mA (measuring) 60uA (standby)
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%

Table 2.8 DHT11 Sensor Specification Table

In our project we have used the DHT11 Temperature and Humidity sensor Board to get the data of factory environment and analyze it and send the data to Cloud and check it and get back the corresponding output from the server and it to the Fan or HVAC system and make other corresponding actions if any available.

2.3.8 Flame Sensor

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source.

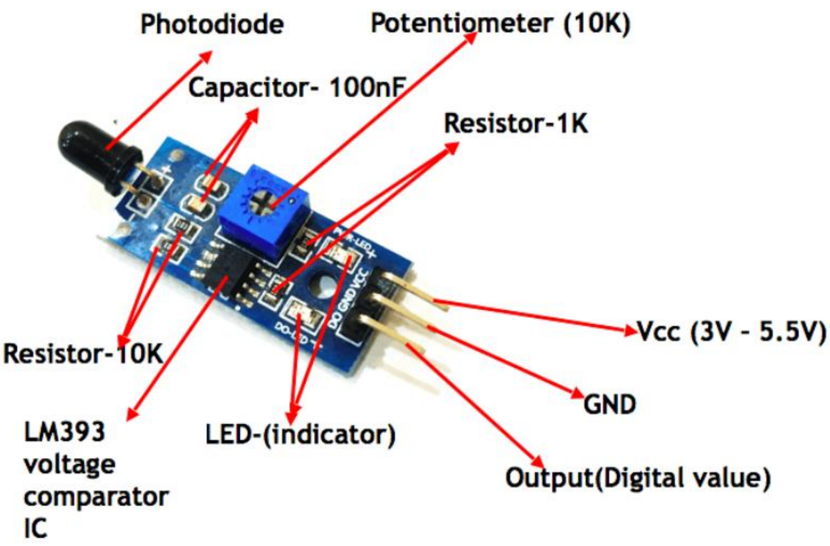


Figure 2.10 Pinout Diagram of Flame sensor

Pin1	VCC pin
Pin2	GND
Pin3	AOUT
Pin4	DOUT
A0	This is an analog output pin (MCU.IO)
Input Voltage	3.3V to 5.3V
D0	This is a digital output pin (MCU.IO)
Range	Upto 100cm
Wavelength	760 nm to 1100 nm

Table 2.9 Flame sensor Specification Table

In our project we have used the Flame sensor Board to get the data of fire detected in the factory environment and send the data to Cloud and check it and get back the corresponding output from the server and display it on the OLED Display and make other corresponding actions if any available.

2.3.9 BO motor

It is a BO Series 1 100RPM DC Motor Plastic Gear Motor. The BO series straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors.

Figure 2.11 Pinout Diagram of BO motor

MOTOR	Permanent Magnet DC Gear Motor BO(Battery Operated)
VOLTAGE(V)	3-9v
CURRENT	0.01A(no load);0.07A(at max. eff.)
LOCKED-ROTOR CURRENT	>=0.15A
SPEED(RPM)	60RPM+-10%(no load)
TORQUE	0.5Kg-cm
ROTATION	CW/CCW
MOUNTING TYPE	Horizontal or Vertical

Table 2.10 BO motor Specification Table

In our project we have used the 2 Bo motors are used parallel the conveyor belt, and we can adjust the speed of conveyor belt through the motors.

2.3.10 Mini 9v water pump

A 9V water pump is a small device that uses a 9-volt battery to pump water. It has a motor and rotating blades that push the water out. It's handy for things like aquariums or fountains.

Figure 2.12 Pinout Diagram of Water pump

Diameter	7mm
Max Flow Rate	100L/H
Temperature	-20~50°C
Voltage	9V DC
Maximum Rated Current	0.18A - Power: 0.36W

Table 2.11 Water Pump Specification Table

In our project we have used the 9v water pump for safety of factory environment, when flame sensor detects the will triggered and the data was sent to the thinger cloud.

2.3.11 Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Figure 2.13 Pinout Diagram of Buzzer

frequency range	3,300Hz
Operating Temperature ranges	– 20° C to +60°C
voltage ranges	3V to 24V DC
sound pressure level	85dBA or 10cm
supply current	below 15mA

Table 2.12 Buzzer Specification Table

In our project we have used the as actuator for flame sensor, when flame detects the buzzer will vibrates for every one second.

2.3.12 Arduino IDE software

Arduino is a firm that creates and produces single-board microcontrollers and microcontroller kits for creating digital devices. It is an open-source hardware and software initiative. The software is distributed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), allowing anybody to produce Arduino boards and distribute the programme. Its hardware goods are licenced under a CC BY-SA licence. Commercial Arduino boards are offered on the official website or from accredited distributors.

Different microprocessors and controllers are used in the designs of Arduino boards. A variety of extension boards (referred to as "shields"), breadboards (used for prototyping), and other circuits may be interfaced to the boards' sets of digital and analogue input/output (I/O) pins. The boards have serial communications ports that are also used to load applications, including on some models, Universal Serial Bus (USB). The C and C++ programming languages, along with a modified version of the Processing IDE, can be used to programme the microcontrollers. This standard API is also referred to as the Arduino Programming Language.

2.3.12 Thinger.io Cloud platform

Thinger.io is a cloud IoT Platform that provides every needed tool to prototype, scale and manage connected products in a very simple way. Our goal is to democratise the use of IoT making it accessible to the whole world, and streamlining the development of big IoT projects.

Free IoT platform: Thinger.io provides a lifetime freemium account with just few limitations to start learning and prototyping when your product gets ready to scale, you can deploy a Premium Server with full capacities within minutes.

Simple but Effective With our web-based Console, which can connect and manage thousands of devices easily, you can connect a device and start retrieving data or controlling its functions with just a few lines of code.

Hardware independence: The infrastructure of Thinger.io can be simply integrated with any device from any manufacturer.

Extremely scalable and effective infrastructure: A single Thinger.io instance can manage thousands of IoT devices with little computational load, bandwidth, and latency thanks to our novel communication paradigm, in which the IoT server subscribes device resources to retrieve data only when it is necessary.

Open-Source: The majority of the platform modules, libraries, and APP source code can be downloaded and modified under the terms of the MIT licence by visiting our Github repository.

2.4 DESIGN SPECIFICATION

ESP8266 Microcontroller: The ESP8266 serves as the main control unit for the system. It is responsible for handling all the communication with the sensors and actuators and managing data flow between different components.

- **Arduino Uno:** The Arduino controls the Weighing scale machine and displays real-time information about the weight of products on LCD screen.
- **DHT`11:** The temperature and humidity sensor monitors and provides surrounding environment, and it was connected to the cloud through microcontroller.
- **Flame Sensor:** The flame sensor monitors and provides information about the safety of the factory, and it was connected to the cloud through microcontroller.
- **IR Sensor:** The IR sensor and provides information about the number of Products manufactured, and it was connected to the cloud through microcontroller.
- **Fan:** The fan is controlled by temperature and humidity sensor based on the surrounding temperature it operates.

- **Water Pump:** The pump is controlled by Flame sensor it acts as a fire extinguisher.

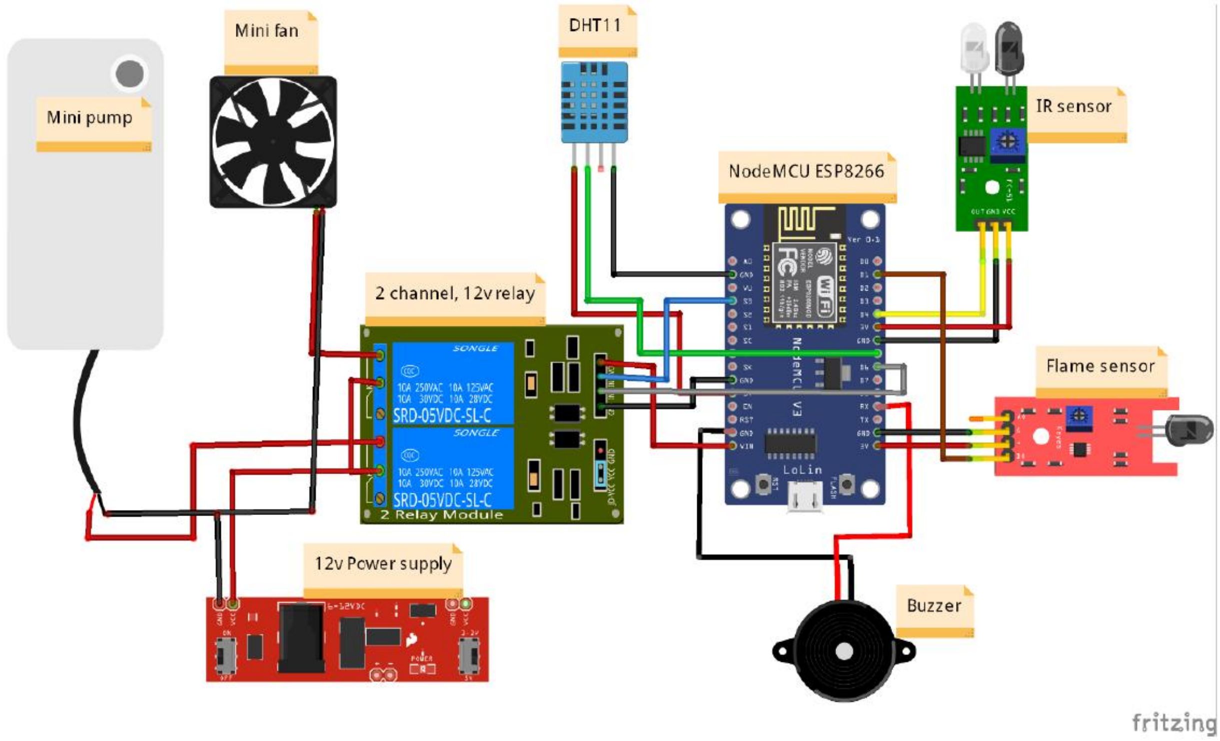


Figure 2.14 Circuit Diagram of Smart Factory

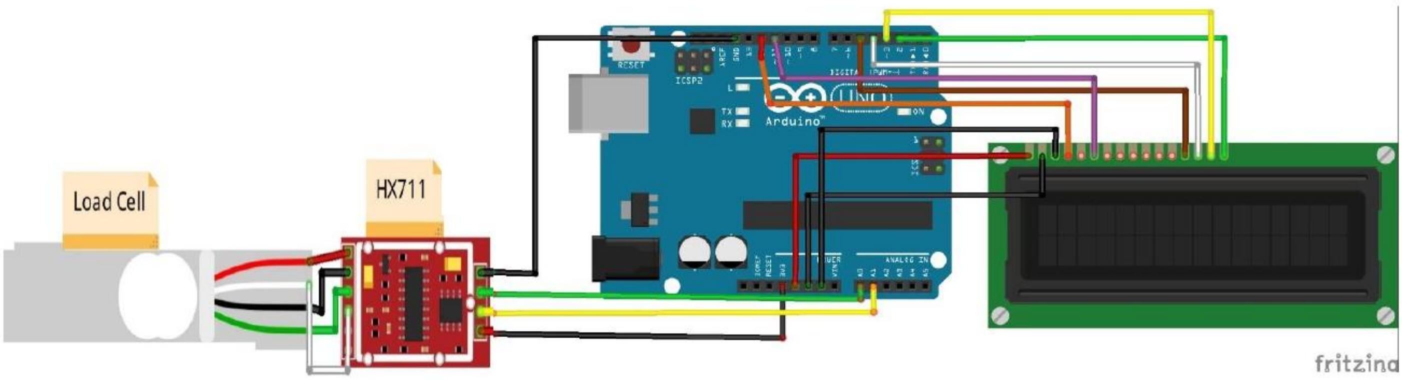


Figure 2.15 Circuit Diagram of Weighing Scale machine

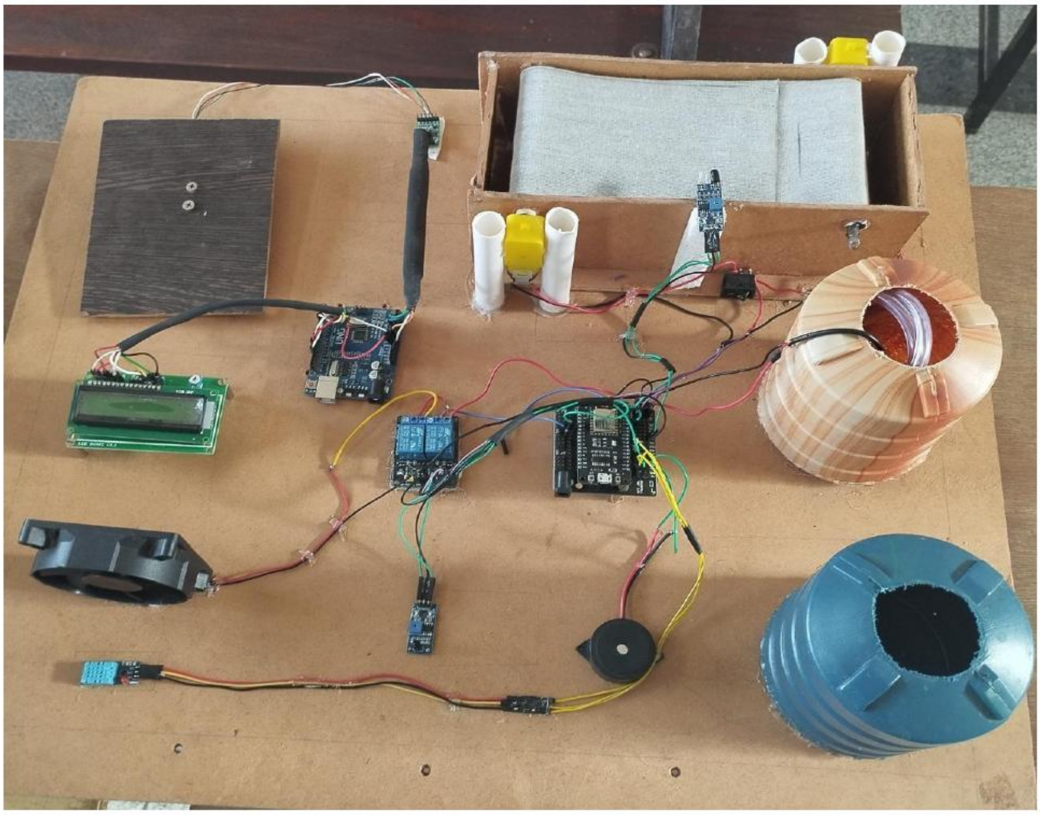


Figure 2.16 Smart Factory System Project Model

CHAPTER 3

3.1 APPROACH & METHODOLOGY

1. **Requirement Analysis:** We thoroughly understanding the specific needs and objectives of the project for Smart Factory system. This helps us understand the needful functions and determine the integration of sensors and cloud connectivity. The components that are used for our project as per requirement analysis they are ESP8266, Arduino Uno, Load cell, LCD display, Base connector , sensors, actuators, and etc.

2. **Technology Research:** We will more research to explore available technologies, sensor types, cloud platforms, and protocols. This research enables us to select the most suitable components and tools for the project. In our project Smart Factory system we implemented Thinger.io Cloud platform and Arduino IDE software platform, etc.

3. **System Design:** Based on the requirements analysis and technology research, we design the Smart Factory system in detailed. This involves the placement and configuration of sensors, Microcontrollers, Actuators, defining communication protocols, and outlining the integration with Thinger cloud services.

4. **Hardware Setup:** After all these three steps next to set the hardware components, such as Esp8266, Arduino, Conveyor belt, Load cell, HVAC system and communication modules. This step up includes proper wiring and compatibility between components, and testing to ensure proper functioning.

5. **Software Development:** Develop the necessary software components, including firmware for microcontrollers used for programming the Arduino and Esp8266, user interface software, and data handling algorithms. The software facilitates seamless communication between sensors, actuators, and the cloud platform.

6. **Testing and Optimization:** To test the software and hardware components, we conduct testing and optimization process to verify the reliability, accuracy, and performance of the

project Smart Factory system. This includes verifying the performance and functionality of sensor readings, efficiency of testing control mechanisms, and evaluating overall system functionality and they work as expected and meet the requirements of the project.

7. **Documentation:** We prepare comprehensive documentation, including system manuals, user guides, working principles, working procedures, references, used system versions, when the last update done, time period for maintenance and technical specifications. This documentation will serve as a reference for future maintenance, or system expansion.

8. **Deployment:** Once fully tested and documented, we deploy the system in the factory environment. We provide ongoing support and maintenance to address any issues and make necessary improvements.

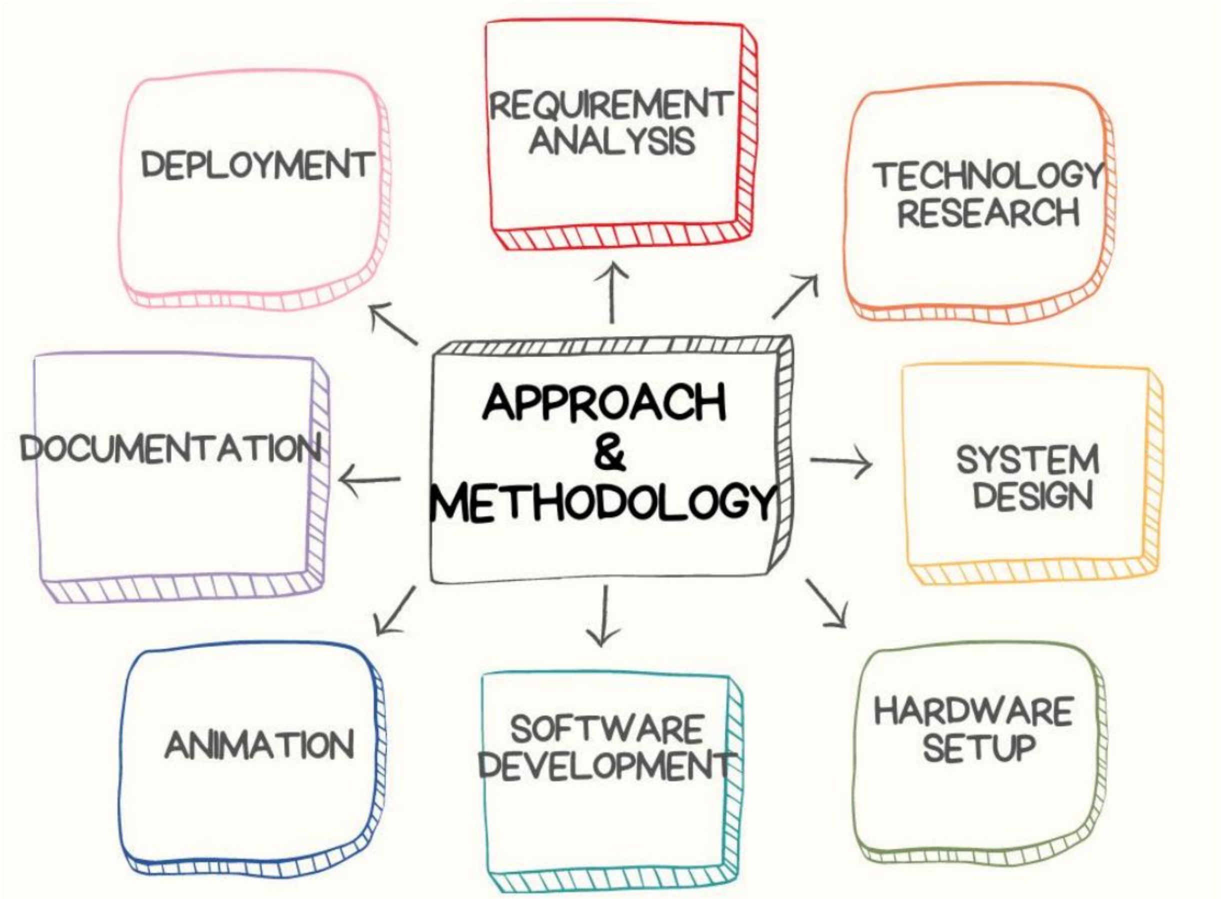


Figure 3.1 Block diagram of Approach and Methodology

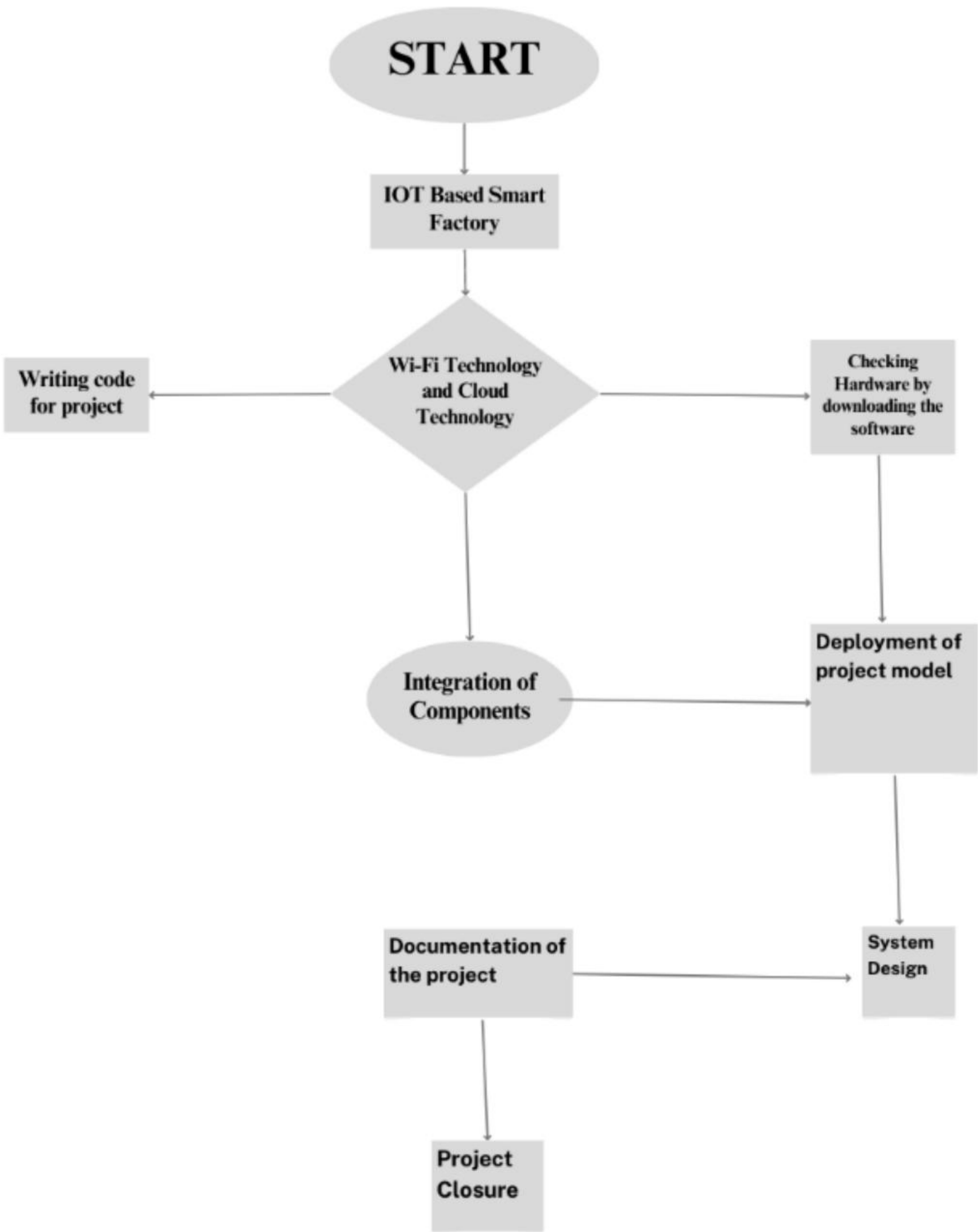


Figure 3.2 Flow chart of Approach and Methodology

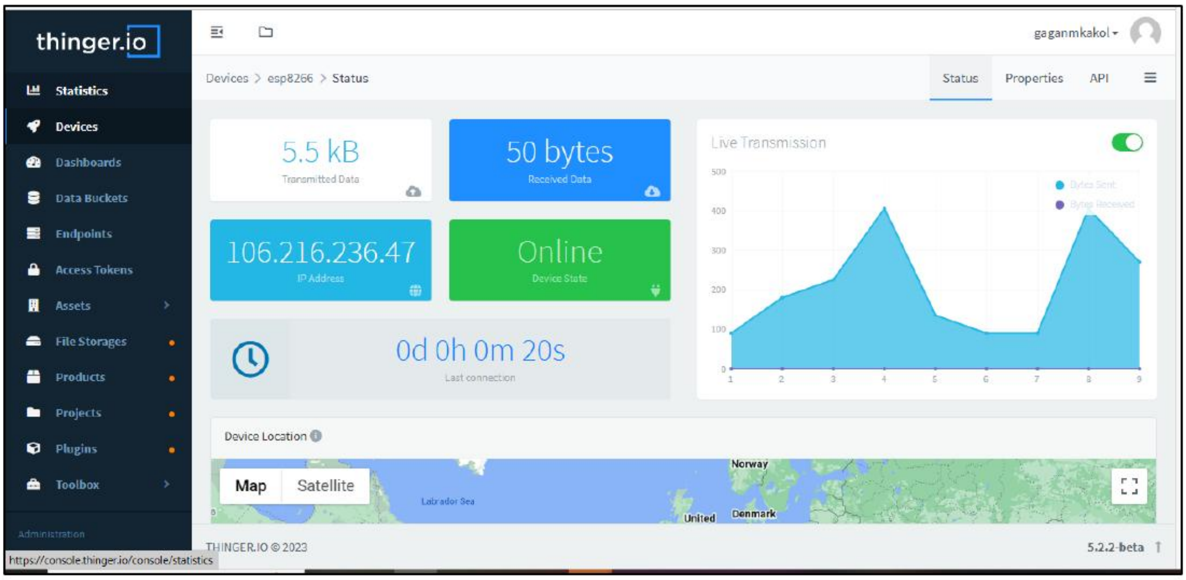
CHAPTER 4

4.1 TEST AND VALIDATION

Test and validation is crucial and important part of a project or system it helps as to find out any errors in the system. And solve them before deployment of the project.

4.1.1 Test and Validation for ESP8266

- Connect the ESP8266 to the power supply and check it boots up successfully.
- Write a test code to establish a Wi-Fi connection and send/receive data.
- The ESP8266 module successfully establishes a Wi-Fi connection to the specified network.
- Connect the GPIO pins with LED, buttons or any devices and check the pins correct working.
- Features tested: Wi-Fi connectivity, Data transmission and reception.
- No interference or significant issues observed during testing.
- Check that ESP8266 is compatible with required of your project like libraries, programming and cloud that you use for the project. Make that all the things mentioned above works perfectly in ESP8266.



4.1 ESP8266 is connected to cloud via Wi-Fi

4.1.2 Test and Validation for Arduino Uno

- Connect the Arduino Uno to the computer and power source.
- Write a test code to perform basic operations, such as blinking an LED.
- Upload the test code to the Arduino Uno and verify the expected behavior.
- Test various input/output pins and verify their functionality.
- Evaluate the stability and reliability of the Arduino Uno during extended operation.
- All input/output pins function properly.
- No interference or significant issues observed during testing.

4.2.3 Test and Validation for Relay Module

- Apply the required supply voltage to the relay coil. Verify the switches that contacts form open to closed or closed to open when the coil is energized or de-energized
- Connect relay to suitable load example; Light or bulb, and also test the relay's ability to handle specified current and voltage rating of load without exceeding maximum capacity
- Measure the time taken by the relay to energize or de-energize the coil. Observe the time with the manufacturer's specification to ensure it works within the acceptable limits.
- Endurance testing of relay: repeatedly energize and de-energize the relay for extended period under operating condition. Make sure that the relay can handle more number of cycles without degradation or failure.
- Environmental testing of relay: test the relay in various condition like temperature, humidity. Make sure that relay can easily operate in these temperature condition and work perfectly.
- Apply minimum voltage that is needed to the relay in which relay works perfectly. Also test the relay by applying over voltage and low voltage make sure that it can handle both.

- Verify the relay with safety measures and conditions. Also check it for overvoltage, isolation protection against the electrical hazards.

4.2 Proper working of Relay Module

4.1.4 Test and Validation for Loadcell

- Connect the load cell to the appropriate interface circuitry and Arduino Uno.
- Write a test code to read and display weight measurements from the load cell.
- Calibrate the load cell to ensure accurate weight readings.
- Place known weights on the load cell and compare the readings with the expected values.
- Repeat the test with different weights to evaluate consistency and reliability.
- Features Tested: Weight measurement accuracy, Calibration functionality, Consistency and reliability of readings
- Consistent and reliable performance observed during testing.

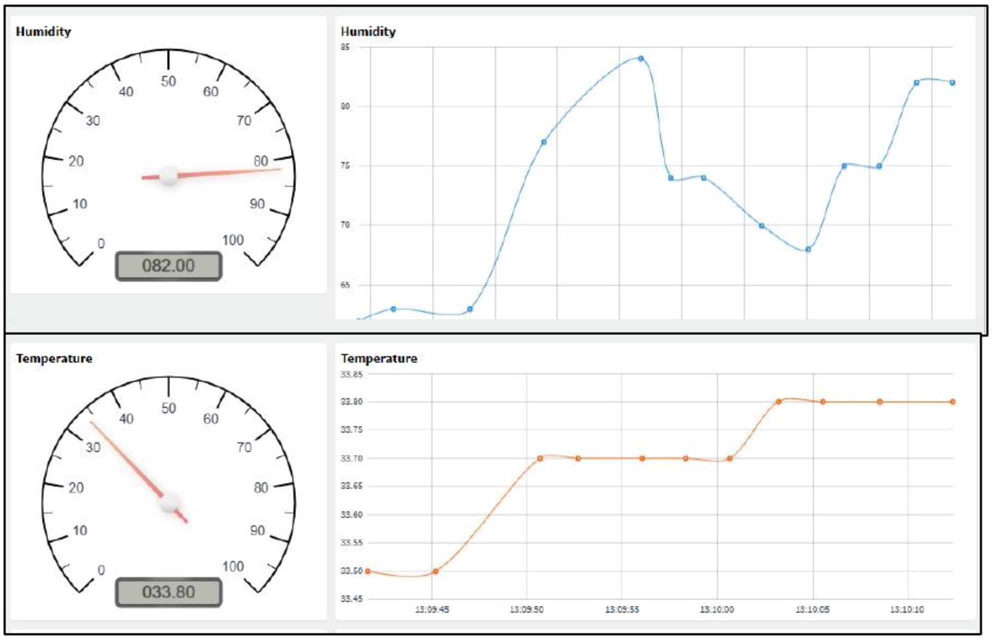
4.3 Proper working of Load cell sensor Module

4.1.5 Test and Validation for LCD Display

- Connect the LCD display to the Arduino Uno.
- Write a test code to display text and/or numerical values on the LCD.
- Verify the readability of the displayed information under various lighting conditions.
- Test different display functionalities, such as scrolling and clearing the display.
- Evaluate the stability and reliability of the LCD display during continuous operation.
- Features Tested: Display readability, Display functionalities
- No interference or significant issues observed during testing.

4.1.6 Test and Validation for DHT11 Sensor

- Connect the DHT11 sensor to the ESP8266.
- Write a test code to read and display the temperature and humidity values.
- Place the sensor in a controlled environment with known temperature and humidity.
- Compare the readings from the DHT11 sensor with the expected values.
- Repeat the test multiple times to ensure consistent and accurate readings.
- Features Tested: Temperature sensing, Humidity sensing, Readings accuracy and consistency.
- The readings are consistent across multiple test runs.
- No interference or significant issues observed during testing.



4.4 Temperature & Humidity readings on DHT11 sensor

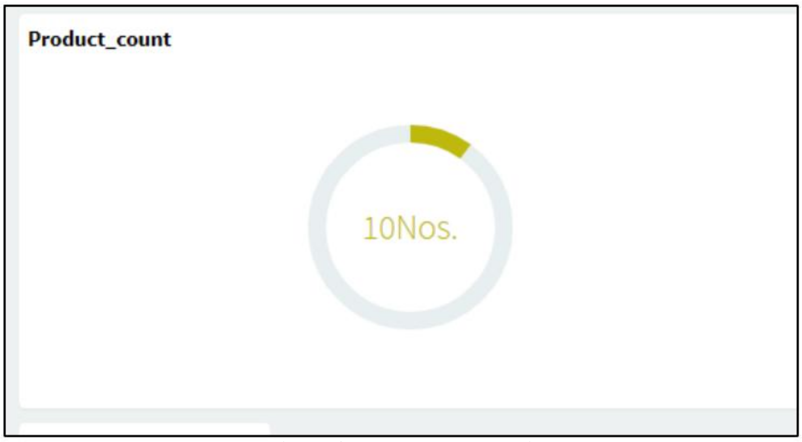
4.1.7 Test and Validation for Flame Sensor

- Connect the flame sensor to the appropriate pins of ESP8266.
- Write a test code to detect and respond to flame presence.
- Present a flame source to the sensor and observe the response.
- Repeat the test with varying flame intensities and distances to evaluate detection accuracy and sensitivity.
- Ensure the sensor responds correctly by activating a connected device (e.g., water pump) upon flame detection.
- Features Tested: Flame detection accuracy, Sensitivity to flame intensity and distance, Triggering of connected device upon flame detection.
- Proper triggering of connected devices upon flame detection observed.

4.5 Flame detected on dashboard via Flame sensor

4.1.8 Test and Validation for IR Sensor

- Connect the IR sensor to the ESP8266.
- Write a test code to detect the presence of objects using the IR sensor.
- Place objects of different sizes and materials within the sensor's range and observe the detection.
- Evaluate the accuracy of object detection by comparing the sensor's output with the actual presence of objects.
- Test the sensor's response time and sensitivity to different objects.
- Features Tested: Object detection accuracy, Response time and sensitivity
- No interference or significant issues observed during testing.



4.6 Working of IR sensor counting the products

4.1.9 Test and Validation for Fan and Motor

- Connect the fan and motor to the appropriate pins of the ESP8266.
- Write a test code to control the activation and deactivation of the fan and motor.
- Verify that the fan and motor turn on/off as expected based on sensor inputs or programmed conditions.
- Test different speed settings for the fan to ensure proper control.
- Evaluate the stability and reliability of the fan and motor operation during extended periods of use.
- Features Tested: Activation and deactivation control, Speed control of the fan
- No interference or significant issues observed during testing.

4.1 Test and Validation of Arduino Code

```
#include

#include


#define USERNAME "Enter your username"

#define DEVICE_ID "Enter your Device ID"

#define DEVICE_CREDENTIAL "Enter your Credential"


const int IRPIN = 2;     // IR sensor pin

#define FLAME_PIN 5  // Flame sensor pin

#define DHTPIN 14     // DHT11 sensor pin

#define Buzzer 3     // Buzzer pin

#define FANPIN 10     //Fan pin

#define MOTOR_PIN 12  // Motor pin

#define DHTTYPE DHT11      // DHT11 sensor type

DHT dht11(DHTPIN, DHTTYPE);  // initialize DHT11 sensor object


int count = 0;          // product count variable

int lastState = LOW;     // last IR sensor state

int currentState = LOW;  // current IR sensor state


#define SSID "Enter Wi-Fi Name"

#define SSID_PASSWORD "Enter Wi-fi Password"
```

```
ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);

float temperature,humidity;

void setup() {
   Serial.begin(9600);
  pinMode(IRPIN, INPUT);
  pinMode(FLAME_PIN, INPUT);
  pinMode(Buzzer, OUTPUT);
  pinMode(FANPIN, OUTPUT);
  pinMode(MOTOR_PIN, OUTPUT);

  thing.add_wifi(SSID, SSID_PASSWORD);  // add wifi credentials
  thing["count"] >> [](pson& out) { out = count; };  // read product count

 thing["dht11"] >> [](pson& out) {
    out["temperature"] = temperature;
    out["humidity"] = humidity;
    };

 thing["flame"] >> [](pson& out) {
    out = digitalRead(FLAME_PIN);
  };
```

```
  thing["fan"] << digitalPin(FANPIN);

  thing["motor"] << digitalPin(MOTOR_PIN);  // read motor status

  dht11.begin();

}

void loop() {
  thing.handle();  // handle ThingSpeak communication
  temperature = dht11.readTemperature();  // read temperature
  humidity = dht11.readHumidity();
  int flame_value = digitalRead(FLAME_PIN);
  thing.stream(thing["dht11"]);

  lastState = currentState;
  currentState = digitalRead(IRPIN);

  if (lastState == LOW && currentState == HIGH)
  {
    count++;
    Serial.print("Product count: ");
    Serial.println(count);
  }
```

```
 if (temperature > 35 || humidity >70) {
   digitalWrite(FANPIN, 0);            // turn on fan
    pson data;
     data["temperature"] = temperature;
     data["humidity"] = humidity;
     thing.call_endpoint("HVAC_Notification", data);
 }else{
    digitalWrite(FANPIN, 1);
 }
 if (flame_value == 0) {
   digitalWrite(MOTOR_PIN, 0);  // turn on motor if flame is detected
    pson data;
     data["Flame"] = flame_value;
   thing.call_endpoint("Flame_Notification", data);
   digitalWrite(Buzzer, 1);
   delay(100);
   digitalWrite(Buzzer, 0);
   delay(100);
 } else {
   digitalWrite(MOTOR_PIN, 1);  // turn off motor if flame is not detected
 }
}
```

CHAPTER 5

5.1 BUSINESS ASPECTS

The smart factory system developed using ESP8266, Arduino Uno, sensors and actuators brings together various technologies to automate factory system and access control. The integration of these components into a seamless solution offers convenience, efficiency, and enhanced security compared to tradition factory.

Market Potential:

The manufacturing sector, which is experiencing an increase in demand for automation and smart solutions, is the target market for the IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project.

Cost Savings:

For industrial organizations, the project might result in significant cost savings by automating a variety of operations and procedures.

Improved Quality and Compliance:

Real-time monitoring of crucial parameters is made possible by the adoption of sensor integration, ensuring quality control and adherence to industry standards.

Scalability and Flexibility:

The architecture of the project is created to be scalable and flexible to the unique requirements of various industrial environments.

Data-driven Decision Making:

Large volumes of data generated by the sensors may be gathered, stored, and analyzed because to the project's cloud connectivity.

Enhanced Customer Satisfaction:

The project gives producers the tools they need to deliver goods more quickly, with better quality, and with more customization possibilities.

Regulatory Compliance:

The project ensures compliance with safety, environmental, and quality standards by taking into account the legislative requirements that apply to the manufacturing sector.

Business Growth and Sustainability:

Companies can position themselves as innovative and forward-thinking by adopting smart industrial solutions.

Return on Investment (ROI):

The IoT-based Smart Factory System may need a substantial initial investment, but over time, the project's potential for cost savings, efficiency gains, quality enhancements, and competitive advantage could result in a sizable return on investment.

5.2 FINANCIAL CONSIDERATIONS

The budget for the project would depend on various factors such as the scale of implementation, hardware and software costs, development resources, and any additional expenses related to research, testing, and documentation. But the budget of the components (ESP8266, Arduino Uno, LCD, IR, DHT11, Flame sensors, Relay, etc.) development tools and software licenses, server or hosting costs and any other miscellaneous expenses are mentioned in the **Table 2.1**

- Initial investment required for hardware, software, and infrastructure setup.
- Ongoing operational costs for maintenance, software updates, and connectivity.
- Potential cost savings through improved efficiency and resource utilization.
- Return on Investment (ROI) based on increased output and reduced expenses.
- Financial viability assessed through payback period and profitability projections.
- Funding options such as internal budget, external financing, or grants.
- Cost-benefit analysis to compare benefits against investment costs.
- Risk management plan to mitigate financial risks.
- Long-term sustainability and scalability of the project.
- Monitoring and evaluation of financial performance and benefits.

5.3 CONCLUSION AND RECOMMENDATION

In summary, the IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project offers great advantages to the manufacturing industry. By using Internet of Things technologies, the project aims to improve efficiency, product quality, and resource management in factories.

By seamlessly integrating sensors and connecting to the cloud, the project enables real-time monitoring of important factors like temperature, humidity, weight, and flame detection. This helps make better decisions, predict maintenance needs, and optimize processes for increased productivity and reduced downtime.

The project also provides valuable insights and analytics through cloud connectivity, allowing for informed decision-making and continuous process improvement. Storing and analyzing sensor data in the cloud offers a flexible and scalable solution for long-term data management.

- The project represents a significant advancement in the manufacturing industry, leveraging the power of Internet of Things technologies to enhance operational efficiency and optimize resource utilization.
- By seamlessly integrating sensors and establishing cloud connectivity, the project enables real-time monitoring of crucial parameters such as temperature, humidity, weight, and flame detection, leading to proactive decision-making and process optimization.

Recommendations:

- Regular Maintenance: Ensure regular maintenance and calibration of sensors and hardware components to ensure accurate data collection and reliable system performance.
- Software Updates: Continuously update and optimize the software system to incorporate new features, enhance security, and address any identified bugs or vulnerabilities.
- Data Security: Implement robust data security measures to protect sensitive information collected by the sensors, including encryption, access controls, and regular security audits.
- Data Analysis and Insights: Regularly analyze the collected data to identify patterns, trends, and areas for process improvement. Use data analytics tools and techniques to gain actionable insights for better decision-making.
- Training and Support: Provide comprehensive training and support to the staff members responsible for operating and maintaining the system. Ensure they have the necessary knowledge and skills to effectively utilize the system and troubleshoot any issues.
- Integration with ERP Systems: Explore integration possibilities with existing enterprise resource planning (ERP) systems to streamline operations, optimize resource allocation, and enable seamless data exchange between different systems.

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AI Detection Report Content

Government of Karnataka
Department of Collegiate and Technical Education

Board of Technical Examinations, Bangalore

IOT Based Smart Factory System with Sensor
Integration and Cloud Connectivity

Submitted by
Gagan M Kakol (170EC20017)
Under the guidance of
Mr. Gopalkrishna BE, M.Tech (VLSI Design), MISTE

In partial fulfilment of the award of Diploma in Electronics and Communication Engineering

Department of Electronics and Communication Engineering
Government Polytechnic College,
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CERTIFICATE
This is to certify that the project report entitled “IOT BASED SMART FACTORY SYSTEM WITH SENSOR INTEGRATION AND CLOUD CONNECTIVITY”, submitted by GAGAN M KAKOL (170EC20017) is the bonafied work completed under my supervision and guidance in partial fulfilment for the award of Diploma in Electronics and Communication Engineering Government Polytechnic College, Harihar during the academic year 2022-23.

Place: Harihar
Date: / /

Cohort Owner Head of Department Principle

DECLARATION

I hereby declare that the thesis entitled, " IOT BASED SMART FACTORY SYSTEM WITH SENSOR INTEGRATION AND CLOUD CONNECTIVITY " is submitted to the Board of Technical Examination, Bangalore as an award of Diploma in Electronics and Communication Engineering carried out by me in the Department of Electronics and Communication Engineering Government Polytechnic Harihara under the supervision of Mr. Gopalkrishna, Lecturer E&C department, Government Polytechnic Harihara for the year 2022-23.

The primary data in the study of “IOT Based Smart Factory System with Sensor Integration and Cloud Connectivity” project is collected by me together with my project associates. I further declare that the study of the project as not formed the basis for award of Diploma in Electronics and Communication Engineering.

Gagan M Kakol (170EC20017)
Government Polytechnic College,
Harihar

Place: Harihar
Date: / /

I

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II

EXECUTIVE SUMMARY

The IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project uses the power of Internet of Things technologies. By combining various sensors and connecting them to the cloud connectivity, we create a smooth and seamless system, this system revolutionizes factory operations by enabling automation, optimization, and real-time monitoring. These sensors encompass temperature and humidity sensors, flame sensors, infrared (IR) sensors for product counting, and load cells for precise weight measurement. The data collected from these sensors serves as a valuable resource, offering deep insights into the factory environment and facilitating informed decision-making for enhanced operational efficiency. By implementing our IoT-based Smart Factory System, manufacturers gain unprecedented levels of efficiency, and productivity. The integration of sensors, cloud connectivity, and data analytics provides invaluable insight.
The IoT-based Smart Factory System provides a many number of advantages to manufacturers. It automates critical processes such as activating ventilation systems based on temperature and humidity readings, or triggering water pumps in response to flame detection. The system also offers real-time display of weight measurements, allowing precise monitoring of product quantities.

.

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ABBREVIATIONS & NOTATION

Table 1: Abbreviations

English Symbols Meaning
IR Infrared
MCU Micro Controller Unit
Wi-Fi Wireless Fidelity
BLE Bluetooth Low Energy
LCD Liquid Crystal Display
BO Battery operated
IDE Integrated Development Environment
WBS Work Breakdown Structure
CBS Cost Breakdown Structure
IOT Internet Of Things
DTE Department of Technical Examinations
PPT Power Point Presentation
HVAC Heat Ventilation and Air Conditioning
ESP Event Stream Processing
VIA Virtual Interface Architecture
UI User Interface
SOC Security Operational Center
CPU Central Processing Unit
RISC Reduced Instruction Set Computer
GPIO General Purpose Input/ Output
SPI Serial Peripheral Interface
I2C Inter-Integrated Circuit

IC Integrated circuit
PWM Pulse With Modulation
MHz Mega Hertz
VCC Voltage Common Controller
NO Normally Open
NC Normally Close

Com Common
AC Alternate Current
DC Direct Current
PCB Printed Circuit board
NTC Negative Temperature Coefficient
NM Nano Meter
RPM Rotation Per Minute
GNU General Public License
USB Universal Serial Bus
IOT Internet of Things

CHAPTER 1

1.1 INTRODUCTION

The IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project makes use of the Internet of Things. By combining various sensors and connecting them to the cloud, a seamless and fluid system is produced. This technology enables automation, optimization, and real-time monitoring, revolutionising factory processes.

This category of sensors consists of temperature and humidity sensors, flame sensors, infrared (IR) sensors for product counting, and load cells for precise weight measurement. Data from these sensors is a valuable resource that offers in-depth perceptions into the industrial environment and aids in the formulation of well-informed decisions for improved operational efficiency.

An important success of our project is the seamless integration of cloud connectivity. By connecting the smart manufacturing system and the cloud, we make it possible for the safe transfer and archival of sensor data in online databases.

The IoT-based Smart Factory System offers manufacturers a wide range of benefits. It automates crucial procedures like triggering water pumps in response to flame detection or activating ventilation systems based on temperature and humidity sensors. Additionally, the system provides weight measurements in real-time, enabling accurate product quantity monitoring.

Implementing our IoT-based Smart Factory System helps manufacturers achieve previously unheard-of levels of production and efficiency. Data analytics, cloud connectivity, and sensor integration together offer priceless knowledge. In our project, we made use of the following hardware and software elements:

i. Node MCU ESP8266 with integrated Wi-Fi and BLE connectivity which is used in a wide range of applications.
ii. Arduino Uno
iii. LCD display
iv. Load cell sensor
v. HX711 amplifier

vi. IR sensor
vii. Flame sensor
viii. DHT11 sensor
ix. BO motor
x. Node MCU base connector
xi. Fan
xii. Motor pump
xiii. 2channel 5v Relay
xiv. Arduino IDE
xv. Thinger.io Cloud platform

1.2 SCOPE OF THE CAPSTONE PROJECT

 Sensor Integration: In order to monitor and manage the manufacturing system, the Smart Factory System project gathers data from sensors like IR, flame, DHT11, and load cells. The production line, the arriving area, the packaging line safety area, etc. all have sensors built in. This will facilitate the collection of additional data, real-time decision-making, and process improvement.

 Wireless Communication and Cloud Integration: The Project system is connected to the Wi-Fi using Microcontroller board Node MCU ESP8266 to interface with Thinger.io cloud platform. For remote monitoring and to control the system. This improves operational efficiency and responsiveness by giving real-time access to vital information.

 Remote Monitoring and Notifications: We are using Thinger.io cloud platform to enable operate remotely and collect data in data buckets, to track of system life, and get notifications alerts for any accidents or incidents. This makes easy for predictive maintenance, reducing downtime and increasing productivity.

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 User Interface and Data Visualization: The LCD panel of the system displays real-time weight measurements as well as other essential data, enhancing user interaction and simplifying data interpretation. This intuitive interface enables operators to efficiently monitor processes and take choices.

 Power Management and Scalability: The concept employs energy-saving methods to cut down on power usage while also taking scalability into account for potential future growth or the incorporation of extra sensors. As a result, eco-friendly practices are promoted and the changing demands of the smart factory are satisfied.

 Documentation and Support: The project assures thorough documentation, which includes user manuals and instructions, to help users set up, configure, and troubleshoot systems. Continuous assistance is offered to address any technical problems or questions, fostering efficient functioning and user pleasure.

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CHAPTER 2

2.1 CAPSTONE PROJECT PLANNING

We meticulously plan and organise our project throughout the crucial capstone project planning stage of the project management process. It supports our decision-making process and aids in our comprehension of the project's goal. Planning allows us to identify what has to be done, when it should be done, and who will be in charge of each activity. It makes sure that everyone is on the same page and striving to achieve the same goal. Overall, by offering a strategy for its implementation, capstone project planning creates the conditions for a project's success.

2.1.1 Work Breakdown Structure (WBS) for Smart Factory system

Work Breakdown Structure shows the project tasks level from beginning to end of the project, and objectives of smart factory system. It provides a roadmap to build a project with successful with co-ordination.

Figure 2.1 Flow chart of Work Breakdown structure (WBS)

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2.1.2 Timeline Development – Schedule for Smart Factory system

Week-1: Discussing about our capstone project with the reference of marketing scope.
Week-2: Prepared a literature survey based on discussed with the group members.
Week-3: Planning & designing of our project “IOT Based Smart Factory with Sensor Integration and Cloud Connectivity" & collecting related document of our project
Week-4: To start basic requirement of project as per requirement & configuration.
Week-5: To buy the electronic interfacing modules like controller, sensors, and fabrication materials
Week-6: To start a programing for in our project we are using "ARDUINO IDE” software.
Week-7: As per programming to create as separate or individual components circuit diagram with reference of coding.
Week-8: Searched for perfect cloud platform and finalize the Thinger.io Cloud.
Week-9: To complete coding part then finish up necessity of a fabrication works.

Week-10: To connect the hardware components with the controller as per coding instruction then finalize our project.
Week-11: Integration of components as per required for capstone project.

Week-12: To start necessity document preparation for individual components and make a Report on chapter 1-3.
Week-13: Prepared a project banner for introduction and fitted to the wall.
Week-14: To check the report as per DTE plagiarism to check Plagiarism and reduce up to 35%.
Week-15: Finalize our Project designing, testing, and Plagiarism.
Week-16: Planning for PPT and demonstration.

Figure 2.2 Flow chart of Time line schedule

2.1.3 Cost Breakdown Structure (CBS) for Smart Factory system
In our project we have used various components that are listed below with their cost.

Table 2.1 – Cost Breakdown Structure (CBS) Table

Sl. No	Components	Quantity	Cost
1	NodeMCU	1	500
2	Load Cell	1	700

3	Flame Sensor	1	200
4	IR Sensor	1	200
5	DHT11	1	200
6	Mini Fan	1	200
7	Buzzer	1	100
8	Water Pump	1	200
9	DC Motor	2	300
10	jumpers	1set	250

11

Smoke Sensor

1

200

12

Wooden Board

1

200

13

Arduino Uno

1

750

Total

4000

8

2.1.4 Capstone project risk analysis for Smart Factory system

Potential risks and uncertainties are recognised, evaluated, and managed during the critical process of risk analysis in project management. Understanding potential difficulties and how they could affect project goals is helpful. Proactive steps can be taken to mitigate risks and guarantee project success by undertaking a risk analysis.

• Technical risks: Incompatibility between the ESP8266 and Arduino Uno boards, leading to integration challenges.
• Safety risks: Insufficient protection measures for electrical components, leading to potential hazards.
• Employee resistance: The implementation of a smart not supportive for employees who are not familiar with new technologies.
• High upfront costs: Implementing a smart factory can be expensive, investment in advanced technologies and infrastructure.
• Performance risks: insufficient testing to software problems or inaccurate sensor readings.
• Time risks: Delays in the obtaining of required hardware components, causing a delay in project timeline.

2.2 REQUIREMENTS SPECIFICATION
2.2.1 Functional

 Automate turning on of ventilation through HVAC system according to the DHT11.
 Real-time display of the weight of products on the 16*2 LCD display.
 Ability to control the speed of the conveyor belt via ESP8266.
 Automatically turning on of water pump through flame sensor when flame detected.
 Storing the data of all sensors in the data buckets for easy retrieval and analysis.
 Maximum number of products per day was counted through IR sensor via conveyor belt.

2.2.2 Non-Functional (Quality Attributes)
• The system should be capable of handling an increasing workload or expanding requirements
• The UI and overall system design should be user-friendly
• The system should very Strong security measures to protect sensitive data and prevent unauthorized access.
• The system should be stable and operate continuously without any failures.
• The system should demonstrate high performance, with low latency and fast response times.
• The system should be implemented in a way to facilitates for easy to maintenance and to update or replace the components without disrupting the overall system.
2.2.3 User Input
 In this system user input is not needed.
 Only is to monitor the Factory Environment.
 Only you can control the speed of work through web dashboard.
2.2.4 Technical Constrains
 The Microcontrollers used in this, such as NodeMCU and Arduino, having processing capabilities and memory limitations.
 The range and stability of WiFi network could impose constraints on the system functionality.
 The components require a stable power supply to operate effectively.
 The accuracy and reliability of the sensors can impact the overall system.
 The system involves data transmission and remote access and malicious activities is crucial
 The project should consider environmental factors, such temperature and dust that may impact the performance of the hardware components.

2.3 Software and Hardware Details
2.3.1 ESP8266
The open-source NodeMCU firmware and development board are designed specifically for Internet of Things (IoT) applications. Hardware based on the ESP-12 module is used along with firmware that is powered by Espressif Systems' ESP8266 Wi-Fi SoC.

Figure 2.3 Pinout Diagram of Nodemcu ESP8266
CPU

L106 32-bit RISC microprocessor

GPIO

16 Pins

UART

4

SPI

4

I2C

1

Input Voltage

7-12 Volts

Output Voltage

3.3 volts

Wi-Fi

802.11 b/g/n

Bluetooth

BLE (shares the radio with Wi-Fi)

Clock Speed

80 MHz

Table 2.2 Nodemcu ESP8266 Specification Table
In our project we have used the ESP8266 Development Board to get the data from all sensors and sends to the actuators and analyze it and send the data to Cloud and check it and get back the corresponding output from the server and collected in different data buckets.

2.3.2 Arduino Uno
Using an 8-bit ATmega328P microprocessor as its foundation, the popular Arduino Uno development board. A crystal oscillator, serial communication, a voltage regulator, and other supporting parts are included with the ATmega328P MCU IC to help the microcontroller function.

Figure 2.4
Pinout Diagram of Arduino Uno
CPU

ATmega328P – 8 bit AVR family microcontroller

Analog pins

6 Pins

Digital pins

14 Pins

Serial pins

Rx, Tx

PWM

5 Pins

Input Voltage

6 to 12 volts

Output Voltage

5 volts

SPI

4 Pins

Flash memory

ATmega328P – 8 bit AVR family microcontroller

Clock Speed

16 MHz

Table 2.3 Arduino Uno Specification Table
In our project we have used the Arduino Uno Development Board to get the Weight Measure data from Load cell and analyze it and send the data to HX711 amplifier and check it and get back the corresponding output from the Arduino and LCD display.

2.3.3 Relay
With a few additional capabilities, such optical isolation, the dual-channel relay module is essentially identical to a single-channel relay module. A microcontroller's pins can be utilised to switch mains powered loads using the dual-channel relay module.
Figure 2.5 Pinout Diagram of 2channel 5v Relay
Current when
relay is active

~70mA (single), ~140mA (both)

GND

Input ground reference

IN1

Input to activate the first relay

IN2

Input to activate the second relay

VCC

Input for directly powering the relay coils

Supply Voltage

3.75V to 6V

Trigger current

5mA

maximum

current

10A

maximum
contact voltage

250VAC, 30VDC

Clock Speed

240MHz

Table 2.4 2channel 5v Relay Specification Table
In our project we have used the 2channel 5v Relay used for fan and water
pump for external supply when esp8266 triggered these two will turn on through
relay module.

2.3.4 LCD Display
16x2 LCD modules are very commonly used in most embedded projects,
the reason being its cheap price, availability, programmer friendly and available
educational resources.

Figure 2.6 Pinout Diagram of LCD display

Vss (Ground)

Ground pin connected to system ground

Data pins

8 Pins

Vdd

Powers the LCD with +5V (4.7V – 5.3V)

VE (Contrast
V)

Decides the contrast level of display. Grounded to get
maximum contrast.

Register Select

Connected to Microcontroller to shift between
command/data register

Input Voltage

4.7V to 5.3V

Current
consumption

1mA

Read/Write

Used to read or write data. Normally grounded to write data
to LCD

Enable

Connected to Microcontroller Pin and toggled between 1 and
0 for data acknowledgement

LED Positive

Backlight LED pin positive terminal

Table 2.5 16*2 LCD Display Specification Table
In our project we have used the 16*2 LCD Display to get the weight
measured data from load cell through HX711 amplifier and Arduino Uno
microcontroller.

14

2.3.5 ESP8266 Base connector
ESP8266 Base connector is a used for Nodemcu Esp8266 for external
supply.

Figure 2.7 Pinout Diagram of ESP8266 Base connector
PCB
Thickness

1.6mm

Pin Pitch:

2.54mm (0.1in)

UART

3

SPI

4

I2C

2

Input Voltage

6V – 24V DC

Output Voltage

5 volts

NodeMCU Pin
Distance
between sides

~28.0mm

Board
Dimensions

60.0mm x 60.0mm x 15.0mm (L x W x H)

Weight:

22.5 g

Table 2.6 ESP8266 Base connector Specification Table

Pins for Extra connections for microcontroller ESP8266, it will powered by adaptor.

2.3.6 IR Sensor
The IR sensor module consists mainly of the IR Transmitter and Receiver, Op-amp, Variable Resistor (Trimmer pot), output LED along with few resistors

Figure 2.8 Pinout Diagram of IR sensor

VCC

Power Supply Input

GND

Power Supply Ground

OUT

Active High Output

Range

Up to 20cm

supply current

20mA

Input Voltage

3.3 to 5 volts

Table 2.7 IR sensor Specification Table
In our project we have used the IR Sensor for product counting in was installed in the conveyor belt, it counted data was send to cloud thinger.io and stored in the different data buckets.

2.3.7 DHT11 Sensor

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

Figure 2.9 Pinout Diagram of DHT11 sensor

Vcc	Power supply
Data	Outputs both Temperature and Humidity through serial Data
Ground	Connected to the ground of the circuit
Operating Voltage	3.5V to 5.5V
Operating current	0.3mA (measuring) 60uA (standby)
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%

Table 2.8 DHT11 Sensor Specification Table

In our project we have used the DHT11 Temperature and Humidity sensor Board to get the data of factory environment and analyze it and send the data to Cloud and check it and get back the corresponding output from the server and it to the Fan or HVAC system and make other corresponding actions if any available.

2.3.8 Flame Sensor

A sensor which is most sensitive to a normal light is known as a flame sensor. That’s why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source.

Figure 2.10 Pinout Diagram of Flame sensor

Pin1	VCC pin
Pin2	GND
Pin3	AOUT
Pin4	DOUT

A0	This is an analog output pin (MCU.IO)
Input Voltage	3.3V to 5.3V
D0	This is a digital output pin (MCU.IO)
Range	Upto 100cm
Wavelength	760 nm to 1100 nm

Table 2.9 Flame sensor Specification Table

In our project we have used the Flame sensor Board to get the data of fire detected in the factory environment and send the data to Cloud and check it and get back the corresponding output from the server and display it on the OLED Display and make other corresponding actions if any available.

2.3.9 BO motor

It is a BO Series 1 100RPM DC Motor Plastic Gear Motor. The BO series straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors.

Figure 2.11 Pinout Diagram of BO motor

MOTOR

Permanent Magnet DC Gear Motor BO(Battery Operated)

VOLTAGE(V)

3-9v

CURRENT

0.01A(no load);0.07A(at max. eff.)

LOCKED-
ROTOR
CURRENT

>=0.15A

SPEED(RPM)

60RPM+-10%(no load)

TORQUE

0.5Kg-cm

ROTATION

CW/CCW

MOUNTING
TYPE

Horizontal or Vertical

Table 2.10 BO motor Specification Table
In our project we have used the 2 Bo motors are used parallel the conveyor belt, and we can adjust the speed of conveyor belt through the motors.

2.3.10 Mini 9v water pump
A 9V water pump is a small device that uses a 9-volt battery to pump water. It has a motor and rotating blades that push the water out. It's handy for things like aquariums or fountains.

Figure 2.12 Pinout Diagram of Water pump
Diameter

7mm

Max Flow
Rate

100L/H

Temperature	-20~50°C
Voltage	9V DC
Maximum Rated Current	0.18A - Power: 0.36W

Table 2.11 Water Pump Specification Table
In our project we have used the 9v water pump for safety of factory environment, when flame sensor detects the will triggered and the data was sent to the thinger cloud.

2.3.11 Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Figure 2.13 Pinout Diagram of Buzzer

frequency range	3,300Hz
Operating Temperature ranges	– 20° C to +60°C
voltage ranges	3V to 24V DC
sound pressure level	85dBA or 10cm
supply current	below 15mA

Table 2.12 Buzzer Specification Table
In our project we have used the as actuator for flame sensor, when flame detects the buzzer will vibrates for every one second.

2.3.12 Arduino IDE software
Arduino is a firm that creates and produces single-board microcontrollers and microcontroller kits for creating digital devices. It is an open-source hardware and software initiative. The software is distributed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), allowing anybody to produce Arduino boards and distribute the programme. Its hardware goods are licenced under a CC BY-SA licence. Commercial Arduino boards are offered on the official website or from accredited distributors.
Different microprocessors and controllers are used in the designs of Arduino boards. A variety of extension boards (referred to as "shields"), breadboards (used for prototyping), and other circuits may be interfaced to the boards' sets of digital and analogue input/output (I/O) pins. The boards have serial communications ports that are also used to load applications, including on some models, Universal Serial Bus (USB). The C and C++ programming languages, along with a modified version of the Processing IDE, can be used to programme the microcontrollers. This standard API is also referred to as the Arduino Programming Language.

2.3.12 Thinger.io Cloud platform
Thinger.io is a cloud IoT Platform that provides every needed tool to prototype, scale and manage connected products in a very simple way. Our goal is to democratise the use of IoT making it accessible to the whole world, and streamlining the development of big IoT projects.
Free IoT platform: Thinger.io provides a lifetime freemium account with just few limitations to start learning and prototyping when your product gets ready to scale, you can deploy a Premium Server with full capacities within minutes.
Simple but Effective With our web-based Console, which can connect and manage thousands of devices easily, you can connect a device and start retrieving data or controlling its functions with just a few lines of code.

Hardware independence: The infrastructure of Thinger.io can be simply integrated with any device from any manufacturer.
Extremely scalable and effective infrastructure: A single Thinger.io instance can manage thousands of IoT devices with little computational load, bandwidth, and latency thanks to our novel communication paradigm, in which the IoT server subscribes device resources to retrieve data only when it is necessary.
Open-Source: The majority of the platform modules, libraries, and APP source code can be downloaded and modified under the terms of the MIT licence by visiting our Github repository.
2.4 DESIGN SPECIFICATION
ESP8266 Microcontroller: The ESP8266 serves as the main control unit for the system. It is responsible for handling all the communication with the sensors and actuators and managing data flow between different components.
 Arduino Uno: The Arduino controls the Weighing scale machine and displays real-time information about the weight of products on LCD screen.
 DHT`11: The temperature and humidity sensor monitors and provides surrounding environment, and it was connected to the cloud through microcontroller.
 Flame Sensor: The flame sensor monitors and provides information about the safety of the factory, and it was connected to the cloud through microcontroller.
 IR Sensor: The IR sensor and provides information about the number of Products manufactured, and it was connected to the cloud through microcontroller.

 Fan: The fan is controlled by temperature and humidity sensor based on the surrounding temperature it operates.

 Water Pump: The pump is controlled by Flame sensor it acts as a fire extinguisher.

Figure 2.14 Circuit Diagram of Smart Factory

Figure 2.15 Circuit Diagram of Weighing Scale machine

Figure 2.16 Smart Factory System Project Model

CHAPTER 3

3.1 APPROACH & METHODOLOGY

1. Requirement Analysis: We thoroughly understanding the specific needs and objectives of the project for Smart Factory system. This helps us understand the needful functions and determine the integration of sensors and cloud connectivity. The components that are used for our project as per requirement analysis they are ESP8266, Arduino Uno, Load cell, LCD display, Base connector , sensors, actuators, and etc.

2. Technology Research: We will more research to explore available technologies, sensor types, cloud platforms, and protocols. This research enables us to select the most suitable components and tools for the project. In our project Smart Factory system we implemented Thinger.io Cloud platform and Arduino IDE software platform, etc.

3. System Design: Based on the requirements analysis and technology research, we design the Smart Factory system in detailed. This involves the placement and configuration of sensors, Microcontrollers, Actuators, defining communication protocols, and outlining the integration with Thinger cloud services.

4. Hardware Setup: After all these three steps next to set the hardware components, such as Esp8266, Arduino, Conveyor belt, Load cell, HVAC system and communication modules. This step up includes proper wiring and compatibility between components, and testing to ensure proper functioning.

5. Software Development: Develop the necessary software components, including firmware for microcontrollers used for programming the Arduino and Esp8266, user interface software, and data handling algorithms. The software facilitates seamless communication between sensors, actuators, and the cloud platform.

6. Testing and Optimization: To test the software and hardware components, we conduct testing and optimization process to verify the reliability, accuracy, and performance of the

project Smart Factory system. This includes verifying the performance and functionality of sensor readings, efficiency of testing control mechanisms, and evaluating overall system functionality and they work as expected and meet the requirements of the project.

7. Documentation: We prepare comprehensive documentation, including system manuals, user guides, working principles, working procedures, references, used system versions, when the last update done, time period for maintenance and technical specifications. This documentation will serve as a reference for future maintenance, or system expansion.

8. Deployment: Once fully tested and documented, we deploy the system in the factory environment. We provide ongoing support and maintenance to address any issues and make necessary improvements.
Figure 3.1 Block diagram of Approach and Methodology

Figure 3.2 Flow chart of Approach and Methodology

CHAPTER 4
4.1 TEST AND VALIDATION
Test and validation is crucial and important part of a project or system it helps as to find out any errors in the system. And solve them before deployment of the project.
4.1.1 Test and Validation for ESP8266
 Connect the ESP8266 to the power supply and check it boots up successfully.
 Write a test code to establish a Wi-Fi connection and send/receive data.
 The ESP8266 module successfully establishes a Wi-Fi connection to the specified network.
 Connect the GPIO pins with LED, buttons or any devices and check the pins correct working.
 Features tested: Wi-Fi connectivity, Data transmission and reception.
 No interference or significant issues observed during testing.
 Check that ESP8266 is compatible with required of your project like libraries, programming and cloud that you use for the project. Make that all the things mentioned above works perfectly in ESP8266.

4.1 ESP8266 is connected to cloud via Wi-Fi

4.1.2 Test and Validation for Arduino Uno
 Connect the Arduino Uno to the computer and power source.
 Write a test code to perform basic operations, such as blinking an LED.
 Upload the test code to the Arduino Uno and verify the expected behavior.
 Test various input/output pins and verify their functionality.
 Evaluate the stability and reliability of the Arduino Uno during extended operation.
 All input/output pins function properly.
 No interference or significant issues observed during testing.

4.2.3 Test and Validation for Relay Module
 Apply the required supply voltage to the relay coil. Verify the switches that contacts form open to closed or closed to open when the coil is energized or de-energized
 Connect relay to suitable load example; Light or bulb, and also test the relay’s ability to handle specified current and voltage rating of load without exceeding maximum capacity
 Measure the time taken by the relay to energize or de-energize the coil. Observe the time with the manufacturer’s specification to ensure it works within the acceptable limits.
 Endurance testing of relay: repeatedly energize and de-energize the relay for extended period under operating condition. Make sure that the relay can handle more number of cycles without degradation or failure.

 Environmental testing of relay: test the relay in various condition like temperature, humidity. Make sure that relay can easily operate in these temperature condition and work perfectly.
 Apply minimum voltage that is needed to the relay in which relay works perfectly. Also test the relay by applying over voltage and low voltage make sure that it can handle both.

 Verify the relay with safety measures and conditions. Also check it for overvoltage, isolation protection against the electrical hazards.

4.2 Proper working of Relay Module

4.1.4 Test and Validation for Loadcell
 Connect the load cell to the appropriate interface circuitry and Arduino Uno.
 Write a test code to read and display weight measurements from the load cell.
 Calibrate the load cell to ensure accurate weight readings.
 Place known weights on the load cell and compare the readings with the expected values.
 Repeat the test with different weights to evaluate consistency and reliability.
 Features Tested: Weight measurement accuracy, Calibration functionality, Consistency and reliability of readings
 Consistent and reliable performance observed during testing.

4.3 Proper working of Load cell sensor Module

4.1.5 Test and Validation for LCD Display
 Connect the LCD display to the Arduino Uno.
 Write a test code to display text and/or numerical values on the LCD.
 Verify the readability of the displayed information under various lighting conditions.
 Test different display functionalities, such as scrolling and clearing the display.
 Evaluate the stability and reliability of the LCD display during continuous operation.
 Features Tested: Display readability, Display functionalities
 No interference or significant issues observed during testing.

4.1.6 Test and Validation for DHT11 Sensor
 Connect the DHT11 sensor to the ESP8266.
 Write a test code to read and display the temperature and humidity values.
 Place the sensor in a controlled environment with known temperature and humidity.
 Compare the readings from the DHT11 sensor with the expected values.
 Repeat the test multiple times to ensure consistent and accurate readings.
 Features Tested: Temperature sensing, Humidity sensing, Readings accuracy and consistency.
 The readings are consistent across multiple test runs.
 No interference or significant issues observed during testing.

4.4 Temperature & Humidity readings on DHT11 sensor

4.1.7 Test and Validation for Flame Sensor

- Connect the flame sensor to the appropriate pins of ESP8266.
- Write a test code to detect and respond to flame presence.
- Present a flame source to the sensor and observe the response.
- Repeat the test with varying flame intensities and distances to evaluate detection accuracy and sensitivity.
- Ensure the sensor responds correctly by activating a connected device (e.g., water pump) upon flame detection.
- Features Tested: Flame detection accuracy, Sensitivity to flame intensity and distance, Triggering of connected device upon flame detection.
- Proper triggering of connected devices upon flame detection observed.

4.5 Flame detected on dashboard via Flame sensor

4.1.8 Test and Validation for IR Sensor

- Connect the IR sensor to the ESP8266.
- Write a test code to detect the presence of objects using the IR sensor.
- Place objects of different sizes and materials within the sensor's range and observe the detection.
- Evaluate the accuracy of object detection by comparing the sensor's output with the actual presence of objects.
- Test the sensor's response time and sensitivity to different objects.
- Features Tested: Object detection accuracy, Response time and sensitivity
- No interference or significant issues observed during testing.

4.6 Working of IR sensor counting the products

4.1.9 Test and Validation for Fan and Motor

- Connect the fan and motor to the appropriate pins of the ESP8266.
- Write a test code to control the activation and deactivation of the fan and motor.
- Verify that the fan and motor turn on/off as expected based on sensor inputs or programmed conditions.
- Test different speed settings for the fan to ensure proper control.
- Evaluate the stability and reliability of the fan and motor operation during extended periods of use.
- Features Tested: Activation and deactivation control, Speed control of the fan

- No interference or significant issues observed during testing.

4.1 Test and Validation of Arduino Code

```
#include <ThingerESP8266.h>
#include <DHT.h>

#define USERNAME "Enter your username"
#define DEVICE_ID "Enter your Device ID"
#define DEVICE_CREDENTIAL "Enter your Credential"

const int IRPIN = 2; // IR sensor pin
#define FLAME_PIN 5 // Flame sensor pin
#define DHTPIN 14 // DHT11 sensor pin
#define Buzzer 3 // Buzzer pin
#define FANPIN 10 //Fan pin
#define MOTOR_PIN 12 // Motor pin
#define DHTTYPE DHT11 // DHT11 sensor type
DHT dht11(DHTPIN, DHTTYPE); // initialize DHT11 sensor object

int count = 0; // product count variable
int lastState = LOW; // last IR sensor state
int currentState = LOW; // current IR sensor state

#define SSID "Enter Wi-Fi Name"
#define SSID_PASSWORD "Enter Wi-fi Password"
```



```
ThingerESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);

float temperature,humidity;

void setup() {
Serial.begin(9600);
pinMode(IRPIN, INPUT);
pinMode(FLAME_PIN, INPUT);
pinMode(Buzzer, OUTPUT);
pinMode(FANPIN, OUTPUT);
pinMode(MOTOR_PIN, OUTPUT);

thing.add_wifi(SSID, SSID_PASSWORD); // add wifi credentials
thing["count"] >> [](pson& out) { out = count; }; // read product count

thing["dht11"] >> [](pson& out) {
out["temperature"] = temperature;
out["humidity"] = humidity;
};

thing["flame"] >> [](pson& out) {
out = digitalRead(FLAME_PIN);
};
```



```
thing["fan"] << digitalPin(FANPIN);

thing["motor"] << digitalPin(MOTOR_PIN); // read motor status

dht11.begin();
```

```
}

void loop() {
thing.handle(); // handle ThingSpeak communication
temperature = dht11.readTemperature(); // read temperature
humidity = dht11.readHumidity();
int flame_value = digitalRead(FLAME_PIN);
thing.stream(thing["dht11"]);

lastState = currentState;
currentState = digitalRead(IRPIN);

if (lastState == LOW && currentState == HIGH)
{
count++;
Serial.print("Product count: ");
Serial.println(count);
}
```



```
if (temperature > 35 || humidity >70) {
digitalWrite(FANPIN, 0); // turn on fan
pson data;
data["temperature"] = temperature;
data["humidity"] = humidity;
thing.call_endpoint("HVAC_Notification", data);
}else{
digitalWrite(FANPIN, 1);
}
if (flame_value == 0) {
digitalWrite(MOTOR_PIN, 0); // turn on motor if flame is detected
pson data;
data["Flame"] = flame_value;
thing.call_endpoint("Flame_Notification", data);
digitalWrite(Buzzer, 1);
delay(100);
digitalWrite(Buzzer, 0);
delay(100);
} else {
digitalWrite(MOTOR_PIN, 1); // turn off motor if flame is not detected
}
}
```


CHAPTER 5

5.1 BUSINESS ASPECTS

The smart factory system developed using ESP8266, Arduino Uno, sensors and actuators brings together various technologies to automate factory system and access control. The integration of these components into a seamless solution offers convenience, efficiency, and enhanced security compared to tradition factory.

Market Potential:

The manufacturing sector, which is experiencing an increase in demand for automation and smart solutions, is the target market for the IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project.

Cost Savings:

For industrial organizations, the project might result in significant cost savings by automating a variety of operations and procedures.

Improved Quality and Compliance:

Real-time monitoring of crucial parameters is made possible by the adoption of sensor integration, ensuring quality control and adherence to industry standards.

Scalability and Flexibility:
The architecture of the project is created to be scalable and flexible to the unique requirements of various industrial environments.

Data-driven Decision Making:
Large volumes of data generated by the sensors may be gathered, stored, and analyzed because to the project's cloud connectivity.

Enhanced Customer Satisfaction:
The project gives producers the tools they need to deliver goods more quickly, with better quality, and with more customization possibilities.

Regulatory Compliance:
The project ensures compliance with safety, environmental, and quality standards by taking into account the legislative requirements that apply to the manufacturing sector.

Business Growth and Sustainability:
Companies can position themselves as innovative and forward-thinking by adopting smart industrial solutions.

Return on Investment (ROI):
The IoT-based Smart Factory System may need a substantial initial investment, but over time, the project's potential for cost savings, efficiency gains, quality enhancements, and competitive advantage could result in a sizable return on investment.

5.2 FINANCIAL CONSIDERATIONS
The budget for the project would depend on various factors such as the scale of implementation, hardware and software costs, development resources, and any additional expenses related to research, testing, and documentation. But the budget of the components (ESP8266, Arduino Uno, LCD, IR, DHT11, Flame sensors, Relay, etc.) development tools and software licenses, server or hosting costs and any other miscellaneous expenses are mentioned in the Table 2.1

- Initial investment required for hardware, software, and infrastructure setup.
- Ongoing operational costs for maintenance, software updates, and connectivity.
- Potential cost savings through improved efficiency and resource utilization.
- Return on Investment (ROI) based on increased output and reduced expenses.
- Financial viability assessed through payback period and profitability projections.
- Funding options such as internal budget, external financing, or grants.
- Cost-benefit analysis to compare benefits against investment costs.
- Risk management plan to mitigate financial risks.
- Long-term sustainability and scalability of the project.
- Monitoring and evaluation of financial performance and benefits.

5.3 CONCLUSION AND RECOMMENDATION
In summary, the IoT-based Smart Factory System with Sensor Integration and Cloud Connectivity project offers great advantages to the manufacturing industry. By using Internet of Things technologies,

the project aims to improve efficiency, product quality, and resource management in factories.

By seamlessly integrating sensors and connecting to the cloud, the project enables real-time monitoring of important factors like temperature, humidity, weight, and flame detection. This helps make better decisions, predict maintenance needs, and optimize processes for increased productivity and reduced downtime.

The project also provides valuable insights and analytics through cloud connectivity, allowing for informed decision-making and continuous process improvement. Storing and analyzing sensor data in the cloud offers a flexible and scalable solution for long-term data management.

 The project represents a significant advancement in the manufacturing industry, leveraging the power of Internet of Things technologies to enhance operational efficiency and optimize resource utilization.

 By seamlessly integrating sensors and establishing cloud connectivity, the project enables real-time monitoring of crucial parameters such as temperature, humidity, weight, and flame detection, leading to proactive decision-making and process optimization.

Recommendations:

 Regular Maintenance: Ensure regular maintenance and calibration of sensors and hardware components to ensure accurate data collection and reliable system performance.

 Software Updates: Continuously update and optimize the software system to incorporate new features, enhance security, and address any identified bugs or vulnerabilities.

 Data Security: Implement robust data security measures to protect sensitive information collected by the sensors, including encryption, access controls, and regular security audits.

 Data Analysis and Insights: Regularly analyze the collected data to identify patterns, trends, and areas for process improvement. Use data analytics tools and techniques to gain actionable insights for better decision-making.

 Training and Support: Provide comprehensive training and support to the staff members responsible for operating and maintaining the system. Ensure they have the necessary knowledge and skills to effectively utilize the system and troubleshoot any issues.

 Integration with ERP Systems: Explore integration possibilities with existing enterprise resource planning (ERP) systems to streamline operations, optimize resource allocation, and enable seamless data exchange between different systems.

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