BOILER TANK TEMPERATURE MONITORING SYSTEM USING IOT

A PROJECT BASED LEARNING REPORT

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BONAFIDE CERTIFICATE

Certified that this Project-Based Learning report of **“BOILER TANK TEMPERATURE MONITORING SYSTEM”** is the bonafide work of **“PRANAV S (21CS068), PRAVEEN N (21CS069), SEHSHAN SURYA G (21CS081), VIGNESH V (21CS111)”** who carried out the project work under my supervision.

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ABSTRACT

In this IoT endeavor, an ESP-8266 microcontroller serves as the cornerstone for monitoring temperature and humidity. Data acquisition is seamlessly facilitated by wireless transmission to the Blynk IoT app, where comprehensive visualization and analysis await. Leveraging the ESP32's multifaceted connectivity capabilities, real-time monitoring and management of environmental parameters are made effortless. This integration empowers users with unparalleled access to accurate data, fostering informed decision-making and precise control over their surroundings. Through the fusion of hardware and software, this project epitomizes the potential of IoT technology in providing actionable insights for optimizing environmental conditions and enhancing user comfort and efficiency

LIST OF FIGURES

LIST OF ABBREVATIONS

ESP-8266	Espressif System Programmable System on Chip
DHT	Digital Humidity and Temperature
IOT	Internet of Things
UI	User Interface

CHAPTER -1

INTRODUCTION

1.1 INTRODUCTION: BOILER TANK TEMPERATURE MONITORING SYSTEM

In today's industrial landscape, efficient and safe operation of boiler tanks is paramount. Temperature regulation within these tanks not only ensures optimal performance but also safeguards against potential hazards. Recognizing the critical importance of monitoring boiler tank temperature, our project aims to develop an innovative IoT-based solution utilizing readily available components.

The primary objective of our project is to design and implement a robust IoT system capable of continuously monitoring the temperature of boiler tanks. By leveraging the power of Internet of Things (IoT) technology, we intend to create a versatile and cost-effective solution that provides real-time temperature data for enhanced operational efficiency and safety.

This system comprises several key hardware components, including the ESP8266 Wi-Fi Module, DHT11 Temperature and Humidity Sensor, and supporting accessories such as breadboards, jumper wires, and USB cables. Through seamless integration of these components, we aim to establish a reliable and scalable platform for monitoring boiler tank temperature in various industrial settings.

By providing real-time temperature data accessible remotely via wireless connectivity, our IoT Boiler Tank Temperature Monitoring System offers operators the ability to proactively manage boiler operations, identify potential issues, and implement timely interventions. This proactive approach not only optimizes operational efficiency but also mitigates risks associated with temperature fluctuations, thereby ensuring a safer and more reliable industrial environment.

1.2 SCOPE OF THE PROJECT:

Our IoT Boiler Tank Temperature Monitoring System encompasses a comprehensive range of functionalities and features aimed at delivering a robust and versatile solution for industrial boiler management. The scope of the project includes:

1. Hardware Implementation:

- Integration of ESP8266 Wi-Fi Modules and DHT11 Temperature and Humidity Sensors into a cohesive hardware setup.
- Utilization of breadboards, jumper wires, and USB cables for prototyping and connecting the components.
- Testing and calibration of hardware components to ensure accurate temperature readings and reliable wireless connectivity.

2. Software Development:

- Writing firmware for the ESP8266 modules to enable data transmission and communication with the DHT11 sensors.
- Implementation of algorithms for temperature data processing, including error handling and calibration routines.
- Integration with Wi-Fi networks and protocols for seamless connectivity and data transfer to remote monitoring stations.

3. Remote Monitoring and User Interface:

- Development of user-friendly interfaces for accessing real-time temperature data and system status remotely.
- Implementation of data visualization tools for presenting temperature trends and historical data.
- Integration with web-based or mobile platforms to enable convenient access to monitoring features from any location.

4. Scalability and Adaptability:

- Designing the system architecture to support scalability for monitoring multiple boiler tanks within a facility.
- Implementation of modular components and protocols to facilitate easy integration with existing industrial automation systems.
- Consideration of environmental factors and industrial standards to ensure compatibility and reliability across diverse operational environments.

5. Documentation and Support:

- Creation of comprehensive documentation including hardware schematics, software codebase, and user manuals.

- Provision of technical support and troubleshooting resources to assist users in system setup, configuration, and maintenance.
- Continual refinement and updates based on user feedback and evolving industry standards to enhance system performance and usability.

In summary, the scope of our project encompasses the design, implementation, and deployment of a sophisticated IoT solution for monitoring boiler tank temperature in industrial settings. Through meticulous attention to hardware integration, software development, user interface design, and scalability considerations, we aim to deliver a reliable, user-friendly, and future-proof system that empowers operators with real-time insights for optimizing boiler operations and ensuring safety and efficiency in industrial environments.

CHAPTER -2

HARDWARE DESCRIPTION

2.1 ESP-8266:

The ESP8266 Wi-Fi Module stands as a cornerstone in the realm of IoT hardware, boasting a rich array of features essential for building robust and efficient connected systems. At its core lies a formidable 32-bit Tensilica L106 microcontroller unit, capable of handling diverse tasks with ease. Operating at clock speeds reaching up to 80 MHz, this MCU ensures swift execution of instructions, vital for real-time processing in IoT applications.

One of the module's standout features is its integrated Wi-Fi connectivity, adhering to IEEE 802.11 b/g/n standards. This empowers seamless wireless communication, enabling the module to effortlessly connect to existing networks or serve as an access point for other devices. Such versatility is a boon in scenarios where network integration and connectivity are paramount.

Memory and storage capabilities are equally impressive, with flash memory options ranging from 512 KB to 4 MB. This provides ample space for firmware, configuration data, and web server resources, ensuring smooth operation and flexibility in application development. Coupled with onboard RAM for dynamic memory allocation, the ESP8266 adeptly handles data buffering and resource management.

2.2 DHT11:

The DHT11 Temperature and Humidity Sensor is a fundamental component in our IoT boiler tank temperature monitoring system, offering precise measurements of environmental conditions crucial for operational efficiency and safety. Below, we delve into the intricate hardware features of this sensor:

Nestled within the DHT11 sensor is a high-performance microcontroller, meticulously calibrated to ensure accuracy and reliability in temperature and humidity sensing. Its compact yet robust design makes it an ideal choice for embedded applications where space is a premium.

The heart of the sensor lies in its capacitive humidity sensor, meticulously designed to detect even the slightest changes in humidity levels with unparalleled precision. This enables the sensor to provide real-time humidity readings essential for maintaining optimal conditions within the boiler tank.

Complementing its humidity sensing capabilities is a highly sensitive thermistor, meticulously calibrated to provide accurate temperature measurements across a wide range of operating conditions. This ensures that operators have precise insights into temperature variations within the boiler tank, enabling proactive intervention to prevent potential issues.

In terms of connectivity, the DHT11 sensor boasts a straightforward interface, typically comprising a digital signal output that communicates temperature and humidity data to the microcontroller or host system. This simplicity in communication streamlines integration into our IoT system, facilitating rapid deployment and seamless operation.

2.3 BREAD BOARD:

Central to the prototyping phase of our IoT boiler tank temperature monitoring system is the breadboard—a versatile tool that facilitates the temporary assembly and testing of electronic circuits without the need for soldering. Here, we explore the key hardware attributes of the breadboard

At its core, the breadboard features a grid of interconnected metal clips housed within a durable plastic enclosure. This grid is divided into multiple rows and columns, with each row typically dedicated to a specific electrical node or component connection point. These rows are further divided into groups of five interconnected clips, allowing for convenient insertion and connection of components.

The breadboard's design promotes flexibility and ease of use, enabling rapid iteration and modification of circuit layouts during the prototyping phase. Components such as microcontrollers, sensors, and resistors can be securely inserted into the breadboard's clips, forming temporary electrical connections without the need for soldering.

2.4 B TYPE USB CABLE:

The B Type USB cable plays a crucial role in powering and interfacing with the ESP8266 Wi-Fi modules in our IoT boiler tank temperature monitoring system. Below, we delve into the key hardware features of this essential component:

The B Type USB cable is characterized by its distinctive trapezoidal connector shape, which is designed to interface with devices featuring B Type USB ports. This connector configuration ensures a secure and reliable connection, minimizing the risk of accidental disconnection during operation.

At one end of the cable is the B Type USB connector, which plugs into the corresponding port on the ESP8266 Wi-Fi module. This connector is typically equipped with sturdy housing and reinforced contacts to withstand frequent insertions and removals, ensuring durability and longevity in demanding usage scenarios.

The other end of the cable features a standard Type-A USB connector, which plugs into a USB power source such as a computer, USB wall adapter, or power bank. This connector provides the necessary power to the ESP8266 module, enabling it to function autonomously or communicate with other devices over the Wi-Fi network.

The B Type USB cable is constructed using high-quality materials, including robust shielding and insulated wires, to minimize signal interference and ensure reliable data transmission. This shielding helps maintain signal integrity, particularly in environments with high electromagnetic interference or noise.

Furthermore, the cable's length and flexibility provide convenience and versatility in various deployment scenarios. Whether connecting the ESP8266 module to a nearby computer for programming and debugging or to a distant power source for standalone operation, the cable offers ample reach and maneuverability.

2.5 JUMPER WIRES:

Jumper wires are essential components in our IoT boiler tank temperature monitoring system, facilitating the interconnection of various electronic components on the breadboard and enabling seamless integration of the hardware subsystems. Below, we explore the key hardware features of these versatile wires:

Jumper wires are slender, flexible conductors typically made from copper or aluminum, encased in insulating materials such as PVC or silicone. This construction ensures electrical conductivity while providing flexibility and durability, making them ideal for routing connections within electronic circuits.

These wires come in various lengths, colors, and gauges to accommodate different circuit layouts and requirements. Shorter wires are suitable for close-range connections between adjacent components on the breadboard, while longer wires offer flexibility in spanning larger distances within the circuit.

Jumper wires feature connectors or tips at each end, which may be designed to fit snugly into the sockets on the breadboard or to attach securely to the pins of electronic components. These connectors ensure reliable electrical contact, minimizing signal loss and ensuring proper circuit operation.

The insulation surrounding the conductive core of the jumper wires serves to prevent short circuits and electrical interference between adjacent wires or components. Additionally, the insulation provides protection against accidental contact with conductive elements, enhancing safety during circuit assembly and testing.

Jumper wires are available in different configurations, including male-to-male, male-to-female, and female-to-female variants, to accommodate various connection requirements. Male-to-male wires are commonly used for direct connections between components, while male-to-female and female-to-female wires facilitate connections between components and the breadboard or other interfaces.

CHAPTER 3

SOFTWARE DECRIPTION

3.1 BLYNK IOT APP:

The Blynk IoT app serves as the interface between users and our boiler tank temperature monitoring system, providing real-time access to temperature data, system status, and control functionalities from any location. Below, we delve into the key features and capabilities of this versatile mobile application:

The Blynk app offers a user-friendly and intuitive interface, designed to streamline the process of monitoring and controlling IoT devices remotely. With its sleek design and customizable dashboards, users can effortlessly visualize temperature trends, set alert thresholds, and interact with the system's functionalities with just a few taps on their mobile devices.

One of the app's standout features is its seamless integration with a wide range of IoT hardware platforms, including the ESP8266 Wi-Fi module used in our monitoring system. Through Blynk's extensive library of supported hardware, users can easily configure and connect their devices to the app, eliminating the need for complex setup procedures and enabling rapid deployment of IoT solutions.

Real-time data visualization is a hallmark of the Blynk app, empowering users to monitor temperature fluctuations within the boiler tank with precision and accuracy. Customizable widgets such as graphs, gauges, and value displays provide a comprehensive view of temperature trends over time, enabling users to identify patterns and anomalies quickly.

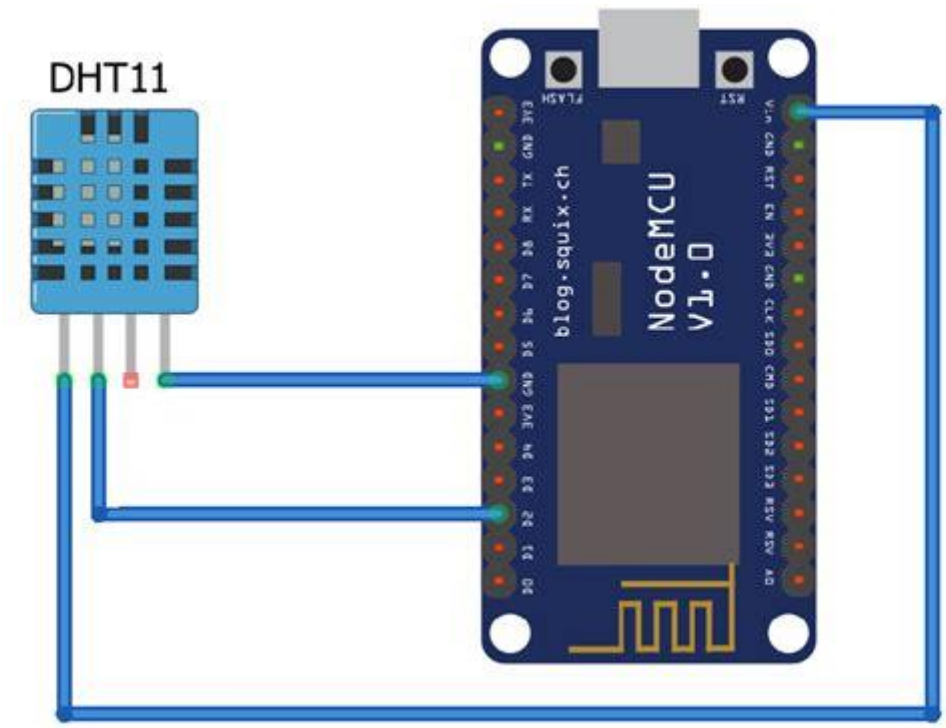
In addition to monitoring, the Blynk app offers robust alerting and notification features to keep users informed of critical events and system status updates. Users can set custom alert thresholds for temperature deviations, triggering notifications via push notifications, email, or SMS, ensuring timely intervention in case of emergencies or abnormal conditions.

Furthermore, the Blynk app supports bi-directional communication, allowing users to remotely control system parameters and adjust settings as needed. Whether activating heating elements, adjusting temperature setpoints, or toggling system modes, users can execute commands seamlessly from the convenience of their mobile devices, enhancing operational flexibility and efficiency.

The app's cloud-based architecture ensures seamless synchronization of data across multiple devices, enabling collaborative monitoring and control of the boiler tank temperature monitoring system. With support for both Android and iOS platforms, the Blynk app offers universal accessibility, empowering users to stay connected and informed anytime, anywhere.

In summary, the Blynk IoT app serves as a powerful tool for monitoring, controlling, and managing IoT devices, including our boiler tank temperature monitoring system. With its user-friendly interface, real-time data visualization, robust alerting capabilities, and seamless integration with IoT hardware, the Blynk app provides a comprehensive solution for empowering users with actionable insights and remote control functionalities.

CIRCUIT DIAGRAM



CHAPTER 4

PROJECT DECRIPTION

In today's industrial landscape, the efficient and safe operation of boiler tanks is paramount. Boiler tanks serve a crucial role in various industries, from heating to power generation, and ensuring optimal temperature levels within these tanks is essential for maintaining efficiency and safety standards. Traditional methods of temperature monitoring often rely on manual checks or limited automation, which can lead to delays in identifying issues and responding to potential risks. To address these challenges, our project focuses on developing an innovative IoT-based solution for real-time boiler tank temperature monitoring.

The primary objective of our project is to design, implement, and deploy a robust IoT system capable of continuously monitoring the temperature of boiler tanks. Leveraging the power of Internet of Things (IoT) technology, we aim to provide operators with real-time insights into temperature fluctuations, enabling proactive maintenance and optimization of boiler operations. By harnessing IoT technology, we strive to create a versatile and cost-effective solution that enhances operational efficiency and safety in industrial environments

Our boiler tank temperature monitoring system offers a comprehensive range of functionalities designed to meet the diverse needs of industrial operators. Central to the system is its capability for real-time monitoring of boiler tank temperature, providing operators with immediate visibility into temperature trends and deviations. Continuous monitoring enables operators to detect anomalies early, facilitating timely interventions to prevent potential issues and optimize boiler performance.

In addition to real-time monitoring, our system features a customizable alerting mechanism that notifies operators of critical temperature thresholds or system malfunctions. These alerts enable operators to respond swiftly, mitigating risks and ensuring the safety and integrity of boiler operations. By providing operators with timely notifications, our system empowers them to take proactive measures to maintain operational efficiency and prevent costly downtime.

Furthermore, our boiler tank temperature monitoring system includes robust data logging and visualization capabilities. Temperature data is logged over time and presented through intuitive graphs and charts, allowing operators to analyze historical trends and identify patterns. This data-driven approach provides valuable insights for optimizing boiler operations, scheduling maintenance activities, and making informed decisions to improve overall efficiency and performance.

Remote access functionality is another key feature of our system, allowing operators to monitor temperature data and adjust system parameters from anywhere with internet connectivity. This remote access capability enhances operational flexibility, enabling operators to manage boiler operations efficiently and respond to changing conditions in real-time. Whether accessing the system from a control room or remotely monitoring operations from a mobile device, operators have the tools they need to ensure optimal performance and safety.

Implementing our boiler tank temperature monitoring system offers numerous benefits for industrial operators. Improved efficiency, enhanced safety, cost savings, and data-driven insights are just a few of the advantages our system provides. By leveraging IoT technology to provide real-time monitoring, alerting, and remote access functionalities, we empower operators with the tools and insights needed to optimize performance, ensure safety, and make informed decisions in industrial environments.

In conclusion, our boiler tank temperature monitoring system represents a proactive approach to enhancing efficiency, safety, and cost-effectiveness in industrial boiler operations. By leveraging IoT technology to provide real-time monitoring, alerting, and remote access functionalities, we empower operators with the tools and insights needed to optimize performance, ensure safety, and make informed decisions in industrial environments. With its comprehensive range of features and capabilities, our system offers a versatile and cost-effective solution for monitoring and managing boiler tank temperature in industrial settings.

CHAPTER 5

SCOPE FOR FUTURE ENHANCEMENT

While our boiler tank temperature monitoring system offers comprehensive functionality to meet current industrial needs, there are several areas where future enhancements can further improve its capabilities and address evolving requirements. The following are potential avenues for future enhancement:

Predictive Analytics: Integrating machine learning algorithms into the system to analyze historical temperature data and predict future temperature trends. This predictive capability can help operators anticipate potential issues and take proactive measures to prevent downtime and optimize performance.

Integration with Predictive Maintenance Systems: Enhancing the system's integration with predictive maintenance systems to enable predictive maintenance scheduling based on temperature data and equipment condition. By correlating temperature fluctuations with equipment health, operators can optimize maintenance schedules and minimize unplanned downtime.

Expansion to Multi-tank Monitoring: Extending the system's architecture to support monitoring of multiple boiler tanks within a facility. This expansion would involve scaling up the hardware infrastructure and software architecture to accommodate simultaneous monitoring and control of multiple tanks, enabling centralized management of boiler operations.

Integration with Energy Management Systems: Integrating the system with energy management systems to optimize energy consumption based on real-time temperature data. By correlating temperature fluctuations with energy usage, operators can identify opportunities for energy savings and implement energy-efficient strategies to reduce operational costs.

Enhanced Remote Monitoring and Control: Enhancing the remote monitoring and control capabilities of the system by incorporating advanced visualization tools, real-time alerts, and interactive dashboards. This would provide operators with a more intuitive and user-friendly interface for monitoring boiler operations and adjusting system parameters remotely.

Enhanced Security Features: Strengthening the security features of the system to protect sensitive temperature data and prevent unauthorized access or tampering. This may involve implementing advanced encryption techniques, multi-factor authentication, and intrusion detection systems to safeguard the integrity and confidentiality of the data.

Integration with Environmental Monitoring Sensors: Integrating environmental monitoring sensors, such as air quality sensors and humidity sensors, into the system to provide additional context for temperature readings. This holistic approach to monitoring can help operators identify environmental factors that may affect boiler performance and take corrective actions accordingly.

Cloud-based Data Analytics: Leveraging cloud-based data analytics platforms to perform advanced analytics on temperature data collected from multiple sources. Cloud-based analytics can provide scalability, flexibility, and computational power for processing large volumes of data and extracting actionable insights for optimizing boiler operations.

CHAPTER 6

RESULT AND DISCUSSIONS

6.1 CONCLUSION:

In the realm of industrial operations, the significance of real-time monitoring and control cannot be overstated. Our endeavor to develop a robust boiler tank temperature monitoring system represents a leap forward in ensuring efficiency, safety, and reliability in industrial boiler operations. Through the fusion of IoT technology, data analytics, and user-centric design, we have crafted a solution that empowers operators with actionable insights, proactive maintenance capabilities, and remote control functionalities.

Our system's ability to provide continuous monitoring of boiler tank temperature in real-time offers operators unprecedented visibility into temperature trends and deviations. This empowers them to detect anomalies early, respond swiftly to critical events, and optimize boiler performance for enhanced efficiency and reliability. The customizable alerting mechanism ensures that operators are promptly notified of temperature fluctuations or system malfunctions, enabling timely interventions to mitigate risks and prevent costly downtime.

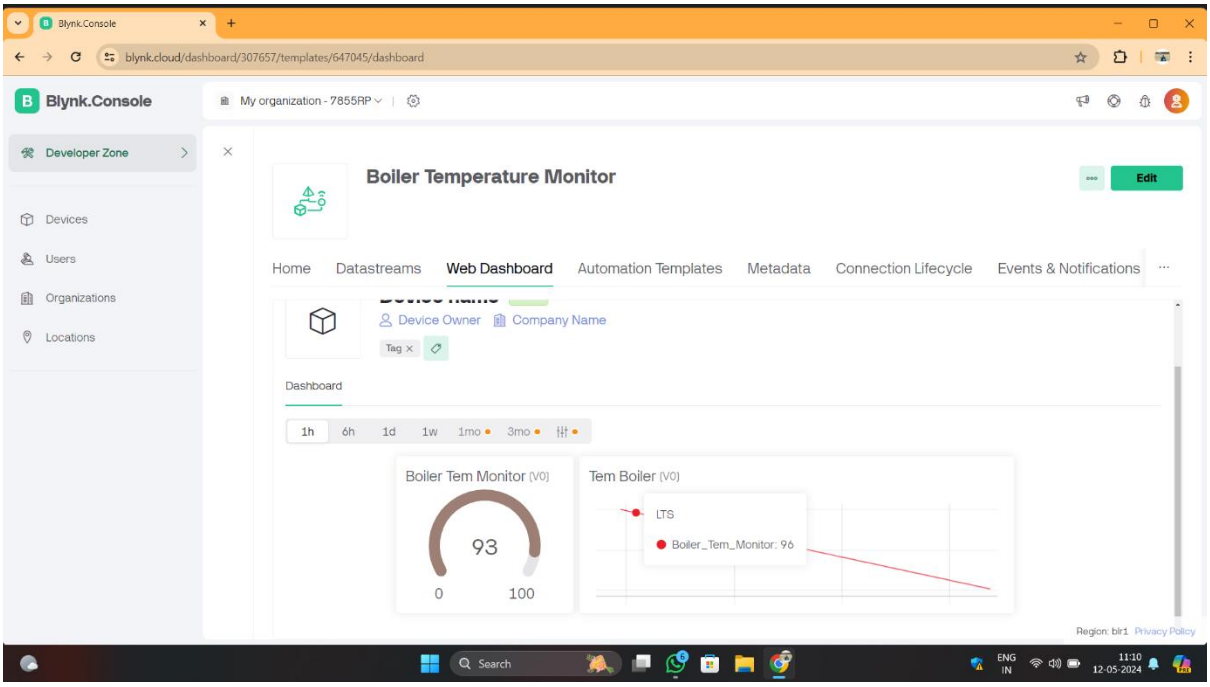
Furthermore, the integration of data logging and visualization features facilitates in-depth analysis of historical temperature data, allowing operators to identify patterns, optimize maintenance schedules, and make data-driven decisions to improve overall operational efficiency. The remote access functionality adds another layer of flexibility, enabling operators to monitor and control boiler operations from anywhere with internet connectivity, facilitating seamless management and optimization of boiler operations.

Looking ahead, our system presents numerous opportunities for future enhancement, including predictive analytics, integration with predictive maintenance systems, expansion to multi-tank monitoring, and integration with energy management systems, among others. By exploring these avenues, our system can evolve to meet the evolving needs of industrial operators, driving continuous improvement and innovation in boiler performance and safety.

In conclusion, our boiler tank temperature monitoring system represents a cornerstone in the quest for efficiency, safety, and reliability in industrial boiler operations. With its comprehensive functionality, user-centric design, and potential for future enhancement, our system stands poised to revolutionize the way boiler operations are managed and optimized, ushering in a new era of efficiency and excellence in industrial manufacturing.

6.2 SCREENSHOTS:

SCREENSHOT 1:



CHAPTER 7

APPENDIX

7.1 SOURCE CODE:

```
#define BLYNK_TEMPLATE_ID "TMPL3-JFrGhLG"
#define BLYNK_TEMPLATE_NAME "Boiler Temperature Monitor"
#define BLYNK_AUTH_TOKEN "Nc9EcRJWH86Y_RZ3_2mohr8nr7ZTIC2V"

#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

#include <DHT.h>


char auth[] = BLYNK_AUTH_TOKEN;

char ssid[] = "Samsung Galaxy F12";
char pass[] = "manoj051";

BlynkTimer timer;


#define DHTPIN 2
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);


void sendSensor()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }

    Blynk.virtualWrite(V0, t);
    Blynk.virtualWrite(V1, h);
    Serial.print("Temperature : ");
    Serial.print(t);
    Serial.print("    Humidity : ");
    Serial.println(h);
}
void setup()
{
```

```
  Serial.begin(115200);


  Blynk.begin(auth, ssid, pass);
  dht.begin();
  timer.setInterval(100L, sendSensor);

  }

void loop()
{
  Blynk.run();
  timer.run();
}
```

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