LabVIEW Based Temperature and Humidity Real-Time Monitoring System Using ML

Kulkarni Sheetal Vijay.[1], *Saahieel.K.Sasane*[2], *Mrunali.S.Bajare*[3] , *Rahul.A.Deshmukh*[4]

[1]Assistant Professor, [2,3,4]B.E Instrumentation Engineering

Department of Instrumentation Engineering
AISSMS Institute of Information Technology, Pune, India

Address

[1]sheetal.kulkarni@aissmsioit.org

[2]saahieelsasane24@gmail.com

***Abstract*— This project introduces a LabVIEW-based Real-Time Temperature and Humidity Monitoring System enhanced with AI predictive analytics. It enables real-time data acquisition from various sensors, ensuring accurate monitoring of environmental conditions. The system's AI algorithms predict future temperature and humidity trends, aiding in proactive decision-making. Users benefit from an intuitive graphical interface for data visualization, historical trend analysis, and alert notifications for threshold deviations. The system also offers remote monitoring capabilities, data logging, and reporting, enhancing its usability and accessibility. This integrated solution addresses the critical need for precise environmental monitoring, making it applicable across industries such as manufacturing, agriculture, and climate control, ultimately improving efficiency and decision-making in these domains.**

***Keywords*— LabVIEW, DAQ card, Artificial Intelligence, Machine learning**

I. Introduction

In today's world, monitoring environmental parameters such as temperature and humidity is crucial in various domains, including industrial processes, agriculture, and climate control. This project presents a comprehensive LabVIEW-based solution for real-time monitoring of temperature and humidity, enhanced by AI algorithms for predictive analytics. Our system employs LabVIEW as the primary software platform, which provides an intuitive graphical interface for data acquisition, processing, and visualization. Temperature and humidity data are collected in real-time from various sensors and devices, ensuring accurate and up-to-date information.

We attempt to succinctly summarize the applications of data capture (mostly, but not exclusively, temperature and humidity data) with LabVIEW in this post. A portion of our material came from books and the internet, and we also mentioned work from 40 research articles from various journals. Our focus during the survey was on LabVIEW applications used for data acquisition. applications. We have included a detailed table in the literature study that will provide readers with some insights into a variety of applications for temperature data collection in LabVIEW. Additional information about LabVIEW's uses in various applications is offered in the piece.

II. The Key Components of Our System Includes:

1. Sensor Integration: We integrate a range of temperature and humidity sensors, such as thermocouples, thermistors, and humidity sensors, into the LabVIEW environment. These sensors are strategically placed in the target environment to collect relevant data.

2.Real-Time Data Acquisition: LabVIEW is configured to continuously acquire data from the sensors, ensuring that Temperature and humidity levels are recorded in real time.

3. Data Visualization: The collected data is displayed in a user-friendly graphical interface, allowing users to monitor the current environmental conditions. Historical data is also available for trend analysis.

4. Ai-Based Predictive Analytics: To enhance the system's capabilities, we incorporate AI algorithms for predictive analytics. Machine learning models are trained on historical data to predict future temperature and humidity trends. These predictions help users make informed decisions and take proactive measures to maintain optimal conditions.

5. Alerts And Notifications: The system is equipped with alerting mechanisms to notify users when temperature or humidity levels deviate from predefined thresholds. This ensures timely responses to critical changes in the environment.

6. Data Logging And Reporting: All data, including real-time measurements and AI predictions, is logged for further analysis. Reports can be generated to summarize trends and anomalies over time.

7. Remote Monitoring: The LabVIEW system can be configured for remote monitoring, allowing users to access real-time data and predictions from anywhere with an internet connection.

By integrating LabVIEW with AI-based predictive analytics, this project provides a robust and intelligent solution for temperature and humidity monitoring. It empowers users to maintain optimal environmental conditions, prevent issues, and improve overall efficiency in various applications.

III. SYSTEM DESIGN

Figure 1 depicts the system design framework, which shows that the system contains an NI MYDAQ card, physical factors such as temperature and humidity, data collecting and storage, as well as AI and machine learning for data acquisition and analysis. In which the NI MYDAQ card is used to connect LabVIEW software to system hardware such as temperature and humidity sensors, and in our instance, the DHT11 sensor, which is a combination of temperature and humidity sensors. The sensor observes its surroundings and atmosphere, collecting data that is subsequently processed by the NI MYDAQ card. The data is processed by an NI MYDAQ card, which turns raw data into computer-usable and intelligible data. This data is then sent to the host computer, where the real interfacing occurs between the computer and the NI MYDAQ card via serial transmission and correct communication between hardware and software is formed.

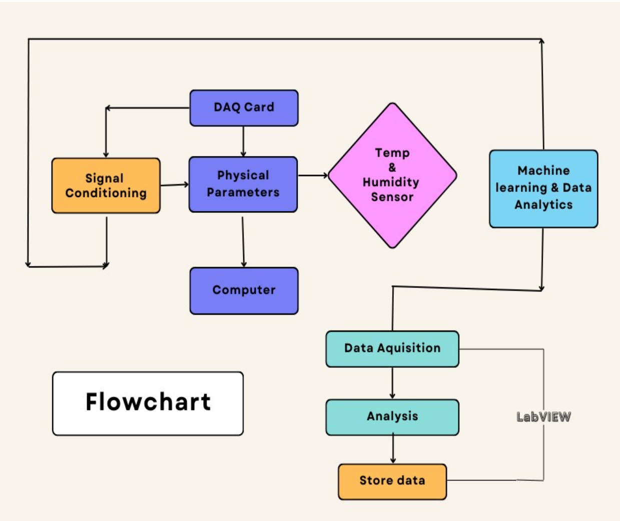


Fig. 1 Framework map of system design

The system then processes this data in accordance with the program and takes the appropriate action. Also, AI is utilized to do analysis on provided data and generate relevant predictions and information for future system actions and upgrades.

IV. SYSTEM HARDWARE DESIGN AND IMPLEMENTATION

CONNECTION OF TEMPERATURE SENSOR(THERMOCOUPLE) WITH NI MYDAQ CARD

The J-type thermocouple has two wires, one of which is attached to AI0+ (analog input 0 positive terminal) on the NI myDAQ card device and the other to AI0- (analog input 0 negative terminal).

This connection enables the myDAQ device to measure the voltage produced by the J-type thermocouple in response to temperature variations. You may read this voltage using LabVIEW or the necessary software, and then use calibration equations unique to the J-type thermocouple to transform the voltage measurements into precise temperature data.

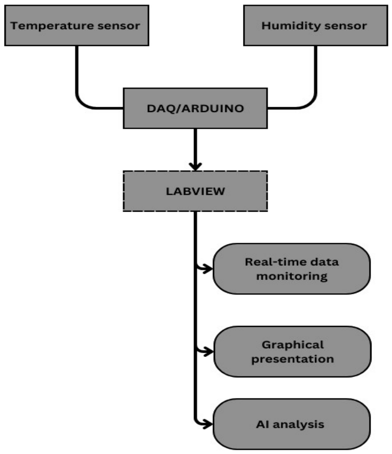
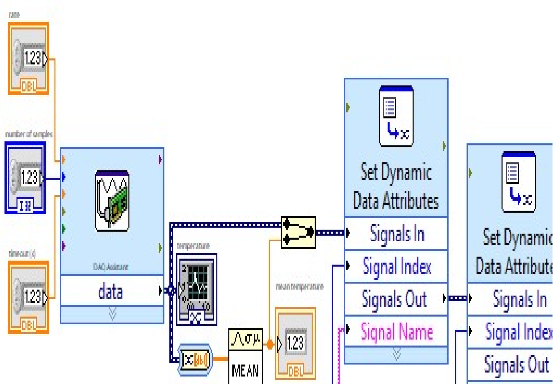


Fig. 2 Hardware Framework flowchart

V. System Software Design



A. LabVIEW programming for temperature measurement

1. *DAQ Assistant Block*: Begin by adding a DAQ Assistant block in LabVIEW. Configure this block by setting parameters like the sampling rate, number of samples required, and timeout settings. This block is used to interface with the NI myDAQ device and collect voltage data from the J-type thermocouple.

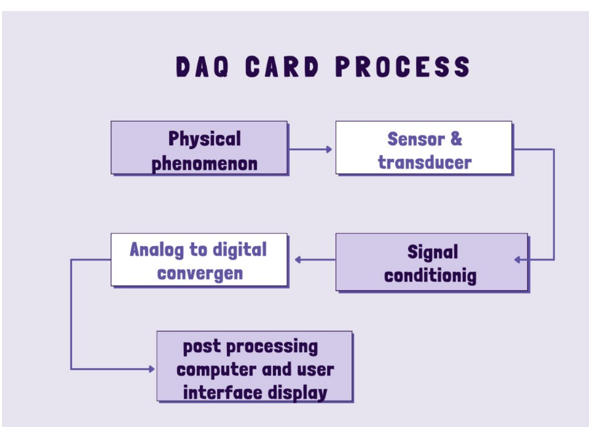


Fig. 3 NI myDAQ card process

2. *Temperature Data Collection:* Once the DAQ Assistant block is set, you'll retrieve temperature data from the J-type thermocouple. This data reflects the instantaneous temperature readings at the given sampling instances.

3. *Mean Temperature Calculation*: Next, you might calculate the mean temperature. Taking the mean (average) of multiple temperature readings over a specific duration can provide a more stable and representative value, reducing the impact of noise or fluctuations in individual measurements.

4. *Signal Manipulation Block (J-type Thermocouple):* Utilize a Signal Manipulation block to process the temperature data obtained from the thermocouple. This block might involve setting dynamic data attributes such as scaling or conversion factors specific to the J-type thermocouple. Assign a name to this block for identification purposes.

5. *Signal Manipulation Block (Mean Temperature):* Similarly, use another Signal Manipulation block, but this time for the mean temperature data. Set this block with constants or specific attributes relevant to handling the average temperature data.

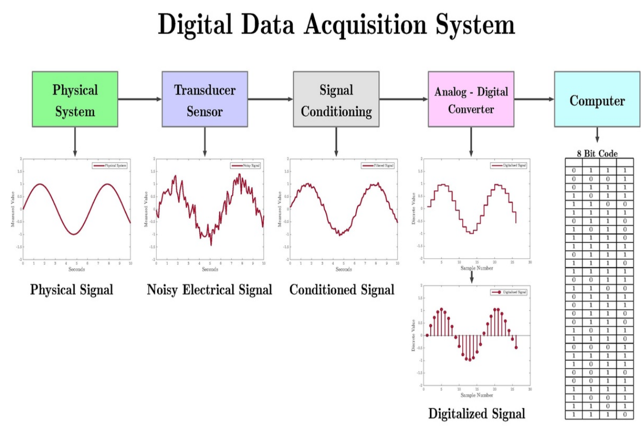


Fig. 4 Digital data acquisition system

6. *Data Output and Display:* To visualize and analyze the collected data, employ a DAQ Assistant output file. This file allows you to view all temperature measurement readings in a controlled manner. Configure its parameters to match your preferences, such as choosing indicators and controls for temperature visualization.

B. Important Blocks in LabVIEW programming

The reason for using the mean temperature calculation and signal manipulation blocks is to enhance data reliability and usability:

Mean Temperature Calculation: Averaging multiple readings helps mitigate errors or fluctuations inherent in individual measurements, providing a more stable representation of the overall temperature.

Signal Manipulation Blocks: These blocks enable you to preprocess and condition the raw temperature data. For thermocouples, this may involve applying calibration equations, scaling factors, or specific conversions to accurately translate voltage readings into temperature values.

This structured approach in LabVIEW allows for accurate data acquisition, processing, and presentation of temperature measurements obtained from the J-type thermocouple connected to the NI myDAQ device.

VI. Machine learning

The acquired data is logged by LabVIEW into an Excel file for subsequent analysis. The Excel sheet keeps track of temperature, humidity, date, and time.
In addition, the sheet computes and logs mean temperature and humidity data, as well as their timestamps.

Python Implementation: Python is used to evaluate data and anticipate future behavior using time series methods.
Data processing, analysis, and machine learning are performed using libraries such as pandas, NumPy, and scikit-learn.

Algorithm Implementation: Time series algorithms are used to estimate the future values of mean temperature and humidity data. Depending on the project needs, common algorithms such as ARIMA (Auto Regressive Integrated Moving Average) or LSTM (Long Short-Term Memory) might be utilized.

Prediction Results: Using the time series algorithms that have been constructed, the project produces forecasts for future temperature and humidity values.These forecasts shed light on the possible behavior of temperature and humidity throughout time.

VII. Literature Survey

Whisnumurti Adhiwibowo (2020) This study covers a novel technique that allows minuscule, processing-capable devices to record or retrieve information from a sensor and deliver it to a central computer. This technique has applications in a variety of fields, including agriculture and medicine. Many processes necessitate precise temperature and humidity monitoring, and this technology aids in meeting those requirements. The oyster mushroom cultivation technique is used to monitor temperature and humidity, with the temperature inside the culture range being between 25°C and 30°C and the humidity ranging from 70% RH to 90% RH. The goal of this project is to create an autonomous monitoring system based on Internet of Things technology, with the DHT22 sensor and Cayenne API serving as the data retrieval channel to the system. This monitoring system retrieves data from a DHT22 sensor and sends it to the farmers using a processing-capable device like a Raspberry Pi. The DHT22 sensor offers superior temperature and humidity accuracy compared to the DHT11 sensor. In comparison, DHT22 monitors temperature and humidity 4% and 18% more accurately. [3]

Shubham Gautam (2020) Conventional analog humidity sensors require signal circuit design, calibration, and modification; for these, linearity, recurrence swapping, and uniformity cannot be assured, nor can accuracy. Sensirion Company's new DHT11 and DHT22 temperature/humidity sensors relies on CMOSens technology, which integrates a CMOS chip into a sensor. The initial of this project's four components is the Humidity and Temperature Sensor DHT11, which measures the data related to temperature as well as humidity. Second, the data from the DHT11 sensor is extracted by Arduino Uno and sent to the Wi-Fi Modules as an appropriate value in percentage and degrees Celsius scale. Furthermore, the data is sent to ThingSpeak's Sever using the Wi-Fi Module ESP8266. and examines the information before presenting it as a graph.
Additionally, an indication of temperature and humidity display is provided via an optional LCD.

C. A. Belhadj (2017) LabVIEW Based Real time Monitoring of HVAC System for Residential Load. This study introduces and addresses the tracking, analysis, and assessment of performances of a Saudi Arabian home's heating, ventilation, and air conditioning (HVAC) system. In difficult and severe weather conditions, the installed air conditioning (A/C) system activates. The surrounding area is characterized by high ambient temperatures, irradiance, humidity, and frequent dust storms. The laboratory virtual instrument engineering workbench interface capabilities addressed a variety of objectives, including system parameter measurements and A/C unit performance evaluation. The built-in LabVIEW engine continually displays environmental metrics and electrical variables on the interface's front panel windows, including inside house air temperature at various places, ventilation, humidity, temperature outdoors, light intensity, wind direction, voltage, current, and power. LabVIEW has shown excellent performance while connecting to several devices at the same time, as well as the ability to display the behavior of multiple variables in real time. The suggested virtual instrument (VI) filters prioritized different activities. Cloud data presented in a multi-scale window frame is instructive and enlightening at the same time. System assessment and operations can benefit from the use of internet-based efficiency evaluation.

Hong Zhang, Fan Zhang (2020), A Kind of Design of Greenhouse Environment Monitoring System Based on LabVIEW. Greenhouses are becoming an essential infrastructure for farmers and businesses as contemporary agriculture evolves. Real-time monitoring of greenhouse environmental factors is crucial for optimizing growing conditions and generating more output and revenue. A greenhouse environmental monitoring system was developed using sensors, data collecting cards, and LabVIEW. The system transfers readings from temperature, humidity, CO2 concentration, and soil pH sensors to the computer via the NI 9201 data acquisition card and other hardware components. The software architecture enables automated monitoring of parameters. The device will alert if the temperature or humidity levels exceed the established parameters. The software successfully performed display, storage, alert, and other operations as required. The menu interface is user-friendly. The technology effectively monitors crop environmental factors.

Ong Wee Chuan, Siti Hawa Ruslan (2016), Medical Warehouse Monitoring and Control System Using LabVIEW. The project's purpose is to create a monitoring and control system for a medical warehouse to guarantee that the drugs housed there are preserved at the proper temperature and humidity levels1. The system uses LabVIEW software to provide a virtual instrument (VI) with a graphical user interface (GUI) for real-time monitoring and control of environmental conditions1. LabVIEW is used to display and log sensor data, while Arduino is the system's brain. Additionally, as soon as the email gets delivered, the user might receive an SMS alert. The user may link the code to get free alert SMS by setting the Google Calendar. When the environment's temperature & moisture go outside of the predetermined range, this system may notify the user by email, brief messages and LED display.

Rohit Agrawal, Saumitra Mohan (2012), Complete Industrial Solution for Automation in Temperature and Humidity Monitoring using LabVIEW. The study discusses the significance of controlling humidity and temperature in manufacturing facilities, especially in electronic assemblies. Lack of control over these elements may have an adverse effect on parts, machinery, procedures, and operator comfort, which could ultimately result in production losses. Although individuals must possess a certain skill set and undergo training before operating any given equipment, every industrial machinery is secured by a password to provide for controlled access. A red alarm messages for any humidity or temperature appears whenever these parameters exceed the designated limitations, and it is visible which specific place it is. In order to appropriately notify the user when the limitations are exceeded, the buzzer also sounds. The Wireless Sensor Network Module by National Instruments will be used to remotely monitor the temperature and humidity levels in various plant locations. The system provides and is based on the LabVIEW software platform.

VIII. EXPERIMENTAL RESULTS

Different tests are carried out with the system at high and low temperatures to test and evaluate the effectiveness of the temperature measurement system proposed in this work.

The system enables real-time temperature and humidity monitoring, which is critical for a variety of applications such as climate management in industrial settings, agricultural, and research areas.

The collected data, including raw measurements and forecasts, may be presented using graphs and charts, allowing for a more in-depth knowledge of environmental conditions.

The research improves the system's ability to forecast future temperature and humidity trends by using machine learning algorithms, allowing for proactive decision-making.

The following are the experimental outcomes of our system.

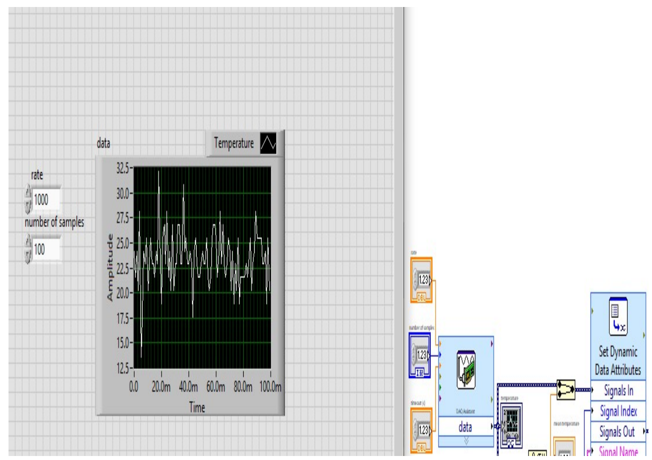
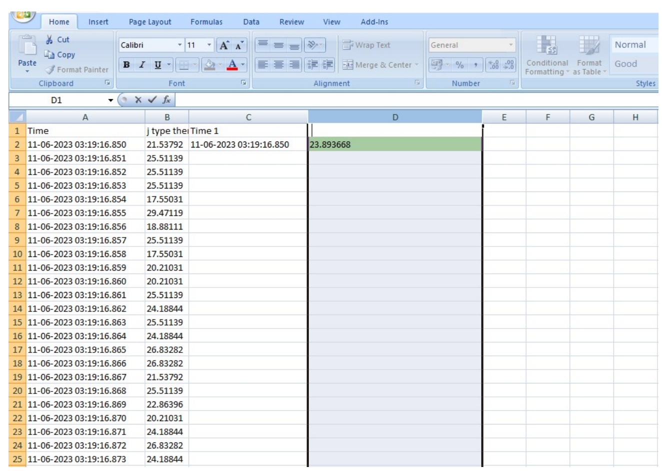


Fig 7. Experimental Result in Graph



	A	B	C	D
1	Time	j type ther	Time 1	
2	11-06-2023 03:19:16.850	21.53792	11-06-2023 03:19:16.850	23.893668
3	11-06-2023 03:19:16.851	25.51139		
4	11-06-2023 03:19:16.852	25.51139		
5	11-06-2023 03:19:16.853	25.51139		
6	11-06-2023 03:19:16.854	17.55031		
7	11-06-2023 03:19:16.855	29.47119		
8	11-06-2023 03:19:16.856	18.88111		
9	11-06-2023 03:19:16.857	25.51139		
10	11-06-2023 03:19:16.858	17.55031		
11	11-06-2023 03:19:16.859	20.21031		
12	11-06-2023 03:19:16.860	20.21031		
13	11-06-2023 03:19:16.861	25.51139		
14	11-06-2023 03:19:16.862	24.18844		
15	11-06-2023 03:19:16.863	25.51139		
16	11-06-2023 03:19:16.864	24.18844		
17	11-06-2023 03:19:16.865	26.83282		
18	11-06-2023 03:19:16.866	26.83282		
19	11-06-2023 03:19:16.867	21.53792		
20	11-06-2023 03:19:16.868	25.51139		
21	11-06-2023 03:19:16.869	22.86396		
22	11-06-2023 03:19:16.870	20.21031		
23	11-06-2023 03:19:16.871	24.18844		
24	11-06-2023 03:19:16.872	26.83282		
25	11-06-2023 03:19:16.873	24.18844		

Fig 9. Results in Excel sheet

Conclusions

Here in this research paper, we have presented a vast study on the design and implementation of a LabVIEW-based temperature sensor system. The primary objective of this study was to develop an accurate and reliable temperature measurement system suitable for various applications. Through a systematic approach, we have achieved the following key outcomes:

1. Design and Development: We successfully designed and developed a LabVIEW-based temperature sensor system that integrates hardware components, such as temperature sensors and data acquisition devices, with LabVIEW software.

2. Applications: We discussed potential applications for the LabVIEW-based temperature sensor system, including industrial processes, environmental monitoring, and research laboratories. The flexibility of LabVIEW allows for easy adaptation to various use cases.

3. Future Work: While our research has provided a solid foundation for LabVIEW-based temperature sensing, there are opportunities for further improvement and expansion. Future work could involve enhancing the system's robustness, exploring additional sensor types, or integrating machine learning algorithms for predictive analysis.

Acknowledgment

DAQ CARD (Hardware)AICTE MODROB Scheme - File no. 9- 167/RIFD/MODROB/Policy – 1/2017-2018.

LabVIEW (Software) – AICTE MODROB Scheme – File no. 9 – 230/RIFD/MODROB/Policy – 1/2018-2019

References

[1] R. Agrawal, Complete Industrial Solution for Automation in Temperature and Humidity Monitoring using LabVIEW, Vellore, India: School of Electronics Engineering.

[2] S. H. R. Ong Wee Chuan, Medical Warehouse Monitoring and Control System Using LabVIEW, Johor, Malaysia: Faculty of Electrical and Electronic Engineering,Universiti Tun Hussein Onn Malaysia, 2016.

[3] A. F. D. A. M. H. Whisnumurti Adhiwibowo, Temperature and Humidity Monitoring Using DHT22 Sensor and Cayenne API, Soekarno Hatta, Tlogosari, Semarang: University Semarang, 2020.

[4] F. Z. Hong Zhang, A kind of Design of Greenhouse Environment Monitoring System Based on LabVIEW, Wuhu, Anhui, China : Electrical Engineering School, Anhui Polytechnic Science and Technology Research Office, Anhui Xinhua, 2020.

[5] S. G. A. B. M. M. S. Kalaiarasi, Arduino Based Temprature and Humidity Sensor, Chennai: Assistant Professor, SRM Institute of Science & Technology, Chennai, Tamil Nadu, India., 2018.

[6] M.S Danladi* , M. Baykara, Design and Implementation of Temperature and Humidity Monitoring System Using LPWAN Technology Department of Software Engineering, Faculty of Technology, Fırat University, Elazığ 23119, Turke.,2022

W. M. H. M. K. C. A. Belhadj, LabVIEW Based Real time Monitoring of HVAC System for Residential Load, Dhahran 31261, Saudi Arabia : Electrical Engineering Department King Fahd University of Petroleum and Minerals, 2017.

[8] W.-T. H. ,. C.-C. W. a. T.-Y. C. Kai-Chao Yao, Establishing an AI Model on Data Sensing and Prediction for Smart Home Environment Control Based on LabVIEW, Changhua City, Taiwan: Department of Industrial Education and Technology, National Changhua University of Education, No. 2 Shi-Da Road,Changhua City, Taiwan, 2021.

[9] Y. S. Qian Zhang, AN INTELLIGENT SYSTEM TO AUTOMATE HUMIDITY MONITORING AND HUMIDIFIER CONTROL USING INTERNET-OF-THINGS (IOT) AND ARTIFICIAL INTELLIGENCE, California: Jserra High School, San Juan Capistrano, CA 92675, California State Polytechnic University, Pomona, CA, 91768. 021. DOI: 10.5121/csit.2021.111711, 2021.

[10] S. M. S. A. M. P. M. Olivier Debauchea, Edge Computing and Artificial Intelligence for Real-time Poultry Monitoring, Belgium: Elsevier B.V, 2020.

[11] G. A. N. L. F. Muhammad Syafrudin, Performance Analysis of IoT-Based Sensor, Big Data Processing, and Machine Learning Model for Real-Time Monitoring System in Automotive Manufacturing, Seoul 100-715, Korea: Department of Industrial and Systems Engineering, Dongguk University, doi:10.3390/s18092946, 2018.

[12] A. D. N. T. Ianire Taboada, Artificial Intelligence Enabled Project Management: A Systematic Literature Review, Melbourne 3011, Australia: Victoria University Business School, Victoria University. 5014. DOI 10.3390, 2023.

[13] K. C. Azharul Islam, Real-Time AI-Based Informational Decision-Making Support System Utilizing Dynamic Text Sources, Incheon 22212, Korea: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations. DOI. 10.3390, 2021.

[14] K. N. A.-K. a. A. M. H. Abdulaziz Aldoseri, Re-Thinking Data Strategy and Integration for Artificial Intelligence: Concepts, Opportunities, and Challenges, Doha P.O. Box 2713, Qatar: Engineering Management Program, College of Engineering, Qatar University.DOI. 10.3390, 2023.

[15] I. H. Sarker, Data Science and Analytics: An Overview from Data-Driven Smart Computing, Decision-Making and Applications Perspective, Melbourne, VIC 3122,Austrilia: Springer Nature Singapore Pte Ltd 2021, 2021.

[16] K. A. A. Muhammad Hisham Salleh, Artificial Intelligence Augmented Project Management, Selangor, Malaysia: Faculty of Management, Multimedia University, , 2022.

[17] Z. Z. J. G. A. C. X. ZHENYU LIU, Forecast Methods for Time Series Data: A Survey, Hohhot 010018, China: College of Computer and Information Engineering, Inner Mongolia Agricultural University, Digital Object Identifier 10.1109, 2021.

[18] M. P. M. P. C. F. D. M. Alexandra Moraru, Using Machine Learning, Ljubljana, Slovenia: Jozef Stefan Institute, MOBITEL Telecommunication Services Inc. DOI: 10.2498, 2010.

[19] B. N. N. V. S. Srikanth Namudur, Review—Deep Learning Methods for Sensor Based Predictive Maintenance and Future Perspectives for Electrochemical Sensors, Florida, USA: The Electrochemical Society by IOP Publishing Limited. DOI: 10.1149, 2020.

[20] P. C. D. V. B. S. Vaibhav M. Davande, Real Time Temperature Monitoring Using LABVIEW and Arduino, Ichalkaranji, Maharashtra, India: International Journal of Innovative Research in Computer and Communication Engineering. DOI: 10.15680, 2016