Journal of Cognitive Computing and Cybernetic Innovations(JCCCI)
Research Article
Received: 2025-04-20 **Reviewing:** 2025-05-15 **Accepted:** 2025-06-25 **Online:** 2025-07-05 **Issue Date:** 2025-07-25
Year: 2025, **Volume:** 01, **Issue:** 02, **Pages:** 07-11, **Doi:** https://doi.org/10.21276/jccci.2025.v1.i2.2

Implementation of IoT-based Smart Weather Monitoring and Notification System for Township Area in Myanmar *

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***Abstract*—The paper emphasizes the implementation of IoT-based smart weather monitoring and notification system for township area in Myanmar. The aim of this study is to develop an IoT-based system that utilizes historical weather data and real-time information to provide accurate weather predictions, flood alerts ensuring better agricultural planning and disaster preparedness. The research objectives are (i) to provide weekly weather forecasts to farmers, (ii) to notify farmers instantly about critical weather changes or flood risks, and (iii) to design a solution that is simple to use and cost-effective for farmers. This study mainly focuses on for not only IoT system but also support farmers for the development of smart society. The results confirm that the developed system of IoT-based Smart Weather Monitoring and Notification System for Township Area in Myanmar by using the LSTM (Long Short-Term Memory) algorithm for accurate weather predictions for sustainable development.**

Keywords*—*IoT-based Smart Weather Monitoring and Notification System, Smart Society, LMTS Algorithm, Advanced Sensor Technology, Python

I. Introduction

Agriculture is a cornerstone of Myanmar's economy. Weather plays a crucial role for agriculture. Extreme weather events such as heavy rainfall can lead to landslides [1-5]. Farmers need to stay updated on weather conditions to make informed decisions. It allows them to respond quickly to protect their crops. Taikkyi Township is situated in the northern part of Yangon Region, Myanmar. The township is characterized by its three main towns: Taikkyi, Oakkan, and Aphauk. The township features a mix of flat plains and Hlaing riverline areas that are making it suitable for various agricultural activities. Taikkyi is known for its diverse agricultural production including rice, vegetables, fruits, and black grams (Mat Pae). Agriculture is the backbone of the local economy, providing livelihoods for the majority of residents [6-10]. In recent months, significant efforts have been made to address the challenges faced by farmers in Taikkyi Township. In July 2024, continuous rainfall led to extensive flooding, impacting approximately 62,902 acres of monsoon paddy across 55 villages. This disaster resulted 54,042 acres were destroyed

II. Research Method

In order to address the challenges faced by farmers in Taikkyi Area is concerning the sudden weather changes. In Myanmar, the weather conditions are only announced by daily

*Cite (APA):** May Ye Thway1 , Hla Myo Tun2 , Khaing Thandar Soe1, Min Thein Aung Tin1 , Thandar Oo1 , Lei Lei Yin Win1, Devasis Pradhan . (2025). Implementation of IoT-based Smart Weather Monitoring and Notification System for Township Area in Myanmar. *Journal of Cognitive Computing and Cybernetic Innovations, Volume 01* (IssueNo 02), 07-11. https://doi.org/10.21276/jccci.2025.v1.i2.2

weather forecasts news. There has not been smart system to promptly disseminate such kind of information to the local farmers. Reliable data are only collected from the Taikkyi Township's Agriculture Department for the local farmers. The collected data are daily precipitation, maximum and minimum temperature of Taikkyi Area from 2023 Jan to 2024 October. In this study, predicting next 6 months' precipitation and temperature based on the historical weather data are emphasied by using LSTM algorithm and then these predicted results are stored in Thingspeak. On the other hand, a real-time monitoring system that utilizes IoT technology is sensing flood and temperature by using ESP8266, waterproof ultrasonic sensor JSN SR-04T, DHT11 sensor and a rain gauge. These sensing data are stored in Thingspeak and the hardware devices will be fixed at the suitable place of that township to predict flood situation. The information updates will be sent to the farmers by a dedicated Telegram group. Predicted weather data will be sent as next 7 days' weather forecast and real-time weather data will be sent as daily weather information and if there is flood situation, it will also be contained. Although the forces of nature cannot be avoided, the ability to foresee them can be used effectively. By receiving timely information, farmers can take necessary actions to mitigate potential impacts on their crops and livelihoods.

III. Materials and Governing Equations

According to the research methodologies, there are two portions for implementation. Materials are very important for implementation step. The next important one is governing equations for verification steps.

A. Materials

There are two main materials for implementation. LSTM (Long Short-Term Memory) and rain gauge are standard devices for implementation.

1. LSTM (Long Short-Term Memory)

LSTM networks are specialized type of recurrent neural network (RNN) that can learn long-term dependencies. An LSTM network enables input sequence data into a network and make predictions based on the individual time steps of the sequence data. It can work well with non-linear patterns and trends. A common LSTM unit is composed of a cell, an input gate, an output gate and a forget gate. When predicting precipitation and temperature, the data involved is inherently time series in nature. The architecture includes input, output, and forget gates that regulate the flow of information into and out of the memory cell. This allows LSTMs to selectively retain or discard information based on its relevance to future predictions. ARIMA (Auto Regressive Integrated Moving Average) is effective for linear time series with clear trends or seasonality but struggles with non-linear patterns. SARIMA (Seasonal Auto Regressive Integrated Moving Average) is specifically designed to model and forecast seasonal patterns but struggles with long-term dependencies. Convolutional Neural Networks (CNNs) are excellent for spatial data analysis (like satellite images) but may not capture temporal dynamics as effectively as LSTMs when used alone. Decision Trees and Random Forests do not inherently account for temporal relationship, they treat each input independently without considering previous time steps. In summary, LSTM can effectively handle time series data with long-term dependencies and complex non-linear relationships.

2. Rain Gauge

A rain gauge is a simple device used to measure the amount of rainfall. It typically consists of a cylindrical container or funnel that collects rainwater, leading it into a measuring tube. The collected water is funneled into a measuring tube through a small opening at the top. This opening is usually covered with a funnel or cone shape to direct the rain into the tube. The water that falls into the funnel flows down a narrow pipe into the collection container below, where the amount of rainfall can be measured. The collected water is marked in millimeters or inches, making it easy to determine the rainfall level.

Figure I: The rain gauge at the Department of Agriculture, Taikkyi

B. Governing Equations

There are seven governing equations for the evaluation. Scaling, inverse scaling, forget gate, input gate, cell state update, output gate, and root mean squared error are fundamental equations for verification and evaluation.

1. Scaling

$$X_{\text{scaled}} = \frac{X - X_{\min}}{X_{\max} - X_{\min}} \quad (1)$$

where: X = Original Value, X_{scaled} = Scaled Value, $X_{\min}$ = Minimum Value in the Feature, $X_{\max}$ = Maximum Value in the Feature.

2. Inverse Scaling

$$X = X_{\text{scaled}} \cdot (X_{\max} - X_{\min}) + X_{\min} \quad (2)$$

where all symbols retain the same meaning as above.

3. Forget Gate

$$f_t = \sigma(W_f \cdot [h_{t-1}, x_t] + b_f) \tag{3}$$

where: t = Time step, f_t = Forget gate at time t, W_f = Weight matrix of the forget gate, h_{t-1} = Hidden state from the previous time step, x_t = Input at time t, b_f = Bias term.

4. Input Gate

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i) \tag{4}$$

where: i_t = Input gate at time t, W_i = Weight matrix of the input gate, b_i = Bias vector at t, Other terms as defined earlier.

5. Cell State Update

$$\tilde{C}_t = \tanh(W_C \cdot [h_{t-1}, x_t] + b_C) \tag{5}$$
$$C_t = f_t \cdot C_{t-1} + i_t \cdot \tilde{C}_t$$

where: C_t = Updated cell state, $\tilde{C}_t$ = Candidate cell state, W_C = Weight matrix, b_C = Bias term.

6. Output Gate

$$o_t = \sigma(W_o \cdot [h_{t-1}, x_t] + b_o) \tag{6}$$
$$h_t = o_t \cdot \tanh(C_t)$$

where: o_t = Output gate, W_o = Weight matrix, b_o = Bias term.

7. Root Mean Squared Error (RMSE)

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2} \tag{7}$$

where: n = Number of observations, y_i = Actual/Observed value, $\hat{y}_i$ = Predicted value.

IV. Implementation

Figure.2 illustrates the System Block Diagram of the study. There are nine steps for implementation of the study. The very first portion is loading the input dataset. After scaling step, the new dataset is created. And then, the train model must be proceeding. The LSTM model must be built. According to the training and testing steps, the split data could be observed. And then the predicted data could be achieved. The RMSE values must be evaluated from that predictions. Finally, the visualization could be mentioned with graphs and illustrations. Figure.3 demonstrates the System Flowchart for software implementation as well. The software implementation could be done with the step of flowchart.

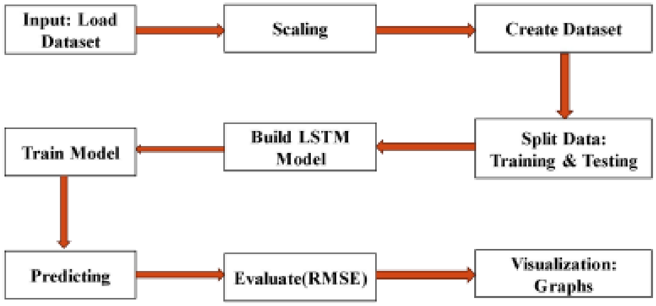

Figure II: **Block Diagram of Audio Acquire from Speaker**

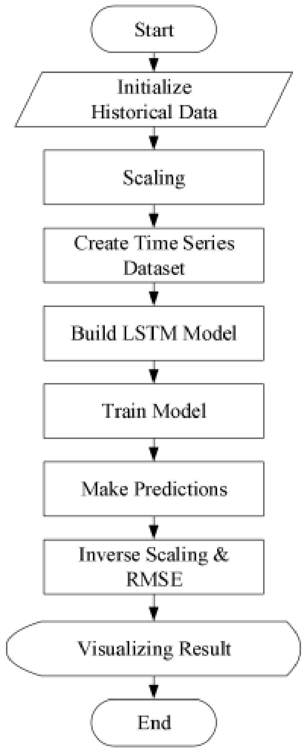

Figure III: System Flowchart

V. Results and Discussion

Figure.4 shows the Collected to Excel File. That is the important data collection for the next step. The next step is the conversion process with python codes. Figure.5 presents the Convert Excel to csv file and run Python code. Figure.6 illustrates the Predicted Min Temperature from 2024 Nov to 2025 April. Figure.7 demonstrates the Predicted Max Temperature from 2024 Nov to 2025 April. Figure.8 mentions the Predicted Precipitation from 2024 Nov to 2025 April. Figure.9 expresses the Actual and Predicted Values from 2024 August to 2024 October. For the implementation and analyses, the predict temperature, precipitation and comparison results are observed by using python code. According to the prediction result of temperature, January is the coldest month and March and April are hottest month from 2024 November to 2025 April. The Actual Vs Predicted Comparison result gets RMSE values of 0.96. The proposed system includes both historical data and real-time data compared with other process. Getting the actual data from local government organizations are accommodating for this proposed system.

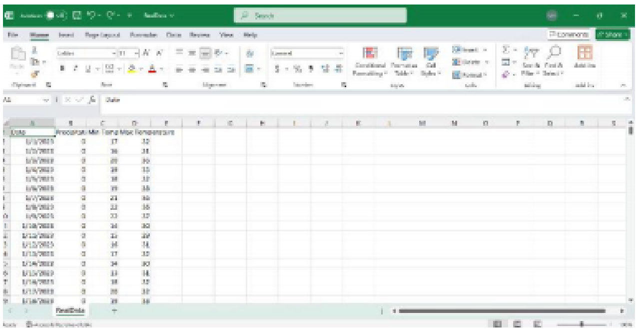

Figure IV: Collected to Excel File

Figure V: Convert Excel to csv file and run Python code

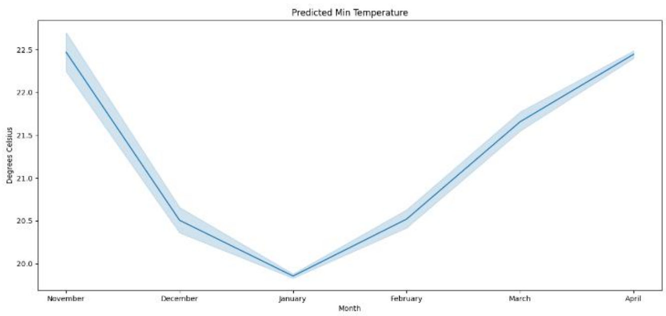

Figure VI: Predicted Min Temperature from 2024 Nov to 2025 April

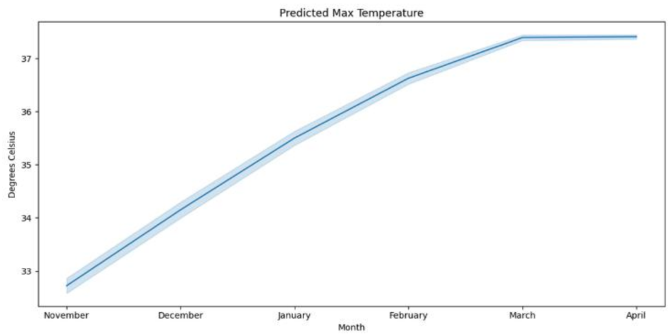

Figure VII: Predicted Max Temperature from 2024 Nov to 2025 April

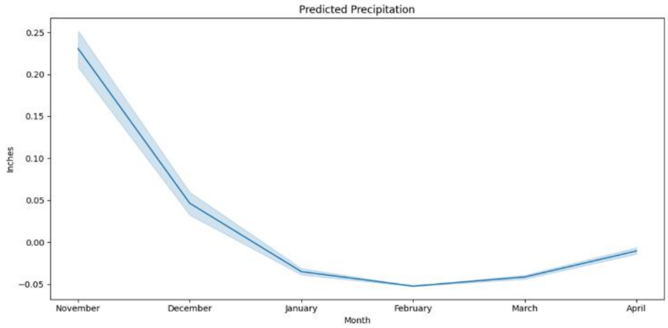

Figure VIII: Predicted Precipitation from 2024 Nov to 2025 April

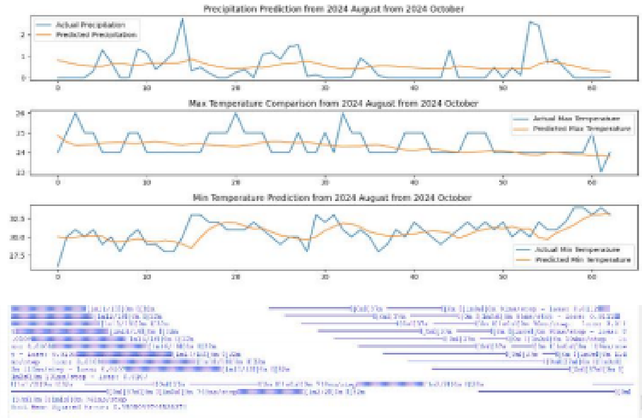

Figure IX: Actual and Predicted Values from 2024 August to 2024 October

VI. Conclusion

The historical weather data from Taikkyi to predict next six months' precipitation, max and minimum temperature and the LSTM (Long Short-Term Memory) algorithm for accurate weather predictions are utilized to confirm the implementation of the study. This study has developed for not only IoT system but also support farmers. The telegram based alert system offers a user-friendly means of delivering information.

Competing interests

The authors declare no competing interests.

Funding

This research was funded by the Yangon Technical University, Myanmar

Ethical Statement

In this article, the principles of scientific research and publication ethics were followed. This study did not involve human or animal subjects and did not require additional ethics committee approval.

Declaration Of AI Usage

No AI tools were used in the creation of this manuscript.

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