© June 2025 | IJIRT | Volume 12 Issue 1| ISSN: 2349-6002

An Approach for Multi-Depth Soil Water Content Prediction with Weather Forecasts Accountability

Rushikesh Patil[1], Jayesh Fegade[2], Mihir Mahajan[3], Prof. R. A. Agrawal[4], Dr. S. M. Shinde[5]
[1,2, 3] UG Student, Artificial Intelligence and Data Science Engineering, Shri Sant Gadge Baba College of Engineering & Technology, Bhusawal, Maharashtra, India.
[4-5]Assistant Professor, Artificial Intelligence and Data Science Engineering, Shri Sant Gadge Baba College of Engineering & Technology, Bhusawal, Maharashtra, India

Abstract—**Agriculture remains the primary source of livelihood for approximately 60% of India's population and plays a vital role in the country's GDP. Despite its importance, Indian agriculture faces challenges in adopting effective crop selection strategies and improving crop yield across diverse regions. This decline in productivity adversely impacts the financial stability of farmers. Therefore, developing an intelligent system to recommend the most suitable crops based on regional factors such as soil quality, rainfall patterns, and weather conditions is essential. To address this, we propose a machine learning-based approach that analyzes these parameters to suggest optimal crops for specific regions. Another major concern is the lack of adequate knowledge and guidance in farming practices. Many Indian farmers come from non-technical and uneducated backgrounds, leading them to rely on traditional, and often inefficient, agricultural methods. To bridge this gap, our system also includes a crop disease prediction module that helps identify potential diseases and provides timely preventive measures. Furthermore, the absence of proper market analysis before crop cultivation often results in economic losses. Our solution aims to integrate market insights to guide farmers in making informed decisions, ultimately enhancing both productivity and profitability in agriculture.**

Index Terms—**Climate Adaptation, Crop Yield, CSS, Deep Learning, Drought Assessment, Environmental Sustainability, Graph-based Output, Hydrological Modeling, Humidity, Irrigation Planning, Linear Regression, Machine Learning, MATLAB, Multi-depth Soil Layers, Precipitation Forecast, Python (Tkinter), Soil Water Content, Solar Radiation, Temperature, Time Series Analysis, Weather Forecast Integration, Wind Speed.**

I. INTRODUCTION

Indian farming is based on economic benefits from crop yields, but now day's agricultural era has failed to proven best crop selection methods and to increase crop yield in all over India. So, decrease in crop yield increases problem in farmer's financial health conditions. So, it becomes most trending problem for our agricultural field to invent such noble method to recommend best suitable crop and need of online market place. Crop recommendation systems heavily rely on environmental parameters such as soil characteristics, weather conditions, and regional rainfall patterns. To effectively classify and cluster these complex datasets, machine learning techniques like Support Vector Machines (SVM) and Convolutional Neural Networks (CNN) are employed. Our approach leverages these regional environmental features to suggest the most suitable crops for a specific location. This contribution addresses the critical issue of optimal crop selection, thereby enhancing agricultural productivity and supporting the economic well-being of farmers.

As well as we are going to provide guidance by technical methods from cultivation to yields by helping out dynamic queries of farmers while farming. We are going to provide

E-mart for online selling of farmer's product which will help to farmers to get more economical benefits than existing market rate. Data mining implies distinguishing concealed examples from enormous datasets and setting up a relationship among them to take care of the issue through information investigation. The application of data mining techniques in the field of agriculture has brought significant advancements to agricultural research.

Classification is fundamental in any scientific discipline, as it helps establish the foundational structure of knowledge. It assists in identifying variations among objects and concepts, while also providing critical information necessary for systematic investigation. In agriculture, soil is one of the most essential components, playing a vital role in determining crop productivity and yield.

Soil classification, an essential task in understanding Earth's surface composition, establishes correlations between soil samples and various physical and chemical properties. In recent years, it has emerged as a significant challenge in the fields of image processing and computer vision. Advanced algorithms—particularly those based on convolutional neural network (CNN) architectures—are being developed to improve classification accuracy. These architectures enable the extraction of detailed features at the pixel level, including edges, colors, and textures, regardless of orientation.

Building upon this foundation, the current research presents a novel framework for multi-depth soil water content prediction by incorporating both real-time environmental data and short-term weather forecasts. The proposed model utilizes Long Short-Term Memory (LSTM) networks to predict soil moisture across various depths. By integrating meteorological variables with temporal data, this hybrid approach enhances the system's ability to model seasonal and short-term variability. Ultimately, the solution aims to provide a robust and practical tool for precision agriculture, supporting efficient water management and informed crop decision-making.

The primary objective of this study is to create a scalable, data-driven solution that not only improves irrigation planning but also aids farmers and policymakers in making informed decisions about water usage. The paper explores the model architecture, the challenges of data collection and system integration, and the potential applications of the proposed solution in real-world farming scenarios. By combining predictive analytics with weather accountability, this work aims to pave the way for smarter, more sustainable agriculture.

II. LITERATURE SURVEY

The purpose of this project is to a two-band variant of the enhanced vegetation index at mature date was applied to establish empirical yield estimation model, coupling with statistical crop yield data in China.

Advantage: - This system give suggestion for agriculture planning and management.

Disadvantage: - The majority result could not reflect the spatial variation of crop yield accurately.

In this system proposed a data-driven model that learns by historic soil as well as rainfall data to analyze and predict crop yield over seasons in several districts, has been developed.

Advantage: - The final predictions obtained were successful in depicting the interdependence between soil parameters for yield and weather attributes.

Disadvantage: - In existing system Wireless Sensor Networks at real-time to collect and transform data directly to predictive models are very costly.

In this System, study focused on the prediction of barley, canola and spring wheat using remotely sensed vegetation indices and compared the effectiveness of MODIS-NDVI, MODIS-EVI and AVHRR-NDVI.

Advantage: Enables the development of crop yield prediction models tailored to the agricultural conditions of the Canadian Prairies.

Disadvantage: Most existing crop forecasting approaches rely on linear techniques, which may fail to capture complex nonlinear patterns present in the data.

In a proposed new technique based on multiple morphological component analysis (MMCA) that exploits multiple textural features for the decomposition of remote sensing images.

Advantage: - The proposed MMCA framework can lead to very good classification performances in different analysis scenarios.

Disadvantage: - In the existing system work on only limited training samples.

In this system, presented a novel approach for trip planning in highly congested urban areas.

Advantage: - Enables early detection and avoidance of traffic-related hazards by computing smart and optimized routes.

III. PROBLEM STATEMENT

India's agricultural sector encounters substantial difficulties in effectively managing soil moisture, a key determinant of crop health and yield. Fluctuating soil water levels—driven by erratic weather conditions, the absence of reliable monitoring systems, and inefficient irrigation practices—frequently result in crop stress, lower productivity, and potential crop failure, and financial distress for farmers. Traditional methods of assessing soil moisture are often inaccurate and time- consuming, leaving farmers unable to make real-time, informed decisions about irrigation and water usage. This results in either overwatering or under watering of crops, both of which are detrimental to growth. Additionally, farmers, especially in rural areas, lack access to advanced technology and real-time data, making it difficult for them to manage soil water levels effectively.

To address these issues, this project aims to develop a system that uses machine learning techniques to predict and monitor soil water levels based on environmental parameters such as date, temperature, humidity, and wind speed. By analyzing these factors, the system will provide accurate insights into the soil's water retention and help farmers optimize irrigation practices. This will not only improve crop yields but also reduce water wastage and ensure sustainable agricultural practices. Ultimately, the project seeks to provide farmers with a reliable, data-driven solution to monitor soil moisture, enabling them to make timely and informed decisions to improve agricultural productivity and safeguard their financial health.

IV. METHODOLOGY USED

LSTM

Long Short-Term Memory (LSTM) networks, a specialized type of Recurrent Neural Network (RNN), are designed to learn and retain long-term dependencies. They have been further refined and widely adopted through subsequent research contributions.

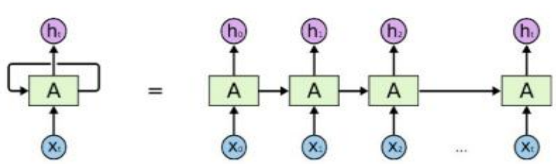


Fig: Architecture of LSTM

LSTMs have demonstrated exceptional performance across a wide range of sequence modeling tasks and have become a standard tool in many applications.

They are purposefully designed to address the difficulty of capturing long-term dependencies in sequential data.Their architecture is inherently capable of retaining information over extended sequences. Let's recall how an RNN looks As we saw in the RNN article the RNN unit takes the current input (X) as well as the previous input (A) to produce output (H) and current state (A).

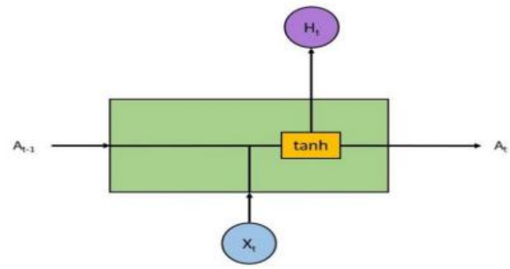


Fig: Architecture of One Block

While LSTMs share a structural resemblance to traditional RNNs, they differ significantly in their internal architecture. Instead of a single tanh activation layer found in standard RNNs, an LSTM block contains four distinct interacting components (or layers) that manage information flow:

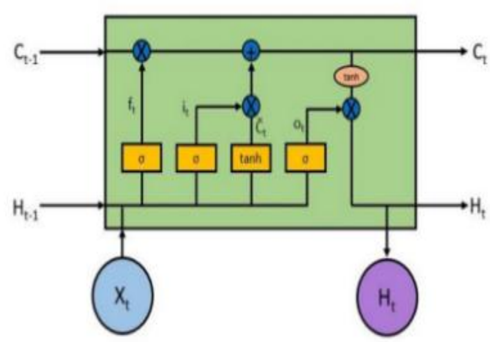


Fig: Layers of LSTM

At first glance, the structure of an LSTM may seem complex and overwhelming. However, by breaking it down, we can better understand the function of each component and how they work together. Central to the LSTM's architecture is the cell state—the top horizontal line that runs from left to right—serving as the main pathway for preserving and transferring information across time steps. preserving and transferring information over time. This pathway facilitates the smooth transmission of information across time steps. The cell state (C) functions as a memory pathway, enabling information to flow through the LSTM unit with only minor linear transformations, thereby preserving context over long sequences. This capability enables the LSTM to retain contextual information from several time steps in the past. Into this line, there are several inputs and outputs which allow us to add or remove information to the cell state. The flow of information within an LSTM cell is regulated by special components called gates. These gates are implemented using sigmoid activation functions (often represented as yellow boxes in diagrams) and produce outputs between 0 and 1, indicating how much information should pass through

• A value close to 0 means very little or no information is allowed through

• A value close to 1 means most or all information is permitted.

• An LSTM unit generally comprises three key gates—input, forget, and output—which work together to regulate and update the cell state, ensuring effective control over the information flow.

V. PROPOSED SYSTEM

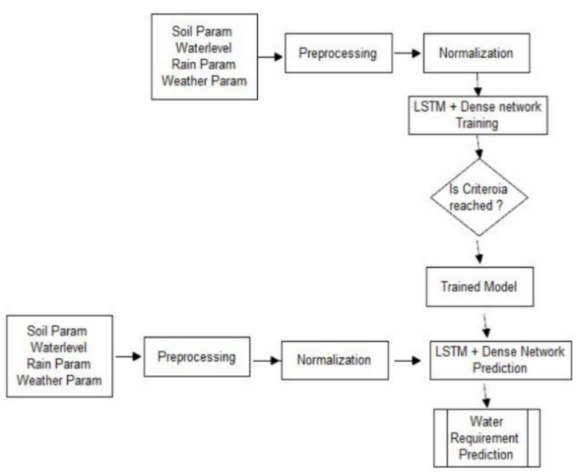


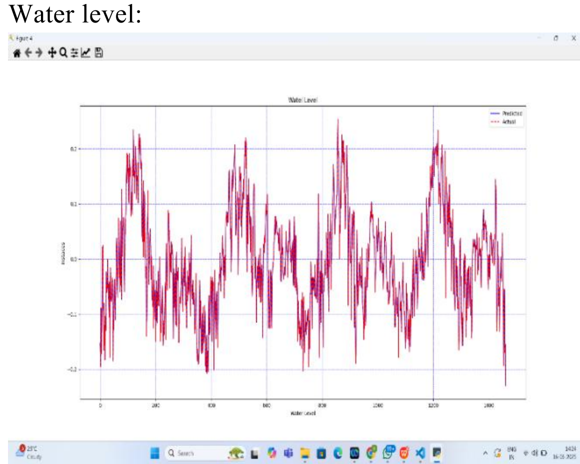
Image classification using a Convolutional Neural Network (CNN) requires an adequate number of training samples, which are collected through field surveys. Important factors in selecting training samples include the image's spatial resolution, the precision of ground reference information, and the difficulty level of the classification task. Once soil images are successfully classified, suitable crops are recommended using a Support Vector Machine (SVM) algorithm. An additional feature of the system is the integration of an online marketplace, allowing farmers to sell their produce digitally particularly useful during pandemic situations where access to physical markets may be restricted. The proposed methodology consists of two main phases: a training phase and a testing phase. It utilizes two datasets: a soil dataset, which includes images of various soil types such as alluvial, black, clay, and red soil; and a crop dataset, which is used to recommend appropriate crops based on the identified soil class.VI. RESULTS

1. User Interface :

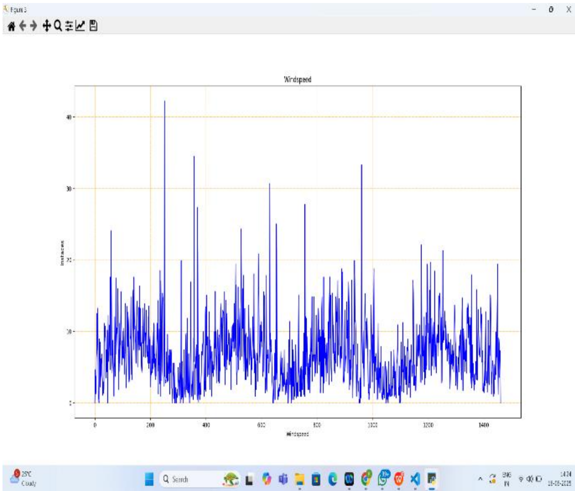
2. Output Interface:

3. Output Graph

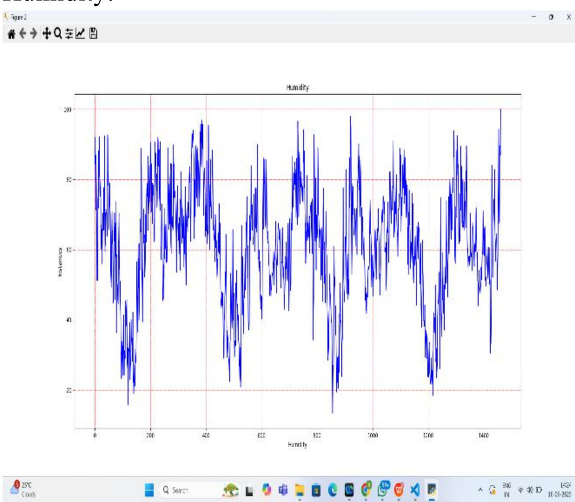
Water level:



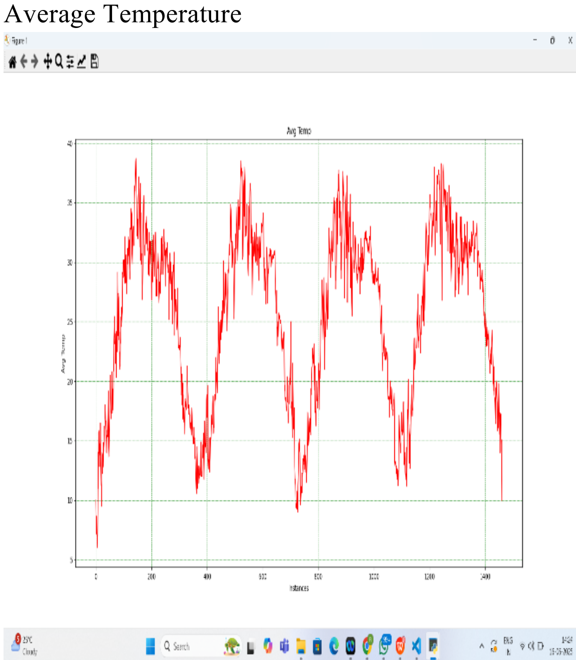
Windspeed:



Humidity:



Average Temperature



VI. CONCLUSION

In the proposed system, we introduce an efficient crop selection technique based on machine learning methods. This approach aims to recommend the most suitable crops tailored to local environmental conditions. Additionally, the system is capable of real-time plant disease detection, thereby enhancing crop yield and supporting farmers through predictive insights. Overall, this contributes significantly to the economic and agricultural development on a global scale. For future work, we intend to expand our study further and develop an Android application to facilitate the e-commerce of agricultural products.

REFERENCES

[1] G. Loukas, and O. Gulay. "Likelihood ratios and recurrent random neural networks in detection ofdenial of service attacks." 2007.

[2] G. Oke, G. Loukas and E. Gelenbe, "Detecting Denial of Service Attacks with Bayesian Classifiers and the Random Neural Network," 2007 IEEE International Fuzzy Systems Conference, London, 2007, pp. 1-6.

[3] A. B. M. A. A. Islam and T. Sabrina, "Detection of various denial of service and Distributed Denial of Service attacks using RNN ensemble," 2009 12th International Conference on Computers and Information Technology, Dhaka, 2009, pp. 603-608.

[4] Z. A. Baig and K. Salah, "Multi-Agent pattern recognition mechanism for detecting distributed denial of service attacks," in IET Information Security, vol. 4, no. 4, pp. 333-343, December 2010.

[5] M. Kim, H. Na, K. Chae, H. Bang, and J. Na: A Combined Data Mining Approach for DDoS

[6] Attack Detection, Lecture Notes in Computer Science, Vol. 3090, pp. 943-950, 2004.

[7] A. Sharma, R. Joshi, and N. Patel, "Data mining techniques for predicting crop Yield based on environmental data," Agricultural Science and Technology, vol. 14, no. 3, pp. 200-215, 2019, DOI:10.1000/AST2019.0011.

[8] Meghan Sindelar, Soil plays a crucial role in agriculture and the environment.[1]