krishimitra

TEAM 13

INTER IIT TECH MEET 10.0

25-27TH MARCH 2022

SILICON LABS' SOCIAL ENTERPRENEURSHIP CHALLENGE

MID-EVALUATION REPORT

CONTENTS

<u>(1.) INTRODUCTION (PROBLEM STATEMENT)</u>

1.1 Overview of Problem:

India is currently one of the world's top two agricultural producers. This industry produces over half of all jobs in India and contributes roughly 18.1% to the GDP. Almost two-thirds of India's employed class live on agriculture. India's agriculture industry occupies over 43% of its land area. Indian agriculture has grown rapidly in recent decades. It climbed from 51 million tonnes in 1950-51 to 250 million tonnes in 2011-12, the greatest since independence, which in present requires out a very robust and smart technology IoT based solution system which can help out on a complete service level platform for the farmers to increase their productivity, to optimize out their resource usage management along with the maximum sustainability of natural resources.

1.1.1 Role of agriculture in India as well as International Economy and Trade

1. National Income Share
2. Largest Job Provider
3. Capital Formation
4. Raw Material Supply to Industries
5. Industrial Product Market
6. Earner of foreign exchange and Exports

1.1.2 Major Agricultural Problems of India

1. Small and fragmented land-holdings
2. Improper Ratio/ Knowledge of Manures, Fertilizers, and Biocides by Farmers
3. Less/ Over Irrigation due to unprecedented weather conditions
4. Lack of Mechanization and crop-specific requirement knowledge
5. Scarcity of capital and lack of ease in getting crop insurances and loans
6. Inadequate customized farm Consulting Services to aware farmers
7. Improper/ Less Agriculture Markets and lack of policies knowledge among farmers

1.2 Motivation of Problem:

"The ultimate goal of farming is not the growing of crops, but the cultivation and perfection of human beings."

We are all aware of our farmers' contributions to our economy and human resources, and agriculture is one of the noblest professions, thus it was an excellent idea and thinking on our part to address the issues surrounding this critical subject.
We, as a tech-growing country, attempt to address many of the above-mentioned issues through an IoT-based data solutions system in agriculture that is inculcated and trained using concepts of Machine Learning and Deep Learning under the various probabilistic and statistical models that can assist the farmer's community with the various problematic aspects discussed above, while also taking into account some of the UN's sustainable development goals such as Zero Hunger, Good Health and Well-Being, Water and Sanitation, Responsible Consumption and Production, Climate Action, Life on Land and many of the future possible goals as well. Several of the difficulties answered by our prospective system solution include the following: Smart Irrigation Systems, AI-based Risk Predictors, Real-Time Farm Forecasts and Analytics, Fertilizers NPK-based predictors, and many more market features. As a result, as a friend in need, we are always willing to assist our farmer friends, which is how the **motivation for KrishiMitra came about.**

(2.) BACKGROUND RESEARCH

IoT is now pervasive. Human survival, growth, and development have all been impacted by it. Agriculture is not exempt. With inexpensive IoT technology, this report aims to improve overall farming efficiency. For commercial IoT solutions, it delivers experimental findings of studies linked to enhancing crop efficiency using Machine Learning and Deep Learning. The paper also discusses the creation of an indigenous farmer-friendly interface. However, while keeping comparable performance, a large reduction in farmer expenditures may be noted together with increased yields, resulting in a win-win scenario for the farming community.

Our ability to remotely monitor agricultural conditions and infrastructure will save us time and effort on routine farm visits. It may also help manufacturers make better decisions utilizing data analytics and give real-time data insights across the supply chain.

Some of the previous IoT based works data and some latest government policies on the field of agriculture which can be implemented are as follow:

1.) Accelerating **IoT** adoption increased by around 20% throughout the Covid-19 pandemic has highlighted the fact that many businesses related to agriculture can be brought to a boon via this technology.

2.) An IoT data strategy ensures data is created, exchanged, and analyzed amongst the correct parties at the right time. This might assist bring a technological revolution to Indian agriculture, as well as help the government achieve its Made in India goal.

3.) **Agriculture is exempt from income tax under Section 2(1A) of the Income Tax Act** which defines agricultural income as "rent/revenue from land, income derived from this land through agriculture and income derived from buildings on that land". Hence this can act as a great source of income for our hardworking farmers if properly powered by the technology devices.

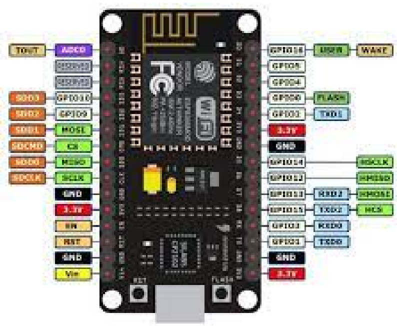
(3.) DESIGN & IMPLEMENTATION

3.1 Methodology:

A farmer-friendly IoT-based farm system is structured in such a manner that the process of watering, irrigation, farming practices, and farming advice is as accessible and much possible to all farmers. We will gather relative humidity and temperature data with a **DHT11** sensor and soil moisture data with a soil moisture sensor in this project and transfer them to the **IoT cloud** using **NodeMCU**. Additionally, an enhanced practical version of this gadget is attainable, which may be developed from the mentioned basic prototype. The IoT cloud transmits data to our application, which displays humidity, temperature, and soil moisture data. A soil moisture sensor is used to determine the soil's moisture content. Based on these data parameters and a few additional advanced input parameters, we can create a deep machine learning model from the datasets that can train itself over time and provide some incredibly useful and insightful data that can be used for automated irrigation, analysis, and risk prediction purposes, thereby increasing farming yields and reducing the farmers' extensive workload. It can be confidently seen as a smart solution to all of agriculture's fundamental demands and needs, utilizing IoT and machine learning technologies.

3.2 System Components:

3.2.1 NodeMCU



NodeMCU pinout

NodeMCU is a low-cost open-source firmware and development kit that helps us to prototype our **IoT** product within a few Lua script lines. The name “NodeMCU” combines “node” and “MCU”(micro-controller unit). It is an open-source software and hardware development environment that is built around a very inexpensive System-on-a-Chip(SoC) called **ESP8266**.

3.2.2 Soil Moisture Sensor

Soil Moisture Sensor

Soil Moisture Sensor measures the volumetric quantity of water based on dielectric permittivity of the soil and therefore gives its moisture content. This sensor module consists of two parts that are amplifier circuits and probes. The amplifier part has Vin, Ground, Analog, and digital data pins, which allows it to give its output in both analog and digital form. The required information is given by analog output and therefore we will use the analog output in the system. The moisture sensor measures the moisture content, as it reaches the limited value or the desired one, it sends a signal to the connected microcontroller which further sends to the relay module, this allows the water pump to turn on.

3.2.3 Temperature & Humidity Sensor DHT11

DHT11

DHT11 is a low-cost humidity and temperature sensor, giving output in digital form. This sensor uses a thermistor for sensing temperature and the capacitive humidity sensor. This capacitor has two electrodes, holding a moisture substrate between them which acts as dielectric to them. As there is a change in humidity level, it shows the change in its capacitance and we measure this change in digital form through the Integrated Chip. The range of humidity sensors is from 20 to 80% with 5% accuracy. It has four pins-VCC, a data pin, a nonconnected pin, and GND.

3.2.4 Thingspeak

ThingSpeak is an open-source "Internet of Things" application and API for storing and retrieving data from things using HTTP over the internet or a local area network.
The channel has data fields, location fields, and a status field. The typical ThingSpeak workflow is:

- Create a Channel and collect data
- Analyze and Visualize the data
- Act on the data using any of several Apps

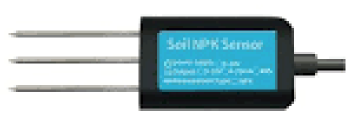
We will measure the temperature and humidity values using DHT11 sensor and soil moisture value with the help of NodeMCU module and then send these values to ThingSpeak channel, and by doing this you can see the temperature and humidity values of your home from any corner of the world using ThingSpeak.

3.2.5 Streamlit

Streamlit Cloud is a workspace for you and your team to easily deploy, manage, and collaborate on the **‘Streamlit’** apps.

→ **Some of the more customized farmer requirement based parts are as follow:**

3.2.6 Soil NPK Sensor



Soil NPK Sensor

The soil NPK sensor is ideal for determining the nitrogen, phosphorus, and potassium concentrations in the soil. It aids in identifying the soil's fertility, allowing for a more methodical assessment of the soil's state. The sensor may remain buried in the soil for an extended period. It has a high-quality probe that is resistant to rust, electrolysis, and salt and alkali corrosion, ensuring the probe part's long-term performance.

3.2.7 Solar Panels (20 V)

Solar Panels

60-cell grid-tied solar panels are sometimes referred to as 20V nominal panels. They have the nominal voltage required to charge a battery bank using a standard charge controller. They may be an excellent complement to areas with an abundance of sunshine and also save money on batteries.

3.2.8 Salinity / Electrical Conductivity (EC) Soil Sensor

The capacity of an aqueous solution to transport an electric current is measured by **electrical conductivity** (EC). Sulfate, chloride, and magnesium chloride are dissolved salts in the soil. The salts may be chlorides or carbonates. Fertilizers like nitrates have low conductivities, hence the EC measured in the soil is mostly salt.

3.2.9 pH Sensor

pH Sensor

The soil pH sensor monitors the soil's present pH. Two stainless steel probes inserted vertically into the soil determine the pH value. These sensors may be used with our soil data recorder to anticipate and manage soil health.

Likewise, to accommodate customized requirements and more advanced input formats needed to train our models, we could add more upgraded system components whenever needed and possible.

3.3 Description of Design Steps

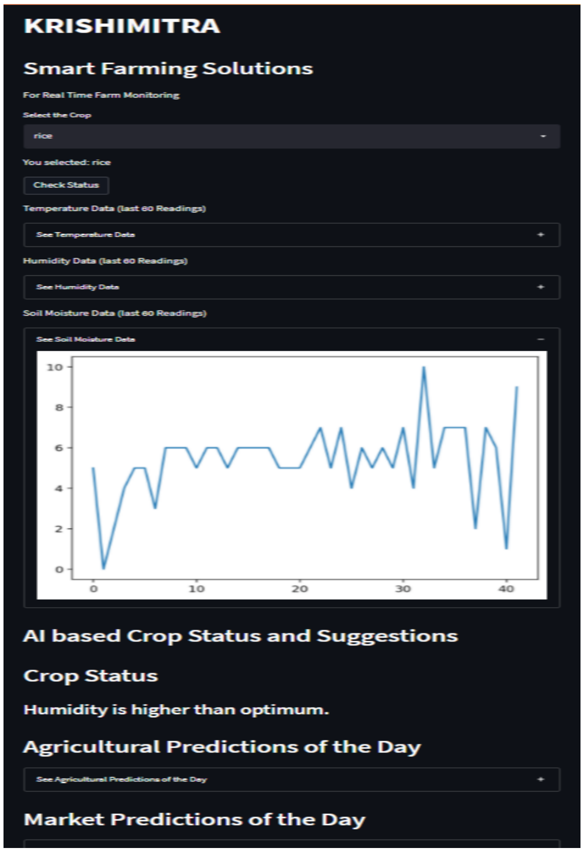
The system design takes place in three parts/phases

1. Hardware :
    - The hardware system is responsible for registering the parameters that the farmers will require (from their farm)
    - Inside the farm, the physical components (all the sensors) are installed, which include:
        - ❖ Soil moisture sensor
        - ❖ Temperature and humidity sensor
        - ❖ pH sensor
        - ❖ Soil NPK sensor
        - ❖ Salinity sensor
    - Because the parameters are continuous ratios, they will be recorded using analog pins.
    - The input and output are to be handled, done by NodeMCU in our case.
    - Since no logic is required, the data is directly forwarded for application purposes.
2. Designing the prediction model :
    - For designing the prediction model we take care of three things:
        - ❖ Getting the training dataset
        - ❖ Modeling the training algorithm
        - ❖ Managing the predictions work
    - The training dataset needs to have all the input parameters as features and output parameters as yield.

- Since a direct model is not available, we combine the features of 2 datasets via mapping. Instead of encoding, we assign specific values to convert them into the decimal type and introduce noise to account for real-life scenarios.
- The data is taken based on usual conditions found over a region and the average weather and the solid condition are noted over a while.
- For modeling purposes, the NN model is used. The hyperparameters tuning is done to increase the accuracy level.
- The flow of input parameters is designed into the convolution network based on their interdependence to get the best result. (The available research works suggest a lot of ML models for this purpose, however, using NN on top of these models provides even better results).
- For testing/ predicting purposes, the data input is taken as real-time and thus needs to be averaged over an interval (8 hours).
- Statistical models are generated for various crops using the available dataset for crop recommendation. **Mahalanobis distance** and **confidence interval estimation** is used to find outliers and inputs on humidity, temperature, and rainfall are given to the farmer.

3. Interface :
    - The interface is in charge of saving NodeMCU data and delivering the averaged data to the ML model for prediction.
    - The data is sent from hardware with the help of Thingspeak.
    - The data is recorded continuously and an asynchronous task of ML prediction is run in the background every time the farmer checks the status.
    - The asynchronous job is in charge of reading the sheet's averaged value and returning the ML model's forecast.
    - Streamlit hosts the full interface, including server code and the frontend.
    - For sustainability purposes, solar panels are used to keep the system running 24/7.

3.4 System Interface



This smart interface will be created in many regional languages to allow farmers to easily use it. It will assist them to enhance their yield and productivity while minimizing their workload. This software will also serve as a one-stop-shop for all agricultural needs, news, and updates for farmers. As Krishimitra, we will create a community where all farmers may discuss issues and concerns with other farmers and specialists.

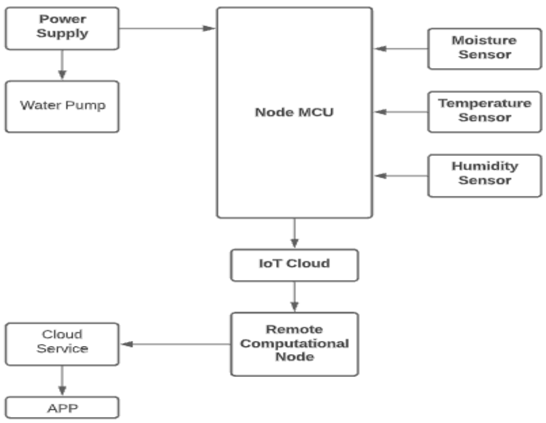
PROTOTYPE INTERFACE LINK FOR THE FARMERS:

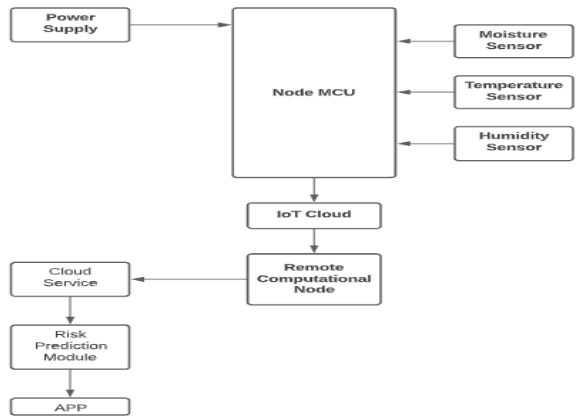
https://share.streamlit.io/hp-sl/hp_sl_t13/main/InterIIT/Interface.py

3.5 End-to-End Working Prototype

The farm sensors record the present status of the functioning prototype (weather, soil, etc). They use NodeMCU to transfer data to our cloud storage via Thingspeak. Solar panels conduct this process 24 hours a day, 7 days a week. Every 8 hours, the data is recorded in our cloud environment and fed into our previously trained machine learning model. The ML model then returns the yield (along with requirements like irrigation, fertilizers as an additional feature). It then updates the system server with the results.

3.6 Block Diagram & Related Figures





(3.6.1) Block diagram of the Automated Irrigation IoT based system

(3.6.2) Block diagram of the Risk Prediction Module

<u>(4.) EXPERIMENTAL RESULTS AND ANALYSIS</u>

4.1 On-field visit to Pomegranate farms for Solar Sustainable Irrigation System

Image (4.1.1) Pomegranate Farms to study on Automated Irrigation System


Image (4.1.2) Automated Irrigation Pipeline for Drip System

Image (4.1.3) Motorized Irrigation done out via Solar Driven Sustainability

4.2 On-field setup verification on nearby farms

Image (4.2.1) Basic prototype implementations at the farms around

(5.) CONCLUSION & FUTURE WORK

The obtained data and characteristics imply that by applying IoT in agriculture, considerable quantities of water may be saved without losing production. We are able to correlate with a range of the United Nations' 17 sustainable development objectives.

Additionally, yields increased significantly in other scenarios where IoT was employed, which may be attributed to a demand-based irrigation plan and high-accuracy predictors. By combining IoT with a variety of technical aspects such as Machine Learning, Deep Learning, and concepts of Probability and Statistics, we can achieve the best possible outputs, which might have a significant benefit for our agricultural community.

The scope of work for this project is expandable across several topics and domains. One perspective may be to look at it from an energy aspect. The total energy spent in each plot may be compared in order to find the least energy-intensive irrigation technique conceivable with and without IoT. This would include converting a variety of parameters, such as human labor, pump running hours, and yield obtained, to their energy equivalents.

Another topic that might be examined is the system's integration of Market and Warehouse data. This would immediately benefit farmers since they would be able to check current market prices and available warehouse space on their PDA before deciding whether to sell or keep their grain. This will require an understanding of the market forces that influence demand and supply, as well as the creation of market models capable of projecting grain prices in the near future. Rather than that, this would have an effect on future warehouse availability. In our experiment, we used sensors and a few devices, some of which are rather expensive to use in real-world contexts. Low-cost sensor nodes with extended battery life, gateways, and indigenous sensors may also be created in our own country, allowing farmers to adopt the system at a far lower cost than is now possible.

A farm generates a tremendous amount of data each day. With the volume of data increasing constantly, there are several opportunities to use effective data mining techniques to uncover critical facts. Following data collection, prediction algorithms based on mathematical models can be created to improve the system's robustness and value to the community.

(6.) BIBLIOGRAPHY

We would like to appreciate and recognize the following links and papers for assisting us in gaining some information and insight into this critical concept. Without the aid of our classmates and teammates, completing this report would have been an impossible undertaking. We are really appreciative of all of the referenced sources and individuals who assisted us with this endeavor.

We have included all connections to instructional images, statistics, and graphs. In the event of any missing links, we would like to express our gratitude to the owner and pledge to adhere to the fact that educational information is used fairly without breaking copyright restrictions and that the offered content remains the property of its particular owner.

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https://www.kaggle.com/datasets/atharvaingle/crop-recommendation-dataset

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