Machine Learning based IoT application to Improve the Quality and precision in Agricultural System

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Abstract

The backbone of the Indian economy is agriculture, and since crop productivity is heavily reliant on natural factors, nature plays a key role in this system. Although it is difficult to alter the natural environment to suit agricultural needs, crops may be chosen based on the current state of the environment. The majority of farmers in India operate on a small or marginal size, hence it is unlikely that they would consult professionals or any other informational source to choose the best crop or crops. We might conclude that there is a disconnect between farmers and current research. The data that is currently available (reports) tends to be static and crop- and duration-specific. There is thus no assurance that it will function well for every farm in the present environment or in every scenario. Here are several hardware and software solutions to the problems mentioned above. The "Internet of Things" is a current trend, and it is suggested here to use it to continually monitor the agricultural field using the "Agriculture Monitoring Model" (AMM), which comprehends and records the soil-environmental conditions. AMM is a lightweight, affordable model. The continually collected data was further analysed for decision-making, acting as a software model for an advising system. A current development is machine learning, which uses both supervised and unsupervised methods. The suggested

system was created using a supervised approach, which takes into account previous data while building the model and making judgements for the present situation. The model is taught to be more accurate the more balanced the input data, and the more correctly it functions for both current and future inputs. The phrase "present inputs" refers to the already accessible natural characteristics, of which only a small number may be purposefully controlled. The AAS (Agriculture Advisory System) will make a determination on the degree of crop suitability and the necessary fertiliser (regular/micro-dose). Farmers incur costs while micro-dosing seeds and fertiliser since there aren't enough devices available when they're needed. Here, a low-cost IoT-based AgriRobot is presented to automate the sowing and micro-dose fertiliser mechanism, reducing the issue of labour reliance.

Keywords: Agriculture, IoT, Agriculture Advisory System, AgriRobot, precision and Agriculture Monitoring Model.

1. Introduction

In a growing nation like India, agriculture constitutes the primary line of work. Small/marginal size, owning scattered holdings, the majority of farmers. The potential to produce a wide range of crops increases with the availability of solar energy, one of the most significant natural sources. Different areas in India adopt various crops depending on other factors related to the soil and the environment. The majority of Indian farmers have a tradition of selecting the same crop pattern over several years[1]. The food and environmental security of India is seriously threatened by land degradation, according to "The India Country Programming Framework, 2016-17" by the FAO. The farmers continue to follow their agricultural patterns in spite of this scenario[2]. The present need is to adjust the crop pattern and cropping style in accordance with the changing factors. Similar to ALSE (Agriculture Land Suitability Evaluator) are the current advising systems[3]. The Tuban Regency, an agricultural regency on Java Island, had its suitability for agricultural land assessed [4]. Its foundation is a spatial multi-criteria analysis that takes into account factors including soil capacity, elevation, slope, direction of the slope, land use and cover, accessibility, and climate. Wheat crop suitability study was carried out in North Carolina, although it was especially for the Soybean crop that was done for the same area [5]. Farmers cannot profit from the static systems and data that are available because they are not user-friendly[6]. The ID3 classification model, which is based on

decision trees, only functions for categorical attributes; it does not function for continuous-valued attributes. Therefore, it is inadequate for the agricultural dataset[7]. The utilised tree-based categorization model is in line with the C4.5 methodology, which can provide dynamic predictions based on historical data, something that crop suitability analysis was unable to do[8]. A logical evaluation matrix for the same crop and region is created to eliminate this overhead and will be used throughout the season. There are several categorization methods, however they are unsuitable for the agricultural dataset's periodic structure. Therefore, it either results in extremely poor accuracy or inaccurate predictions[9]. Agriculture Advisory System forecasts which crop is more suited based on the availability of the existing soil and environmental conditions. The condition of the soil is deteriorating day by day for a number of reasons, including human intervention with natural processes. However, because of soil deterioration, cropping patterns and fertiliser dosages continue to be the same as they have been in the past. The Agriculture Advisory System suggested knowing the best crop or crops for the given condition and offering dosage recommendations for fertiliser. It recommends the proper cropping technique and fertiliser microdose, both of which may be carried out by an AgriRobot. It may be used to create an automated sowing and fertiliser microdosing. AgriRobot is a portable, inexpensive solution. Given that it doesn't need fuel or labour, it is more affordable than other machinery[10]. The controller processes the data in accordance with the instructions, sets up the system, and then begins microdosing fertiliser and sowing seeds.

2. Literature Survey

India has the second-highest population after China. Food is one of the basic requirements of humans. Additionally, farming and raising animals provide the majority of Indians with their daily income. Due to a number of factors, including growing land degradation, food security is becoming an increasingly serious challenge [11]. Therefore, two actions may be taken. 1) One is adopting an appropriate crop based on the characteristics that are now available. 2) Adjust fertiliser application as necessary to prevent soil deterioration In light of answers 1) and 2), this solution must address three distinct issues[12]. In a poor nation like India, soil and water testing is carried out manually in the lab. A soil-nutrient level study using colorimetry kits is also utilised, and a suitability analysis particular to a crop that has to be evaluated

regionally is. Some aspects, such as crop patterns, crop-growing techniques, environmental conditions, soil types, etc., differ depending on an area. a). The appropriateness analysis is more accurate the more characteristics that are taken into account. A method that is appropriate for one location cannot be applied in another[13]. When the appropriate crop has been chosen, as in point c), take steps to address the root causes of soil degradation to minimise the likelihood of soil erosion. The dosage of fertiliser is one that the farmer can manage. India ranks second in fertiliser use, slightly behind China, as a result of Indian farmers' constant practise of increasing fertiliser dosages without knowing the need. The Indian government has long advocated utilising natural manures, but a greater proportion of farmers still rely only on chemical fertilisers, which is excessive [14]. Because the farmers were ploughs were made of wood. The design of the plow's core allows it to simultaneously drop seed and a little amount of fertiliser. Due to the input characteristics mostly being geographical and GIS-based, the first flaw in the present suitability assessment approach is mostly relevant for only unregimented regions. There are several ways for fragmented land, although they tend to be rather static or narrowly focused [15]. Fragmented regions are more common in India, necessitating a field-specific analysis because of the dataset's highest level of variability. We incorporated machine learning because, in order to manage such variance, we need a dynamic system that can operate on both the historical and present datasets. Machine learning classification algorithms now in use handle each input feature uniformly. The second and most important argument is that the present systems do not adequately address the necessity in the agricultural sector to pre-process specific parameters.

3. Proposed Method

The design of the plow's core allows it to simultaneously drop seed and a little amount of fertiliser. In order to get a decent crop yield, the first tiny dosage of fertiliser is applied during sowing, where it falls locally as nearby seed drop, and the second dose is applied later by spreading, etc. Due to the input characteristics mostly being geographical and GIS-based, the first flaw in the present suitability assessment approach is mostly relevant for only unregimented regions. There are several ways for fragmented land, although they tend to be rather static or narrowly focused [15]. Fragmented regions are more common in India, necessitating a field-specific analysis because of the dataset's highest level of variability. We

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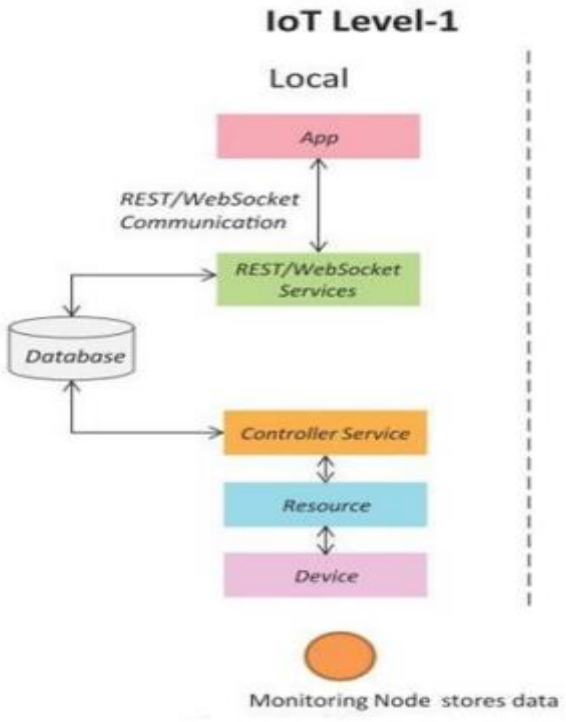

Figure .1: AMM Architecture

Figure 1 illustrates the IoT level 1 architecture that was utilised to create the agriculture monitoring model in order to meet the secondary goals [18]. The third and top module is called application, and it has a web-based user interface.

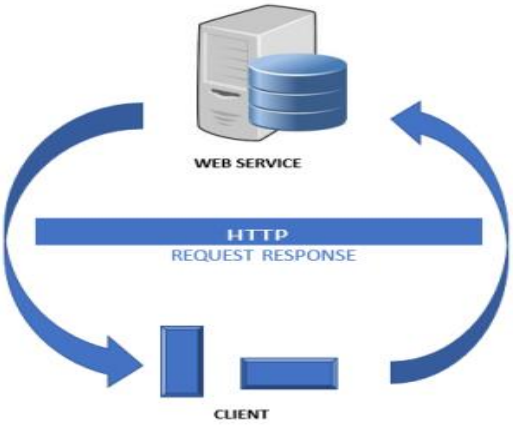

Figure.3: REST of Farmer device AMM

Rainfed cropping is commonly used by Indian farmers, hence a precise crop planner cannot be constructed. Another issue that prevents farmers from completing their task on schedule is a labour shortage. We talk about one agricultural procedure called fertiliser dosage or sowing. Traditionally, labourers are needed for this procedure. On the other hand, timely planting is crucial to crop development and productivity. Early 2-3 good rainstorms establish soil moisture at a depth that is adequate for seed germination; thus, if sowing is delayed due to a lack of labour, the anticipated return will not be realised. People choose alternate income sources because of the unpredictable nature of the climate and its detrimental impact on rainfed agriculture.[19]. Suburban and major cities provide excellent employment prospects with stable pay. In order to avoid unpredictable income from farming, some folks chose employment that provide assured income. People relocating from rural to industrial areas and a lack of labour are two effects of urbanisation that raise labour costs. Therefore, the availability of reasonably priced technology for automated seeding, which will have lower purchase and use costs, might be a win-win scenario. Farmers are unable to buy machinery, hence the issue of availability persists. So there is no answer for timely sowing. Such machinery is not appropriate for medium-height agrivoltaic plants if tractors are needed to move it. AgriRobot suggested taking all of these restrictions into account.

4. Architecture of AgriRobot

According to module wise functionality, the architecture of AgriRobot is primarily separated into seven components, as indicated in the Figure.4.

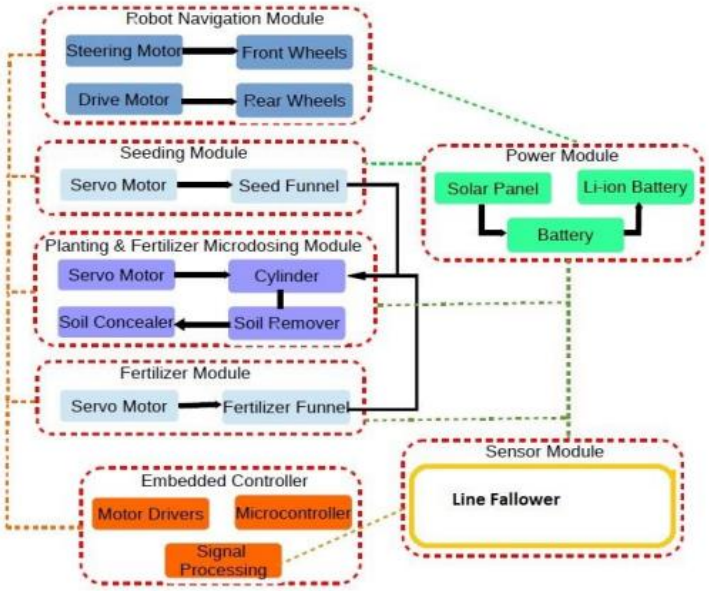

Figure.4: AgriRobot Architecture

The more rational navigation module propels the robot in a direct trajectory even in the absence of user input. If it is configured for white line over black dirt, it will begin to follow the line as soon as it is detected. Navigation operates in accordance with instructions using code, sensor modules, and human input[20]. This module's components are the motor drivers for the front and back wheels. Line follower sensors are employed in the sensor module to determine the route. Servo motor and a seed funnel make up the seeding module. A farmer must keep an eye on the seed funnel to ensure it is not empty. Servo operation is described in the module for planting cum fertiliser. Fertiliser module: Composed of a servo motor, which is once again a common seeding cum fertiliser module. A farmer must continuously check the other portion of the fertiliser funnel to ensure that it is not empty. fertiliser and plant care The micro-dosing module consists of just four parts. The first phase is carried out by the soil remover, who also creates room for the seed and fertiliser drop. The drip is hidden by surrounding loose dirt using soil concealer. Integrated controller: The device's brain, the microcontroller receives and transmits all instructions from linked devices. The signal processing unit converts all of the controls into signals. Power supply: A charged lithium battery is suggested in this situation. a solar panel that can be extended to charge the battery; in the absence of enough solar energy, the electronic battery may also be employed as a backup power source.

5. Results and Discussion

According to the need, a monitoring model for agricultural fields has been created. characteristics such as pH, EC, soil moisture, and the actual temperature recorded in the location. We discovered fragmented land in India, which means that crop variety, fertiliser composition, fertiliser amount, and pesticides may differ from one fragment to another. We cannot presume lands in the same location have the same values or ranges for real field attributes like pH. It is advised to use a rechargeable solar battery to save costs. Not always do you need to be connected to the internet. It was advised to only enable internet access for field devices once every season since recorded data was only uploaded and utilised once per season. Once the system has been installed and set up by technical experts, farmers won't need to take any more effort to keep it on since the power usage and associated costs will be optimised. Because farmers cannot have technological competence, this simplicity was developed. Machine learning has been developed using tailored methods to

capture the dynamic behaviour of key elements influencing crop development. The word "hybrid" is used in the sense that the weighted decision matrix and c4.5 classification algorithm are combined in this way. Customization, on the other hand, refers to data processing methods that are tailored for two distinct types of attributes. It is possible to summarise after looking at the feature values for the crop Wheat in the dataset, as shown in the figures.

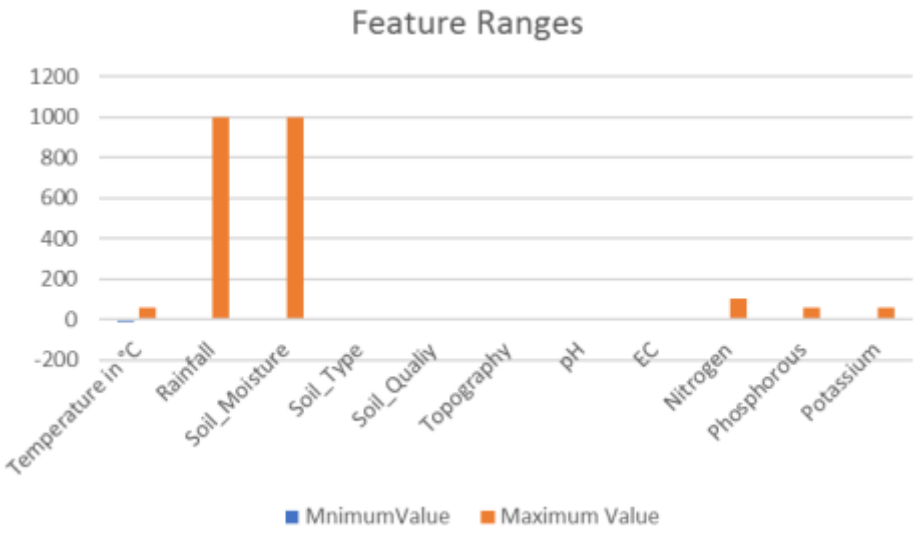

Figure.5: Ranges of Wheat crop input characteristics

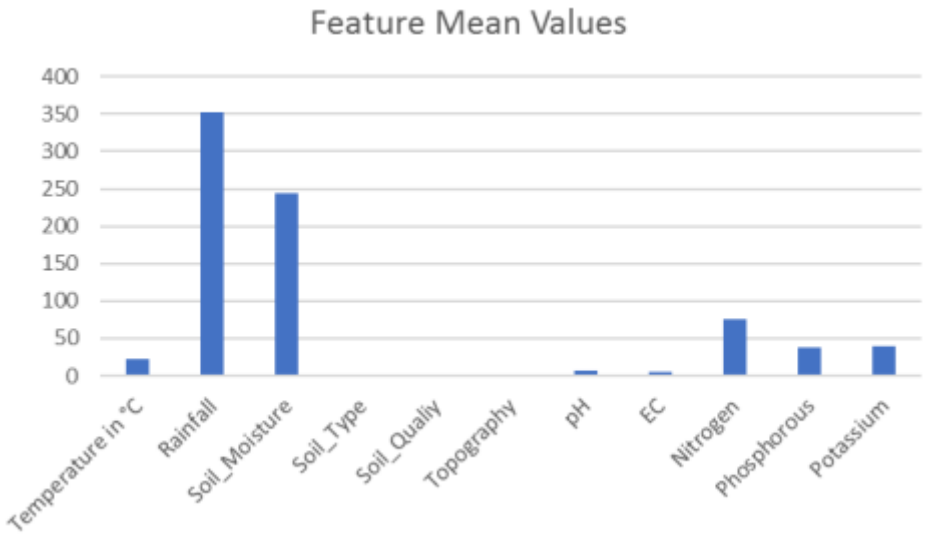

Figure.6: Average input feature values for the crop Wheat

The hybrid approach's similar processes were used while working with the dataset for the Wheat crop. The dataset was created using 1020 tuples in total. Some properties of the dataset may be represented as follows

by looking at feature values that are available for wheat crops.

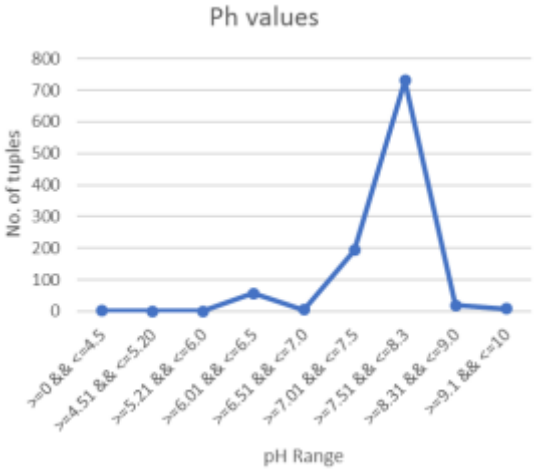

Figure.7: pH values in the wheat dataset

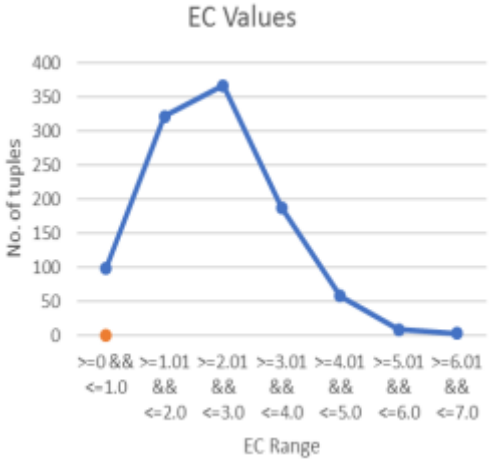

Figure.8: EC values in the wheat dataset

The feature with the greatest information gain will be weighted nine, while the feature with the least information gain will be weighted one. As a weighting option, we might use the information gain values as-is. However, there is just a little variation between certain nearby elements, such as terrain and soil quality. However, if we apply logic, a change in topography has a greater impact on suitability than a change in soil quality. As a result, the ranking is given weightage in order to highlight these distinctions. Another crucial aspect is that a little variation in weighting will not be able to capture the cutoff values of scores that correspond to various appropriateness groups. We cannot get the answer in the

anticipated manner if the threshold value is uncertain.

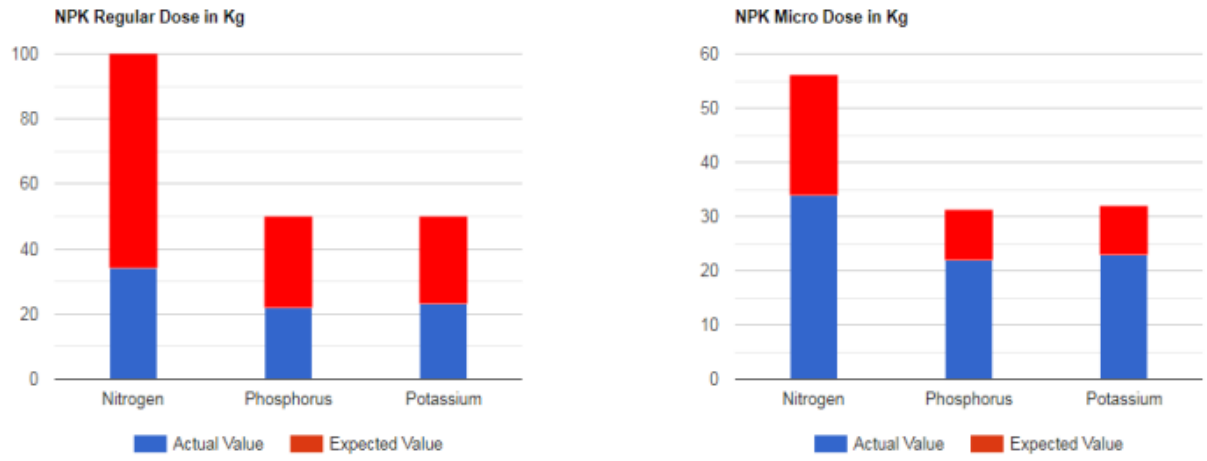

Figure.9: graph showing fertiliser production for the wheat case study.

Both the actual and projected appropriateness levels are included in the result above. Potential appropriateness is the level after adding more characteristics to make up for a shortfall, such a nitrogen shortage. As illustrated in Figure.9, a few customizable elements may assist in achieving potential suitability. Potential suitability level = level above existing appropriateness. The following is one such output for the sample instance.

6. Conclusion

Precision farming systems may be improved with the help of these software and hardware models. For small-scale farmers in underdeveloped nations like India, this lovely fusion of modern technologies—"Machine learning" and "Internet of Things"—helps to produce a cost-effective solution. Both fragmented and unfragmented areas might try to use this approach. The system may be scaled to be used in multiple locations, but only if the user prepares the dataset for that region in structured query language format. The technique is accurate for both irrigated and rainfed, dispersed agricultural areas. AgriRobot is a user-friendly technology that farmers may use right away with minimal instruction or background knowledge. The rechargeable solar battery is the energy source promoted here, resulting in the achievement of both economic and environmental security. Labour shortages, soil degradation, and farmer finances are a few major problems with conventional agricultural techniques. Many developing nations are experiencing a significant labour shortage in the

agricultural sector as a result of people migrating there in search of higher-paying industrial employment in big cities or suburbs. Investigating inexpensive equipment that might be beneficial for agricultural operations is essential.

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