SMART AGRICULTURE USING IoT AND FILTERING TECHNIQUES

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Abstract

This paper focuses on the idea of smart agriculture. The main idea of this project is to make a smart irrigation system that updates live data using Internet of Things(IoT) technology. IoT technology helps to retrieve data from the sensors such as Temperature, Humidity, Soil Moisture. All these sensor values will be accessible to the farmer through a web application. This web application helps farmers better understand the requirement of water content in the soil which will eventually help in better irrigation followed by better crop production. The web application comprises three display sections, each displaying temperature, moisture humidity values, and a manual button has been included for scenarios when there is an abundance of water due to rainfall. In such cases, alerts will be generated and the farmer can dig a way for excess water removal. The temperature sensor values are further processed for filtering out the noise by performing the Kalman Filter technique using Processing IDE application by Arduino. After filtering the noise we get smooth values and these threshold values are passed into a decision tree algorithm which, based on its rules, decides whether the water pump should be switched on or off.

Introduction

Agriculture plays an important role in the development of the economy. In ancient times it was only a mode of food and fodder production but with advancement of technology now it is also a crucial mode of employment. In India the share of agriculture and their related sectors in GDP has increased to 19.9 percent in the year 2020-21 from 17.8 percent in the previous year[1]. Hence working on agriculture advancement is much needed for development of an individual and as well the country. This can be done with the help of emerging technologies.

Technologies Used

Internet of Things: Internet of Things is an arising technology that holds the power of connecting to devices, interacting with them, or controlling them. IoT technology uses both hardware and software to control devices. It has been used for small automation such as the automatic doorbell, automatic fan, etc. But now due to its beneficial qualities, it is being implemented in almost everything. Some of the examples are smart cities, smart devices in the health sector, drone delivery, location sensors, Data Analytics, Smart Homes, Wearables, and many more[2].

NodeMCU as a local webserver: An important part of IoT technology is the transmitter section. For transmitters, we have two options ESP8266 and NodeMCU. The reasons to choose NodeMCU instead of ESP8266 are mentioned below.ESP8266 is a Wi-Fi module that is available at a low cost. ESP8266 can handle up to 3.6 V without causing any harm. But the amount of current obtained by providing this 3.3 V / 3.6 V is not sufficient for transmitting the Wi-Fi signals.To overcome this, NodeMCU is brought into the picture which is basically an ESP8266 with a perfect built-in voltage regulator. Using this voltage regulator, the desired current can be obtained for the transmission of Wi-Fi signals.

Kalman Filtering: The Kalman filter is a mathematical algorithm that processes at each step. It is an efficient and recursive model which inputs inaccurate data (including noise) and generates a statistically optimal estimate of the real system state, by developing a prediction model and an observation model. It has also been called the linear least mean squares estimator (LLMSE) because it minimizes the mean-squared estimation error for a linear stochastic system using noisy linear sensors. It has also been called the linear quadratic estimator (LQE) because it minimizes a quadratic function of estimation error for a linear dynamic system with white measurement and disturbance noise[3].

Implementation

In this system, data is monitored and noise is filtered from the data and it'll further be passed into a decision tree algorithm to perform tasks as per the decision tree rules.

A. Monitoring of sensor data: Real-time live data is continuously being monitored through all three sensors. General values of the temperature, humidity, and soil moisture sensor are updated in the web application. For Kalman filtering it generates in the Processing IDE environment we can copy-paste it in the excel sheet for reference. There is an option of manual switch which the farmer can use in case of emergencies.

B. Kalman Filtering: Generally, the sensor output voltage which we receive from the temperature sensor is noisy. So to reduce this noise we use a Kalman filter.

Prediction Step:

$$\hat{x}f = \hat{x}_f^- + Kf(z_f - H\hat{x}_f^-)$$

$$\hat{x}f = \hat{x}_f^- + Kf(zf - H\hat{x}_f^-)$$

$$Pf = (1 - KfH)P_f^-$$

Measurement step:

$$\hat{x}f^- = A\hat{x}f - 1^- + Bu_f$$

$$Pf^- = APf - 1 + A^T + Q$$

Decision Tree

Functional Requirements:

1.If the soil moisture value is less than the threshold value then it is considered as 'DRY'. Now there are two options - to automatically start the water pump or to check if it's raining.
2.If the rain sensor value changes then it concludes that we don't have to turn the water pump. So the system doesn't do anything.
3.If the rain sensor value is not changing then a signal will be sent to the controller to open the valve and pump.
4.If the water level is low in the tank then the system will shut down automatically.

Web application

This system consists of a web application. It is implemented using the Firebase which is Google's database platform used to create, manage and modify data generated from any application, sensors, etc.

Firebase platform is used as it sets the scope for Real-time database and authentication. The web application used in this project consists of a simple page with a manual button for irrigation and displays values of sensors mentioned above. The sensor data keeps updating every 1 minute in the web application. This delay will help if there is any hinderance in retrieving sensor values.

Results

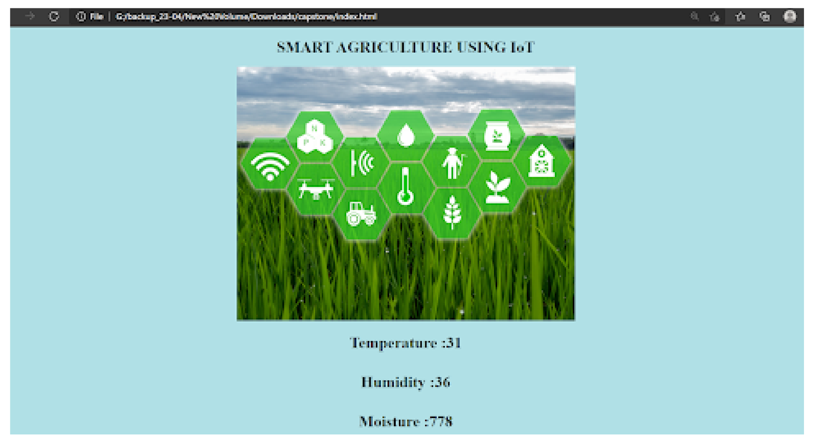

Fig. 1: Web application with sensor values

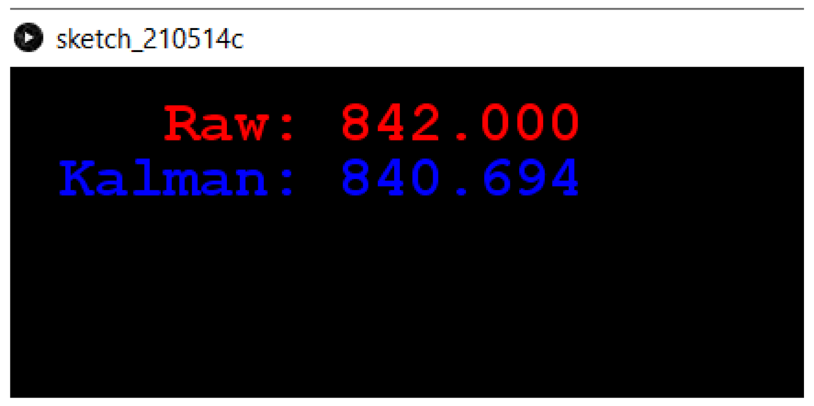

Fig. 2: Kalman Filter in Processing IDE

Soil Moisture Value	Raindrop value	Decision	Result
<300 & <500	<300 & <500	No Rain	Pump "ON"
<300 & <500	>500	Raining	Pump "OFF"
>300 & <500	<500	No Rain and adequate moisture	Do nothing
>500	>500	Raining and moisture is increasing	Alert to farmer

Table - 1: Decision tree rules

Conclusion

This system consists of a kit that has low cost and highly reliable sensors. The fu
the system is it updates sensor data which is useful for real-time monitoring. It
automatic irrigation based on the decision tree rules provided. Before passing th
values directly into the tree they'll be filtered out of noise by a popular and ye
ing technique called Kalman filter. The system also provides a manual button ir
emergencies such as sudden rain or storm. It has been implemented with emer
technology. It also used NodeMCU as a local webserver which lets us control th
with any wifi.

References

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