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Explore The Challenge Of Automatic Crop Monitoring

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ABSTRACT

Sustainable growth of the food system and reduced market volatility need access to timely, accurate, and actionable agricultural data for decision making in the present. Researchers have found that there are challenges with autonomous crop monitoring and that present approaches for identifying crop stress due to drought have limitations that prevent farmers from getting an accurate picture of their crops. Methods including real-time irrigation monitoring, automated crop selection, and Internet of Things (IoT)-based crop management are also proposed.

Keywords: Crop monitoring, Crop condition, Crop production, Ground data, Remote Sensing.

INTRODUCTION

Government institutions involved in the import and export of food crops, food assistance agencies, international organizations tasked with monitoring global food production and commerce, and commodities traders all need accurate and timely data on future crop yields over huge areas. Climate change, natural disasters, and rising tensions in international trade and rivalry have all contributed to a major rise in food market volatility in recent years. Such data can also be used to better guide food imports and exports at the national level, the improvement of farm management support, the informed hiring of seasonal workers, adjustments to stock and logistical routes, as well as new price structures for merchants or insurers, and the revision of national food balance sheets.

Satellite crop monitoring uses spectral data from high-resolution satellite photos of diverse fields and crops in real-time to generate the crop vegetation index, which may be used to track positive and negative dynamics of crop development. Among the precision agriculture techniques, satellite crop monitoring stands out for its ability to reveal discrepancies in single-crop growth, which in turn highlights the need for extra agricultural efforts in certain field zones.

Through the use of satellite technology, farmers can keep an eye on their crops from anywhere in the world, no matter how far apart their fields may be. The technology's strength is that it can automatically analyze the state of the sowed area and provide the results on a map that can be understood by a wide range of users.

LITERARTURE REVIEW

Wu, bingfang et.al (2022). Satellite-driven crop monitoring has become increasingly important for gathering agricultural data at all scales since it sheds light on the spatial and temporal aspects of crops' development and yields. However, the usefulness of crop monitoring is diminished since there are no quantitative, objective, and strong techniques for guaranteeing the accuracy of crop information. In this study, we assess the state of crop monitoring at the present and look forward to the potential and difficulties that lie ahead. Our research shows that satellite-derived measures fall short of their potential in two key areas: (1) completely capturing factors of agricultural output, and (2) quantitatively interpreting crop growth status. To get around the problems of getting your hands on ground truth data, crowdsourcing is one approach. We propose that the quality of agricultural information may be enhanced if users were involved in every step of the crop monitoring process. Unconscious biases may be avoided if people were given access to agricultural information from a variety of sources. Finally, while sharing agricultural data with the public, it's important to stay away from any potential conflicts of interest.

Choudhary, jairam et.al. (2021). The agricultural industry is vital to the economy. The widespread use of automated farming practices is a topic of growing interest and urgency. The ever-increasing population has pushed up the prices of food and labor. The farmers' conventional practices were insufficient to meet these standards. As a result, cutting-edge mechanized techniques have emerged. These innovative practices not only fulfilled the food needs, but also created jobs for billions of people. There has been a revolution in farming thanks to the use of AI. This innovation has mitigated the effects of climate change, population increase, labor market instability, and food insecurity on agricultural output. These innovations reduce wasteful applications of water, pesticides, and herbicides, which in turn helps preserve soil fertility, maximize the effectiveness of labor resources, increase output, and enhance product quality.

Dr R Vijayalakshmi, et.al (2021) Emerging technologies like IoT and Machine Learning are already in widespread usage. Agriculture is essential to human well-being. Improving agriculture requires mapping crops to the present climate. This suggested system uses a variety of sensors. Association learning algorithms are used to assess the current growing conditions and make educated guesses about which crops will thrive on each plot of land. The Ensemble Technique is included for precise categorization for crop selection. In order to increase agricultural output, scientists are increasingly turning to solutions that use both the Internet of Things and machine learning.

Khabbazan s, et.al (2019); The agricultural sector is vital to the Dutch economy; thus, it is crucial that farmers have access to accurate data on crop growth in real time as they move toward precision agriculture. Cloud cover greatly impairs the usefulness of optical imaging in studying crop growth and development. Backscatter time series estimates for emergence and closure are checked against an image library. The findings reported here show that Sentinel-1 data might be quite useful for keeping tabs on the progress of important Dutch crops. Even in cloudy weather, farmers, food manufacturers, and regulators can rely on accurate data thanks to Sentinel-1's availability guarantee.

M.k.dharani et.al (2020) Fewer people to keep an eye on the fields and lower yields as a result of animal encroachment are two of contemporary agriculture's biggest challenges. The primary goal is to solve these issues by employing wireless sensor networks to keep an eye on the agricultural field and sound warnings if animals go too close. The sensors are set up as a master-slave system. Soil moisture, air pressure, and ph value are all measured with the use of three separate wireless sensor networks in the agricultural sector. Sensor data is digitalized and sent to a microcontroller, where it is used to provide real-time readings. The microcontroller and the monitoring system are coordinated via GSM. Lab view technology is used for the monitoring system, with ontology applied to the comparison of real-time values with those already entered into the database. If there are any alterations to the agricultural field, the farmer will get an SMS alert. The mobile texting technology will greatly facilitate the smooth exchange of information. Connecting the central computers through WLAN makes it simple to provide worldwide crop disease alerts. This approach not only decreases the amount of time farmers need to spend in the field, but it also provides timely advice that increases crop yields.

PROPOSED METHODS FOR AUTOMATIC CROP SELECTION AND LIVE IRRIGATION TRACKING

This is the most crucial part of the IoAT app that was built. The farmer may choose from a predetermined list of crops to determine which one will be grown on the field. Information about the chosen crops is uploaded to a remote server. This section revises all system-wide threshold settings to ensure optimal development of the planted crop. Crop selection in IoAT is shown in Fig 1. The farmer may monitor the progress of irrigation in real time over the whole plot. Farmer monitoring is made easier with tracking.

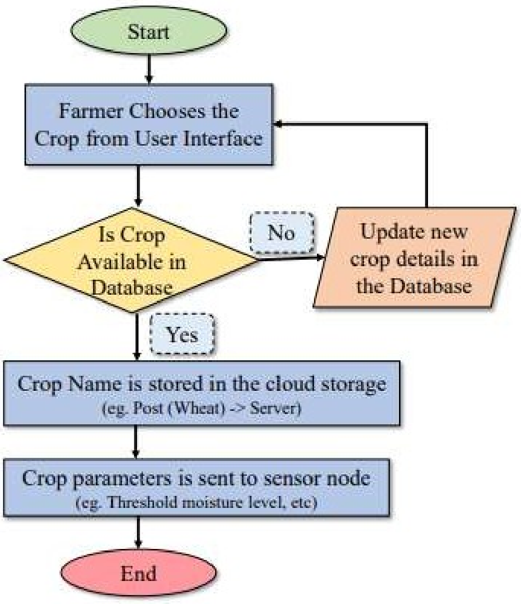

FIG.1: THE PROPOSED METHOD FOR CROP SECTION.

When the cloud receives data in this way, the program is then updated graphically. The software collects data 30 seconds after it has been updated on the cloud. The data flow for automated irrigation is outlined in TABLE 1

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TABLE 1: THE PROPOSED ALGORITHM FOR IRRIGATION AUTOMATION

```
Requires: Sensor Input and Data from Cloud
Ensures: Relay ON/OFF
Notions: TEMP: DHT11 Temperature Data, SM: Soil
 Moisture Value DATE_TIME_S: Date and Time
 Stamp.
(val)*: 1 - ON; 0 - OFF
**: Data is being sent to a different cloud database
while TRUE do
  | ReadFromSensor(var CurrentTEMP,var
  |  CurrentSM);
  | ReadFromCloud(var ThresholdSM);
  | if var CurrentSM <= var ThresholdSM then
  |   | WaterPump = (1)*;
  |   | SendToCloud(DATE_TIME_S)**;
  | else
  |   | if var SM > var RSM then
  |   |   | WaterPump = (0)*;
  |   |   | SendToCloud(DATE_TIME_S)**;
  |   | end
  | end
  | delay(9000(ms));
end
```

A solar-powered sensor node is used to accomplish the aforementioned TABLE. In the next part, we'll go through the specifics of the energy module and the sensor node's calibration.

AGRICULTURAL CROP MONITORING AND CONTROLLING USING IOT

In order to increase agricultural productivity and quality, farmers may benefit from wireless sensor networks by learning about the farm's present condition. Temperature, humidity, light intensity, etc. are just some of the environmental factors that may be tracked with the help of strategically positioned sensors. Here is the Analysis of Outcomes. Temperature, Light, and Humidity probe of the harvest is provided. We expect this endeavor to increase production effectively.

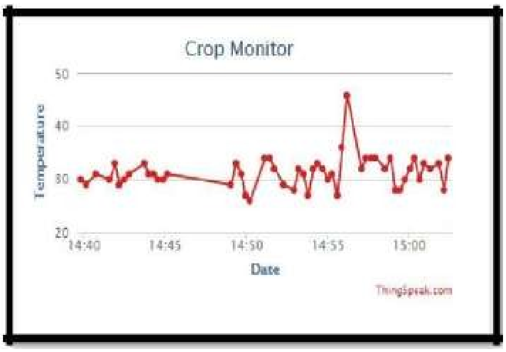

Fig. 2: Shows Temperature analysis of Crop Monitor.

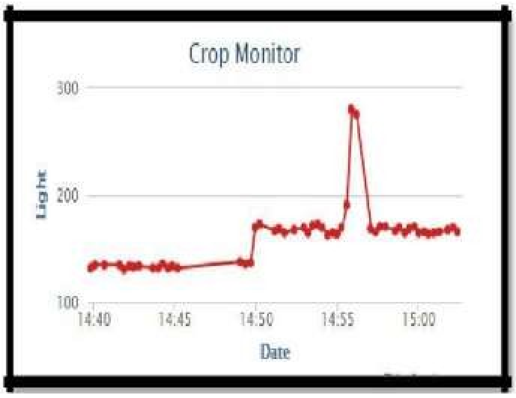

Fig. 3: Shows Light analysis of Crop Monitor

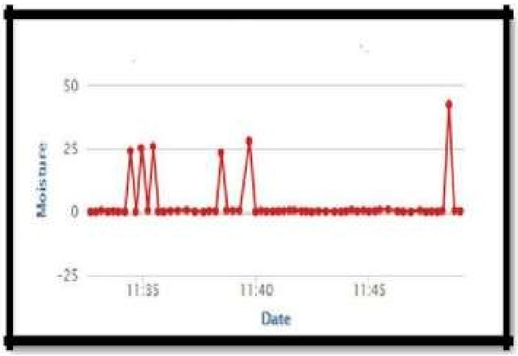

Fig.4: Shows Moisture analysis of Crop Monitor.

LIMITATIONS ON DETECTING CROP STRESS DRIVEN BY DROUGHT

Most crop monitoring systems (CMSs) include drought evaluations as part of the crop condition component or the individual component (Table 2) since drought is the most devastating natural catastrophe in terms of crop stress and yield losses Drought in agriculture may result from a meteorological drought due to a lack of precipitation mixed with greater evaporation rates, causing a drop in crop production or even crop failure. For the goal of recognizing meteorological droughts caused by climatic fluctuations, several drought indicators have been devised. Drought has a direct effect on how crops look, how green they are, how much biomass they produce, and how much water they lose via evaporation. To reflect crop stress before major visual indications, appear, the LST is a timely response signal Taking into account both biophysical and environmental factors, the VHI is a common metric.

However, several of the drought detection indices use climatic factors, environmental variables, and the vegetation state to account for the difference between meteorological drought and agricultural drought (Table 3). Indicators generated from climatic variables, such as the SPI, are adequate for reflecting climatic abnormalities while tracking a meteorological drought. Including factors like soil moisture that might be influenced by human-made drought mitigation strategies diminishes the utility of employing climatic variables alone.

TABLE 2. SUMMARY OF TYPICAL STUDIES CONDUCTED.

Indicator	Climatic variable		Environmental variable			
	Precipitation	Evaporation	Soil moisture	Soil temperature	Vegetation status	Validation method
ESI [62]		ET, PET		MODIS LST	LAI	In situ yield
IDMI [63]	PCI		SMCI		VCI	SPI
VegDRI [64]	SPI, PDSI				PASG, NDVI	USDM
OMDI, OVDI [65]	TRMM		AMSR-E SM, CLSMAS	MODIS LST	NDVI	SPEI
GHDI [66]	PCI		SMCI	TCI	VCI	In situ PDSI, SPI, SPEI, and Z-index
SDCI [67]	TRMM			MODIS LST	NDVI	In situ PDSI and Z-index
MIDI [68]	PCI		SMCI	TCI		In situ SPI, SPEI, and EVI
DSI [69]		ET, PET			NDVI	Drought-damaged crop area and yield statistics
PADI [69]	PCI		SMCI		VCI	SPI, PDSI, and yield loss
PMDI	PCI		SMCI	TCI	VCI	SPEI, NDVI, and SIF

TABLE 3. UNBIASED ESTIMATOR TO ADJUST CROP AREA ESTIMATION

Provinces of China	Location	Morphology	Field size (ha)	Unbiased estimator
Heilongjiang	126.72°E, 45.40°N	Plain	10	0.894
Hebei	114.91°E, 37.02°N	Plain	1.0	0.814
Inner Mongolia	108.47°E, 40.96°N	Slope	0.5	0.875
Jiangsu	120.19°E, 33.20°N	River network	0.2	0.742
Sichuan	105.47°E, 28.82°N	Terrain	0.1	0.599

CONCLUSION

In this study, we took a methodical look at the current state of crop monitoring, identified some of the key problems, and offered some possible remedies based on what we learned. We demonstrated that the availability of in-situ data and the need for knowledge-based analysis of satellite-derived metrics are two significant obstacles that prevent crop monitoring from being widely implemented and lead to undesirable results. There is no doubt that total output and crop yield can be increased if this system is put into place.

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