Towards transforming Agriculture for Challenges of 21st Century by optimizing resources using IOT, fuzzy logic and network coding

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Abstract: Climate risk is one of the confronting factors in Indian agriculture. To overcome this distrust, a large number of sensors can be installed in the fields,The extensive IoT platform can process the data sent by these sensors.The Data stream can be processed in real-timeusing Fuzzylogic, to offer smart solution. Network coding can enhance throughput and security. Thus reducing human interaction and improve efficiency.

Index Terms: IoT, Smart Farming,sensor data, agricultural, Fuzzy logic, Network coding

I.Introduction

The growth of Indian economy and overall development cannot complete without mentioning the role of agriculture. But climate risks is one of the confronting factors that worry Indian farmers. Majority of farmers in our country are small with fragmented land. Apart from this, other issues that worry the farmer community are:

A.Lack of automation: Initiating newest technology is limited which is attributed to reason like lack of accessibility for credit and awareness.

B.Diseases and related pest: Can reduce crop production.

C.Input shortage: Like seeds and irrigation facilities.

A Solution to above-stated problems can be discussed as:

A.Resourcefulness: Farmer-friendly decision-making occampanied by infrastructure enhancment,technological intercession etc, can increase the agricultural growth and farmers income.

B.Technology: Can help to reduce 'yield gaps' and thus improve productiveness.

C.Efficient use of water: The use of drip irrigation technology can save water significantly.

In the present time, all the industries have embraced the influence of Internet-of-Things (IoT). This includes agricultural industry too, New openings are being created due to marked transformation happening in existing agriculture methods. The precise use of fertilizers and pesticides for crops has actually transformed the agricultural enviroment, boosting the productivity , yields and profitability.This has also reduced the environmental footprint.This is attributed to usage of embedded sensors, enabling the vision of smart farming.

To improve yield of agriculture produce, agri resources like land, water and fertilizer should be used optimally.Smart farming can overcome the old agiculture challanges thus improving the yield[10][11].IoT sensors collect accurate field data and use fuzzy logic and network coding to aid data processing, improving system efficiency.

The remaining part of the paper is arranged as follows:In part II, we will study the outcome of a few works. In part III we will see how the sensor works which deployed in agricultural field. In part IV we will study Fuzzy logic,which helps in making more optimistic decision and Network coding,which helps in inreasing in throughput and enhances security. In part V,a typical set up for the proposed system is discussed. Finally we will discuss conclusion in part VI.

II.Literature survey

"Agriculture has been one of the most important industries in human history. A connected farm based on IoT systems aiming to provide smart farming systems for end users was discussed in a detailed design and the application for connected farms is also shown in [1] ".

"In agriculture, environmental parameters like temperature and humidity can be monitered using IoT, by employing sensors in the field.These sensors provides tealtime values,thus saving manual efforts thus it improves the yield[2]."

Thanks to the integration of communication, information and control technologies, Precision Agriculture (PA) is developing very well, thus improving yield. To meet the needs of soil less cultivation in complete re circulation greenhouses using moderately saline water[3].

The work presented in [4] consists of devising a new intelligent IoT-based agricultural stick that helps farmers obtain real-time data (temperature, soil moisture) for effective environmental monitoring that will allow them to do intelligent agriculture and to increase the overall yield and quality of products The agricultural stick proposed in this document integrates with Arduino technology, thus transforming the face of agricultural production not only by improving it, but also making it profitable and reducing waste.

Cotton yield is an important target to achieve its influences and specifies the cotton yield production.

"Fuzzy cognitive maps (FCMs), a knowledge-based approach exploiting fuzzy sytem is presented in this work"[5].The method supposed to characterize and increase the cotton yield.The

fuzzy cognitive maps handles experts knowledge on unsupervised learning algorithm for FCMs to assess measurement data and update initial knowledge.

Farmers' efforts to monitor the field even in the middle of the night can be minimized by transforming traditional agriculture into intelligent agriculture. The work in [6], tries to design a simple water pump controller using a soil moisture sensor and Esp8266 NodeMCU-12E. A message queue telemetry transport protocol is used to transmit and receive information from the sensor. Depending on the state of the soil moisture content, the NodeMCU-12E controls the action of a water pump and displays data from the soil moisture sensor and the status of the water pump on a web page or mobile application.

Plant disease cannot be predicted with precision simply by looking at the individual causes of the disease. Only by building a comprehensive analysis can farmers receive highly probable disease predictions, using cloud-based technology capable of handling the collection, analysis and forecasting of the agricultural environment. The proposed integrated Farm as a Service (FaaS) system supports high-level application services during farm operation and monitoring, as well as the management of associated devices, data and models. This system registers, connects and manages Internet of Things (IoT) devices and analyzes environmental and growth information. An IoT-Hub network model supports efficient data transfer for each IoT device, as well as communication for non-standard products and offers high communication reliability, even in poor communication environments [7].

 The work in [8], "aims to analyze newly developed IoT applications in the agricultural and livestock industries to provide an overview of sub-vertical sensors, technology and data collections such as water management and water management. crops. The processes of the agricultural and livestock industry are more efficient by reducing human intervention through automation ".

Lianmin Shi et al in ,[18] considered the transmission performance and information security parameters in a multi-stream multicast network in IoT using linear network coding (LNC). LNC becomes an effective way to resist passive attacks and provide secure data transmission without key distribution protocols, reducing system complexity.

III.Sensors

The sensors play an important role while measuring some of the parameters related to soil. In the below-mentioned description, some of the sensors with their functions are given[13].

A.Temperature & Humidity sensor

Temperature sensors (figure 1) can measure the correct temperature using the alarm function. The temperature can range from -55C to + 125C. Humidity sensors predict changes that change electrical currents or air temperature. It measures both humidity and air temperature and expresses proportional humidity as a percentage of the relationship between the humidity of the air and the maximum value that can be kept in the air at a given temperature.

B.Soil moisture sensor

The moisture sensor (fig2) uses the pads which act as probes,actually measures the change in the value of resistance which is reflected as an equivalent change in moisture level of the soil.This value is then displayed on the screen.

Fig1: Temperature & Humidity sensor

When the water content is low in the soil, the analog voltage will be low and this analog voltage will continue to increase as

the conductivity between the electrodes in the soil changes. This sensor can be used for the irrigation field.

Fig2: Soil moisture sensor

C.Ultrasonic sensor

Ultrasonic sensors uses logic similar to sonar(fig3).As in case of sonar,frequency sound waves are sent towards the target.It then evaluate the echoes.Sensors determines the time interval between sending the signal & receiving the echoes back, to determine the distance to an object. This technique is used for repelling intrusion due to birds and insect.

Fig3: Ultrasonic sensor

IV A.Fuzzy Logic

Fuzzy logic calculates the extent of accuracy of an event, essential to the growth of human-like capability. As such

in any system 1 and 0 are included as extreme cases of truth(state of matters) but fuzzy system also includes the various intermediate state of truth so that the result of correlation between two things could be "channel busy" or "channel ideal" but say,38% of the channel is busy."We use fuzzy logic in our system to predict exactly the outcome of an event. We aggregate data and forms many fractional truths to predict the exact accuracy of an outcome of an event.

This can be understood by seeing at fig4, In a boolean logic the decision comes out as true or false. But in fuzzy logic,the decision comes out as:

Channel :

i 90% busy, certainly no more occupancy possible.

ii.50% busy, Still half of occupancy possible.
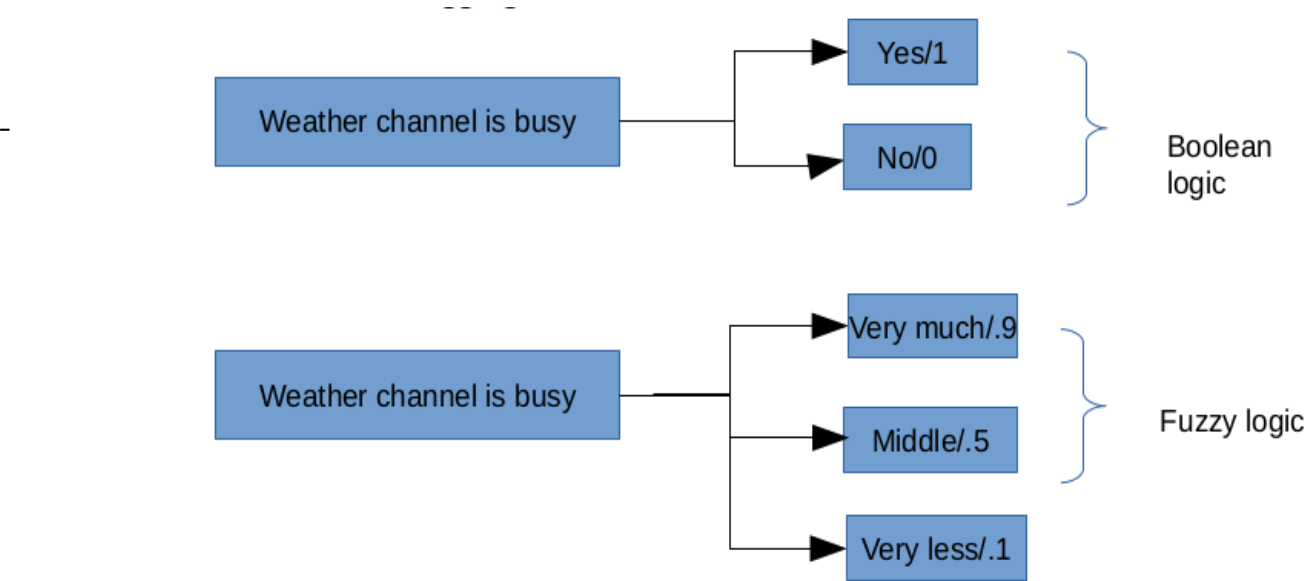
.iii.10% busy, Still a lot of occupancies possible.

To illustrate the increase of throughput and enhanced security, consider the network shown in fig5. Packets originating from node1 and node2 are combined at an intermediate node3, thus resulting in fewer packet transmissions. This enhances security as well. As no other node can decode the information as it requires coding coefficient information.
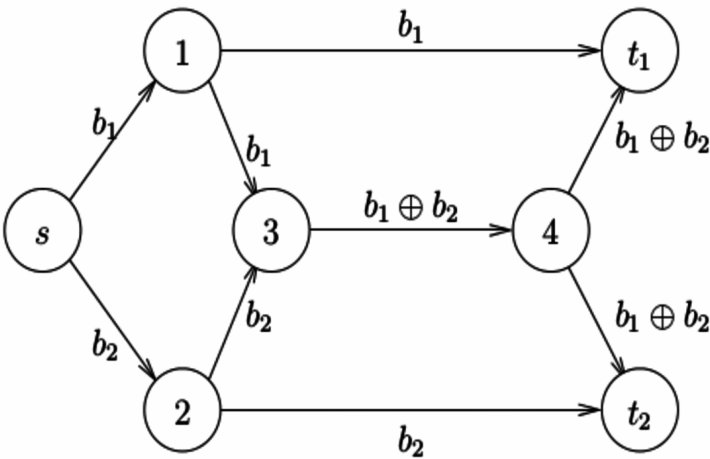

Fig4: Fuzzy logic concept

B.Network coding

Network coding involves mixing of information obtianed from two nodes in a casual way using xoring between them.

Fig5:network coding example

V. Proposed Method

As we know there is high cost of agro-chemicals,which can improve the yield,but these chemicals,if not used in right proportion can lead to environmental hazards.Therefore a rightfull proportion of these chemicals should be used and this can be achieved by applying computational intelligence using fuzzy logic and network coding. The soil comprises of phosphorus, potassium and magnesium etc along with moisture levels.This defines quality of soil.By studying the soil,we can take a right full decision of using correct level of agrochemical to be added to the soil, in order to improve the yield.

A fuzzy logic based system for dealing with inherent ambiguity in the domain of smart farming is therefore proposed.The fuzzy system can help to decide as when to irrigate and use fertilizer to improve the yields. The fig6 shows inputs obtained via various wireless means like from farmers, Metrological dept and market demand to study and suggest as to which crop is more suitable in the present climate.

The various inputs are processed at a central station taking the help of Agri expert and retrieving data from **Big data.**

Big data can determine associations ,drift and pattern related to a mans action.But it is difficult to characterize these parameters by means of a graph or table.But Fuzzy system uses clustering to split the data into small group,thus reducing efforts and saving time while taking accurate decision. This can be seen using an example . Consider the following example given in table1, for three commercial crops which are being sown world wide.

The table displays as to what should be temperature ,soil type,season,pesticide used and fertilizer in ideal conditions.But never everywhere, the conditions are found to be

Big

Weather forcast
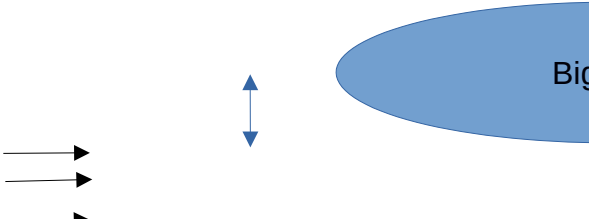
Market demand

Central processing station
With fuzzy logic and network coding

Agri Expert

Fig6:Data collection analysis

ideal.Therefore the variant of pesticide watering and fertilizer should be used in accordance with the soil type and climate variation.But how much it should vary, to increase the yield of a crop can be estimated using fuzzy variables. This is as illustrated in Table1.

Table1: Fuzzy based decision making

Crop name	Temp	Soil type	Season	Pesticide	Fertilizer
Cotton	21-23 C^0	Silty clay	Rainy	Parathyroid	Ammonium nitrate
Rice	16-18C^0	Silty clay	Winter	Carbonate	Urea
Maize	17-23C^0	Silty loam clay	summer	Organo phosphate	Ammonium nitrate

Algorithm

Below we are demonstrating, a typical algorithm for improving the yield of cotton crop using fuzzy.We refer here the content of table1.

Enter crop name:ex:cotton

If cropname=Cotton then

if Temp= ideal   and if soil type=Slity clay and Season =Rainy then

Don't do anything, Everything will be fine.

Elseif Temp >Normal Temp and season not equal to rainy then

Increase watering

Else Increase Fertilizer

Parameters like pesticide can also be included in the algorithm to improve the estimates.The application of network coding techniques further increases throughput and also enhances security of the user. The information is then broadcasted. The users with relevant coding information will intercept it and decode the information for their useful purpose.To illustrate the enhancement of throughput using netwrok coding,consider the graph shown in fig7.
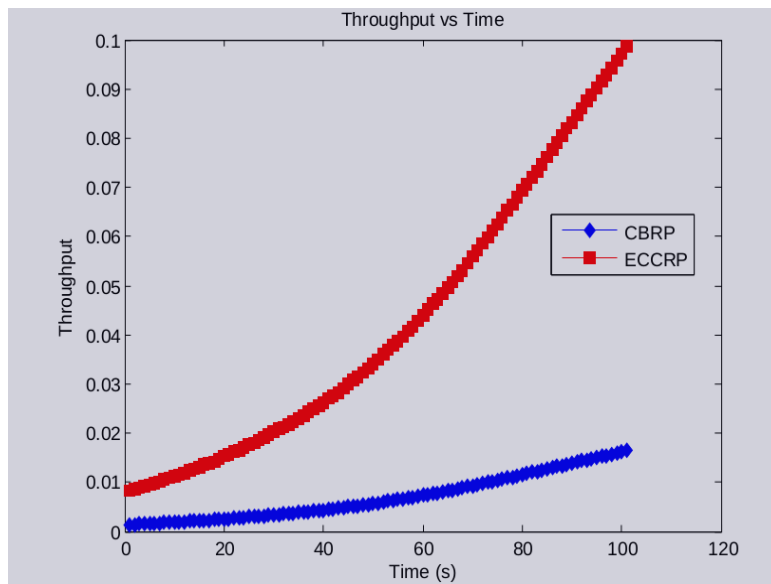
Fig7:Throughput enhancement using network coding

As can be seen there are two curves one is cluster based routing protocol(CBRP),and another CBRP with network coding.As can be seen CBRP with NC perform better compare to just with CBRP.In CBRP nodes just forms cluster for sending packets,thus forming routing table.In CBRP with NC the procedure of forming routing table gets simplified ,thus results in enhancment of throughput.

VI.Conclusion

As IoT is   ubiquitous,inseprable and flexible in nature therefore it's   gaining propulsion in all walks of life,this includes farm sector as well.In few advance coutries like Australia it's mandatory to use RFID tag to cattle to observe their movemnents between farms. This is then reported to a national database[3].If new technologies like Fuzzy and network coding gets combines with the IoT then it can   tranform the way   traditional farming methods are bieng used.One   can optimistically say that it can reduce farmers miseries to a large extent.

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