ISSN: 2278-4632
Vol-10 Issue-7 No. 11 July 2020

FIELD MONITORING AND AUTOMATION USING IOT IN AGRICULTURE DOMAIN

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ABSTRACT-Agriculture sector in India is diminishing day by day which affects the production capacity of ecosystem.There is an exigent need to solve the problem in the domain to rest or evibrancy and put it back on higher growth.The paper proposes an e-Agriculture Application based on the framework consisting of KM-Knowledge base and Monitoring modules. To make profitable decisions, farmers need information through out the entire farming cycle. The required information is scattered in various places which includes real time information such as market prices and current production level stats along with the available primary crop knowledge. A knowledge dataflow model is constructed connecting various scattered sources to the crop structures.The world around is getting automated replacing manual procedures with the advancement of technology, since it is energy efficient and engross minimal man power. The paper proposes the advantages of having ICTin Indian agricultural sector ,which shows the path for rural farmers to replace some of the conventional techniques. Monitoring modules are demonstrated using various sensors for which the inputs are fed from Knowledge base. A prototype of the mechanism is carried out using TI CC3200 Launchpadinterconnectedsensorsmoduleswith other necessary electronic devices. A comparative study is made between the developed system and the existing systems. The system overcomes limitations of traditional agricultural procedures by utilizing water resource efficiently and also reducing labour cost.

Keywords:e-agriculture;knowledgebase;monitoring;sensors.

1. INTRODUCTION

Farmers need agricultural information andpertinentknowledgetomakeknowledgeable decisions and to satisfy informational needs. In agriculture domain through the development of a knowledge management system, enquiries of farmers can be answered with the help of multimedia which is easily accessible.The application of Information and Communication Technology (ICT) has proven for widening the opportunities to promote agriculture on several aspects and domains in developing countries. Technology has crossed hurdles by using wireless technology,networking,mobile etc.to overcome the utilization of energy ,power and cost consuming equipments which was helpful in the agricultural development.The development of ICT in various domains has driven substantial interest in rising investments by private sectors towards the growth of ICT in Agricultural research (Fredrick A wuo retal., 2013).

At present, the key issue in the current domain is utilization of resources like man-power and water which is lacking in many parts ofthe country. There have not been any significant technological advancements being made in agriculturalsectorascomparedtoothersectors. Agricultural system needs to be monitored on a regular basis.The use of the developed framework is to reduce wastage by automating the entire agriculturalsystem.

2. BACKGROUND:

The major challenge identified in the current domain is to provide farmers required information and timely help. It is difficult to find knowledge to aid sustainable agriculture as it may not exist or rigorous to locate. Here,the web application is intelligent to come up with good solutions to enhance circulation and acquisition of information about sustainable agricultural techniques.The developed applications include Knowledge Management System, Agricultural Information Retrieval System, Expert Knowledge System and Agro Advisory System with Mechanism for sharing and reusing agriculture knowledge.Susan F.Ellakwa developed on to logical system for multi matching and merging technique. The system used ASP.NET,C# to match entities of crops. XML was used for building system on tology. Here,on to logy based information retrieval systems helps farmers by retrieving and integrating several information together to meet the information requirement of the queries. Precise usercontext informationisprovidedtofarmerswiththehelpofa specificontology[10].XiangyuHUetal.developed IOTapplicationwhichembedded

IOT-Radio frequency identification, GPS and smartsensorsusedtotransferinformationfrom thefield.TheinformationwasrecordedusingRFID and sensors are used to monitor the field. CGM modules are used to provide intelligence to the system[11].RichardK.Lomoteyetal.proposeda reliable distributed mobile architecture to provide farmers timely information. The proposed architecture was on the spray quality app from multifarmland perspective by constructing athree layeredarchitecturewithcloudhostedmiddleware. The above mentioned design enables

farmerstoaccessvariousinformationviaWi-Fior 3G [2]. Ontology based application haveserious drawbacks also. It mainly concentrates in developingaknowledgebasetoanswerqueriesbut failing to represent the full extension web semanticsthatcanbeusedforthecurrentdomain. Sanjay Chaudhary et al. presented an advisory systemforcottoncropusingcottonontology,web services andMobile

ApplicationDevelopmentAdvisorysystem.Domain knowledge is maintained for answering farmer queries.TheArchitectureofthesystemincludes fivemajorcomponents,theSQLdatabasewhich holdsthestaticinformation.

RDF knowledge contains data on cotton concepts,geographicdataincludesmappingthe fieldingoogleearthorCartoDBandtheRESTful servicestakecareoftheremainingcomponents. There are several existing advisory systems developedinagriculturedomainwhichincludes: eSagu that incorporates advice from experts to improvefarmyieldandproductivity.Agrisnetisweb portalwhichprovidesappropriateknowledgeabout seeds,fertiliserswiththehelpofscalabledatabank. InKKP,theKarshakaInformationSystemsencloses info'soncropgrowth,marketpriceandavailability with general statistics. mKrishi is a mobile application helping farmers with visual and audio means to clear their queries of farmers. [7] The systems developed in IOT and Cloud Computing emphasizes on reliable architectures to provide farmerstimelyinformationfromthefieldover3Gor Wi-Fi. Offline communications are enabled over Bluetooth betweenfarmers

(RichardK.Lomotey,R.D.,2014).Thedeveloped systemsintelligenceisenhancedbyaconsiderable marginbyincorporatingCGMmodulesoverIOT.Use ofsensorsinapplicationsofCloudComputingand IOTarereliablebutcumbersometoinstall,which makes it a major concern for the same. Relying heavilyontechnologylikeGPRS,GPS,3G,Wi-Fiand etc.,canbedisastrousintheeventofunforeseen crash.Theabovementioneddisadvantagesmakea serioussetbackinresolvingthecurrentchallenging scenariosoftheruralpeopleinagriculturesector.

NOMENCLATURE
ET0 - Reference Crop Evapotranspiration
Tmax- Maximum Temperature of the day
Tmin - Minimum Temperature of the day
Tmean - Mean Temperature of the day
Rav- Mean Sun-Earth Distance
R- Actual Sun-Earth Distance
Kc- Crop Factor
SAT- Saturation of Root Zone
PESE- Amount of Percolation and Seepage Losses
WN- Water Need
WLayer- Water needs to establish water layer
EFFR- Effective Rainfall
H- No. of Hours
D- No. of days

3. SYSTEM DESIGN ANDREALIZATION:

Datacollection,monitoringandevaluationofthe systemresultsindeterminingwhichapproachis effective and where these adaptations are most needed.Therefore,ICTengagedinterventionsin agriculturalsectoraremoreproductivethanthe conventionalmethods.Technicalandfinancialaids are vital need for the farmers to become adapt inclusive

and effective method. These challenges can be addressedbyICTbasedinformationdissemination modelstoshareknowledgeimprovingproductivity, social and environmental sustainability of farmer andfarmercommunities.Themainsectionsofthe architecture illustrated as knowledge base and monitoring system. Here, the main sectionsare

ISSN: 2278-4632
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elucidated in brief.

3.1.KNOWLEDGE BASE:

Knowledge Base is constructed to store vast complex structured and unstructured information to assistfarmersorevenanindividualwithnoprior knowledgeoffarming.Butfindingrightinformation inanappropriatemannerisdifficultwhereproviding relevantknowledgeshouldbedistributednotonlyin an organised and complete manner, but also in absoluteway.Theknowledgebasedinfrastructure allowsadaptingthechangesinagriculturefora betterextensionandaddingadvisoryservices.

REALIZEDINPUTS:

Knowledge base contains information modules about farming techniques, market information,Crop structureandgeospatialdata.Farmingtechniques include the best practices in farming to attain maximumyieldandcomprisesofpestanddisease controlsaddedwithphasebasedfarmingmethods. Market information include various cost info's, sellers, dealers, warehouses, funds, credits, dedicated website, call centres, E-learning and marketavailability.

Crop structure encompasses information about crop breed, crop factors, pest, disease information and soil nutrient

requirements.Thegeospatialdataisusedtoimport theweatherdetailsandwatertablecontenthelping farmerschoosingtheirbestsuitablecrop.Itisalso usedforsettingFieldMapaccordingtothelocation set by thefarmer.

KNOWLEDGEACQUISITION:

Knowledge acquisition primarily refers to the process of obtaining, analysing, comprehending, andrecallinginformationthroughthebestofmany existing reliable methods. Here, knowledge is acquiredfromreliablesourcesbyestablishinga model integrating farmers, agriculture agencies, Ministry of agriculture, Agricultural Universities and institutionsalongwithRestAPIservices.

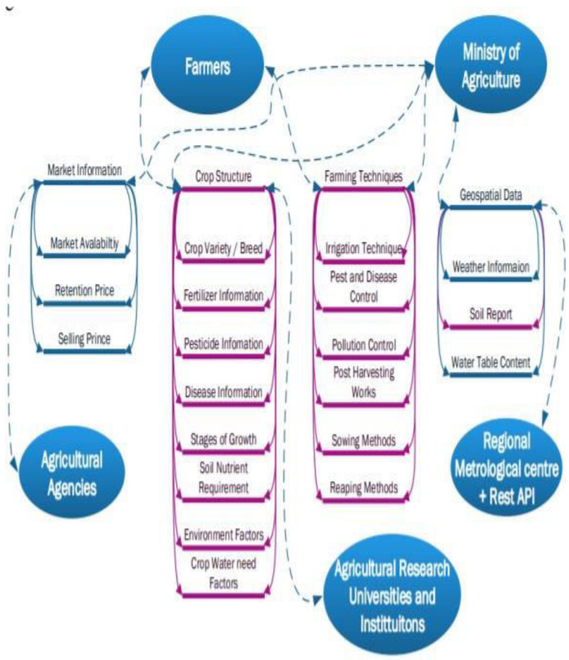

Fig 1. Knowledge acquisition model comprising crop structure.

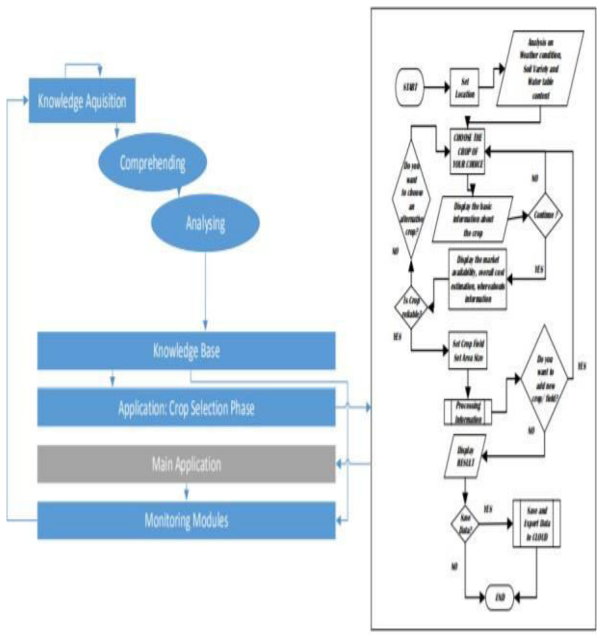

Fig 2. Knowledge flow model of the Application

KNOWLEDGEFLOW:

Crop Data Flow model is used for representing knowledgeflowinaconceptualisednetworkandto provide optimal information for adapting the changingclimaticcondition.Thedataflowmodule explainshowthedataflowsfromonemoduleto

ISSN: 2278-4632
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anotheranditaswellasexplainshoweachmodule areinterconnected.Fig.2.depictstheworkingflow ofthedevelopedsystematvariousphases.

HARDWAREREQUIREMENTS:

TICC3200LaunchpadandArduinoUNOboardwith EthernetShieldisusedtoimplementthemonitoring modules. The following sensors and other peripheralsareusedtocollectrealtimedatafrom thefield:

· DHT11TemperatureandHumiditySensor.

· SoilMoistureSenor(KG003)-Outputishighwhen thereisdeficitinsoilmoisture(i.ethefieldisdry), oroutputislow.Analoginterfacingcanbeusedfor accurateoutput.

· BallfloatliquidlevelSensor-Outputisaccordingto liquidlevelorballraise.

· MagneticFloatSensorforwaterlevelindicator- Thefloatsensorisadeviceusedtodetectthelevel of liquid in the tank. Float sensor is an electromagnetic ON/OFFswitch.

· BH1750ModuleDigitalLightintensitySensor/ LDRresistor.

· AFourChannelRelayBoard(5V)forswitching AC/DC is used to trigger a AC motor (220V) to operate thevalves.

· L293DHBridge(WideSupply-VoltageRange:4.5 Vto36V)whichisatypicalmotordriverthatallows DCmotortodriveoneitherdirection.

SOFTWAREREQUIREMENTS:

EnergiaMTisanopen-sourceelectronicsprototypingplatformwhichisamodifiedversionof wiring/Arduino IDE for the Texas Instrumentsis used to write embedded c code, compile and execute them. 1.6.8, an Arduino programming environmentisusedforwritingcodeintheArduino programming language to instruct theArduino. BlynkisaPlatformwithiOSandAndroidappsto controlArduino,RaspberryPiandthelikesoverthe Internet.It'sadigitaldashboardwhereagraphic interface for any project can be built by simply dragginganddroppingwidgets.

SYSTEMARCHITECTURE:

ModulesofMonitoringInterface:TheMonitoring phasecomprisesofapplication'smainabilitiesand functions. From the knowledge base, the user interfaceisallowedtousedecisionmakingsystem, knowledge assessment on farming, and other systems.

· Reminder:Itisusedtoremindthefarmeronthe schedulesofreaping,fertilizerspraying,pesticides, andonirrigationtimings.Itnotifiestheuserondaily basis based on the input parameters from the knowledge base through an automated SMS notification.

· MonitoringPlantGrowth:Thestagesofgrowth fromtheknowledgebaseisusedtocalculatethe correspondingphaseofgrowth.Theheightofthe plantisfoundoutusingthemappingoutlineimage of that plant and this height is used to predict whethertheplantismeetingtherequirementornot.

· Irrigation Planner: It makes a set of plans to irrigatevarioussectionoffieldinapatterntoget profitable yield. It also displays the information fromfieldasdryandirrigatedfieldsasmonitoring prospect. Based on the estimation of cropwater need,rotationalorcontinuousflowisplannedto irrigate thefield.

· CropProfitCalculator:Itisusedtocalculateprofit forthefarmerbygivinginputsonyearofgrowth, sellingandretentionprice.

· Calamitiescheck:Theirrigationplanandthefield set is changed according to the weather forecast whichisacquiredfromYahooweatherAPI.Itisalso used to monitor unusual activities in the field like immediate firing, etc. • Problem Identifier: This identifiestheproblemwhenthereismisdirectionin irrigationsystem,motorproblem.Itapproximately identifies where the problem has occurred. For example,inthecaseofnopowersupply,thereisno useofgivingcommandstotheperipheralswhereas the user should be notified about the power problem.•CalculationofWaterneed:Theamount ofwaterneedformeetingwaterdissipationthrough evaporation and transpiration is defined the crop waterneed(ETc).Thecropwaterneedissubjected for a uniform crop, disease free, active having favourable soil conditions. Shortly, Evapotranspiration estimates the total amount of water plants consume for a quality growth corresponding to the local weather condition and phase of the plant cycle [3]. Algorithm framed for estimating water need[4]:

· OpticMonitor:Sunlightistheperfectbalanceof wavelengthsnecessaryforplantgrowth,butuse artificiallightcanalsobeusedtohelpplantsalong. Grow lights are used to stimulate plant growth wherethereisnosufficientsunlightorinplaces wheredaylighthoursareless.Thisapplicationis

ISSN: 2278-4632
Vol-10 Issue-7 No. 11 July 2020

mainly used in winter regions/months to enhance theplantgrowth.Here,thedaylightismonitoredby LightIntensitySensorandwhenitgoesbelowthe thresholdvalue,thesupplementedlightisusedto stimulatetheplantgrowth.

· Well Dry Check: This module is used to check whetherthewellisdrybygettingtheinputfromthe soilmoisturesensornode,itnotifiestheuserwhen thevaluegoesbelowthethresholdlimitandthe usercanrespondforwhichcorrespondingaction canbeperformedlikefillingthewellbyturningon themotor.

· FieldDryCheck:Similartothelastmoduleituses soil moisture sensor node, that notifies theuser whetherthefieldisdryornot.

· Identifythesoiltypeandsoildeficiency:Everysoil has its own water holding capacity. Oncomparing therealtimedatawithpredefinedsetsofvaluesin theknowledgebase,soiltypecanbeidentifiedand if the calculated soil capacity differs to a larger extentfromthepredefineddatathenitcanbesaid, the soil isdeficient.

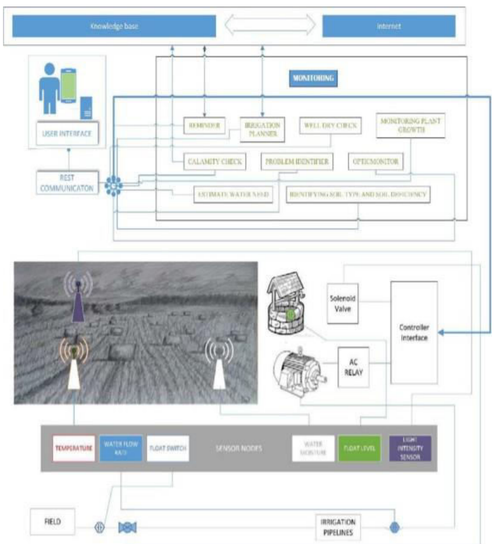
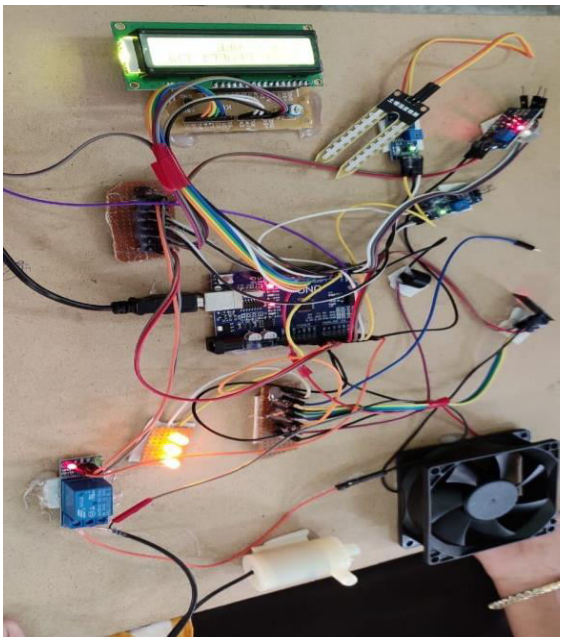


Fig 3. Architecture of e-Agriculture Monitoring module

4. DISCUSSIONS:

As discussed in Background section, InternetofThingsbaseddevelopedsystemsarenot reliable due to reliance of 3g or Wi-Fi communication modules. Search enquires are not helpfultothatextentbecauseitisunabletocope upwithfarmer'spoorknowledgeandalsotheseare developedtoserveparticulargroupcroporregion. Inthecaseofusercenteredontology,onlyasetof farmers of that context can gain knowledge whereasitcannotprovideallnecessaryinformation. Advisory system lacks the procedure orientedapproachandcannotconstructthecompleteridge betweenfarmersandcomputers.Itneedsagroup ofexpertsworkingbehindtoanswerthefarmers' queries. Here the proposed system overcomes constraints as the automation of this system is programmedtofunctioneveninofflinemodealso. Thesystemcanbeeasilyrebuiltorreplacedinthe worst case scenarios. In the traditional farming methods, water need is not constrained. Butthe systemovercomesthesetbacksbycalculatingthe waterneedusingEvapotranspirationwhichreduces thewaterusage.Theframeworkdesigned,instructs thefarmerstocarryoutactivitiesinregularintervals based on the crop life cycle by replacing the existingsystemslikeKBManagement,Advisoryand ExpertKnowledgeSystems.Here,acomparative study has been made which discusses about varioussystem'sconsandpros.

*5.*FINALRESULT



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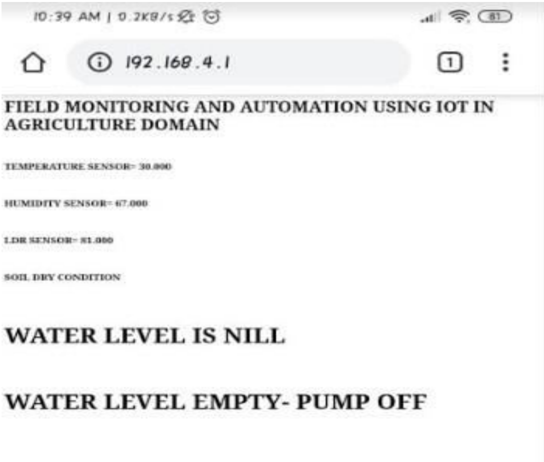

6. CONCLUSION:

Farmers need help during different stagesof cropgrowthandtheguidanceshouldbegivenat the right time. Farmers are suffering a lot economically, socially and politically. Various challengesinagriculturaldomainareidentifiedand an architecture was framed meeting the above mentioned challenges. Knowledge base is structuredwithvariouscropdetailswhichspeak aboutknowledgeacquisition,flow,variousinputlike market availability, geospatial data and weather prediction. Monitoring contains modules like remainder, monitoring plant growth in various stages, irrigation planner, crop profit calculator, calamity check and problem identifier. Evapotranspirationmethodisusedtocalculatethe water need of a plant per day with devised algorithm'shelp.Acomparativestudywasmade betweenvariousapplicationavailablewithcurrent developed system taking various aspects into account like knowledge base, monitoringmodules, efficiency andreliability.

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