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IntelligentWaterLevelMonitoringSystemUsingInternet of Things

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***Abstract*—Eversincetheevolutionofearth,watermanagementhas become one of the crucial factors for human survival. Inevolving years, significant efforts have been put to come up withsolutions based on IoT technology for areas such as water levelmeasurement.Themainissuethatisbeingaddressedinthiswork is about developing an efficient level sensor based watermonitoring system that monitors the water level in the domesticareas i.e. inside homes. The proposed system will detect the waterlevel through depth sensors and verifies the threshold value thatis set i.e.(>20 cm). If the value is less than threshold value, noactionneedstobetakenandifthevalueisbeyondthresholdvalue , the Arduino UNO alerts the user through call by using GSMmodule. Simultaneously, with the increase in the water level, theproposed system evacuates the water to a storage tank throughsubmersible water pump. This extracted water can be used forsomeotherpurposeslikewateringplants,domesticusageetcwitho utwastingthewater.**

***IndexTerms*— IoT,waterlevelsensors,GSM,submersiblepump,threshold,waterm anagement.**

I. INTRODUCTION

Water is an exhaustible resource, which plays vital role indifferent sectors like agriculture, industry and also balancingtheecologicallifecycle,allthelivingcreaturesincluding human beings. People are ignorant towards realising the importanceofconsumptionofminimumrequirementofwaterfor their body. Wastage of water happens in many ways. Thiswastage happens from domestic household to industrial levelthatmaybeintermsofthewaterleakageshappeningintapsord omesticwatertankandalsoaccommodation,filtrationandhighscal emanagementinfactories.Thereforethereisa requirement of real time and an accurate protocol basedsystem. Water has its own level of importance according todifferent fields, it may be for survival or economical or othervarious fields. Hence, saving water is one of the challengingaspects for the survival of human race. Technology nowadayshas become an integrated part of people's lives. The era of IoThas started from the year 2009. IOT is a simple, easy to usetechnology which has its effective scalable applications.TheapplicationofIoTcanbeextendedtowatermanagement,which brings the cost effective and reliable approach that canbeusedforwaterlevelmonitoring.

Motivation

Duetoheavyrainfall,excessivewatergetsaccumulatedinliving area,cancauseterriblesceneofsuffering,lossand devastation. Hence, there is a requirement of water levelmonitoring system, which will check the water level and cantake necessary action immediately without human interventionto save from losses. Water level monitoring system can beemployedinvariousapplicationslikefoodgrainsstorageunits,residentialareaswheretherainfallisrelativelymore.

A. Contribution

This work aims to design and develop an internet of thingsenabled water monitoring system that analyses the level ofwaterandtakesnecessarymeasuretodraintheexcesswaterto storage tank. It also intimates the user about the water level,ifitreachesbeyondthethresholdvalue.

B. Organization

ThecontentsofthepaperarearrangedasfollowsSectionIIhighlights about related work. Section III focuses on proposedsystem. In section IV hardware and software components arepresented. Section V discusses experiment and result and lastsectionVIincludesconclusionofthepaper.

II. RELATEDWORK

Perumal et.al [1] proposed a protocol based on the IOTtechnologyfortherealtimemonitoringofwaterlevelindisaster prone areas. The working principle of this prototypewas based on a water level which is an important parameter,used to control the flow of the system, especially in regionswhich are susceptible to flood. Ultrasonic sensors were used toevaluate the water level, the data collected from sensors weredisplayed on LCD and also stored on server. This managedwater monitoring system is deployed on the host. Once waterlevel exceeds, the results were reflected on remote dashboardandsocialmedianetworkslikeTwitterhandles.

Gunde et.al [2] has developed IoT based water managementsystem in large campus without human intervention. Ultrasonicsensorswereuseddetectthewaterlevelintankandsend water level details to Arduino, which in turns signals toraspberrypitodisplaythewaterleveldetailsonwebpage

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andsamedataisalsostoredoncloud.Thesystemwasprogrammed such that the minimum value(20%) of the waterlevel triggers the submersible water pump to run and stopautomatically when the water level value is maximum(80%).Message was sent as alert on detecting the maximum waterlevel.

Shah et.al [3] has proposed a intelligent water monitoringsystem, along with an android application feature. This systemhastheflexibilitytoprovidetheuserwithremotemonitoring ability through android application. This prototype wasadapted to the existing tanks as well. The android applicationwasdevelopedusinguser-friendlyMITappinventor.

Theappusedinproposedsystemhasasimplemechanismtostore minimumandmaximumvaluesofthewaterlevelintank,based on which current water level in the tank was displayed.The data security is ensured by validating the credentials eachtime the user tries to access the data. The pattern of usage andwastage of water can be analysed and determined measureswas taken accordingly. This remote monitoring is achievedthroughsmartphones/laptops.

Prabaet.al[4]hasproposedwaterlevelmonitoringsystemforconventionalwatertankthroughanandroidapplication.Theproposedsystemhelpsinmonitoringthewaterflow,inraisingissueswithrespecttowaterrelatedproblemsandeventrackingthem.Theproposedsystemhasfourmodules,firstmodulecollectsthedatafromsensorandsendsittothesecondmoduleIoT,fromIoTmodulethedataisstoredincloudmodulewhichservesasthirdmoduleanditusescarriotsatooltodesignanandroidapplication.Inthefourthmoduletheenduserscanaccessthewaterleveldetailsthroughwebpage.Italsogivessecurityintermsofavoidingillegalaccesstothecontrols(i.e.motor),whereonlyprivilegeduserscanaccess.MinAllahet.al[5]hasdevelopedaprototypewhichusestheconceptoftheInternetofThings(IoT)inandroidapplicationforobservingwaterlevelsoftanksinKSA.Theproposedsystemhas3layersnamelyphysical,serviceandpresentationlayers. Thephysicallayerconsistsofultrasonicsensorwhichdetectsthewaterlevel,thisdataisgiventotheservicelayerwhichstoresthedataonthecloudserverandatthepresentationlayertheandroidapplicationisusedtogive informationtotheuser.

Siddula et.al [6] the main intent of this work is to automatemost of the process involved in the management of all thedamsforfuturisticpointofviewforcentrallycontrollingactivitiesfromasingleserver.Thiscentralitycanbegainedbyusing applications which exhibits mechanism to link IOT andcloud services. The very first stage in this process would begathering of the structured data flowing out from the sensorssuch as ultrasonic sensors. Considering the ultrasonic sensorsthey communicate with a base station which is local to them,usingasimplemechanismcomposedofamicrocontrollerwhichcanadoptbothfarandnearcommunications.Thesecondstageis concernedaboutthetransferringofdatainashorterdistancerangewithrespecttoalocalbasestation.

Some of the famous short range data transfer technologieslikebluetoothcanbeusedfortherangeof100metresand successfuldatatransmissionhappenswiththearduinowiththehelp of a interface, technologies of higher range can also beused according to the need. The third stage deals with muchhigher range of transmissions, these transmissions are in termsof several hundreds of kilometres. This technology helps thecentral station to gather data to read and command from thenodes which are much more far away from it. The perfecttechnology which is to be used is not concluded yet. Some ofthe communication technologies used for these purposes arenarrowbandIOTandLPWAnetwork.

De Paula et.al [7] mainly focuses on usable scenarios suchas building apartments or smart building and related workingenvironments for the purpose of alerting users on issues suchas water contamination breakage of tanks and other commonleakagesandtheconsumptionratewithrespecttotheseenvironments. It not only detects vulnerable scenarios but alsohelps in avoiding and controlling the damages that can becaused due to these uncertain situations and maintaining thedamage rate to a minimal. The solution proposed is flexibleenoughtotakeactionsaccordingtothesituationssuchasswitching on and off the water supply to avoid much morewastage of water. The middleware acts as a storage mediumfor the data flowing from the sensors and also display the datawherever required and resuming the flow of the data to otherdevicesintheIOTenvironmentaccordingly.

Manoharan et.al [8], has proposed a wireless connectivitycalled LoRa to keep track of water quality, distribution, usageof potable water and leakage detection of chemical in rivers.Thesensorsformonitoringthequality,quantity,levelareconnected to the KT-LoRa mote through GPIOs to the tanks.Based on the data got by sensors the village head can takedecision refilling the water in tank and check the quality ofwateralso.

Wadekaret.al[9],hasproposedanIOTtoolwhichassisttomanipulateandplanwaterusage.Sensorsarelocatedinside the tank, which constantly updates the water level data.Thisdataisloadedonthecloud.Personcanvisualizethewater level data by using android application. Based on waterlevel in the tank, the working of water pump is controlledautomatically. The water pump turns on, if there is low waterlevelanditshutsoffwhenthetankisabouttobefilled.

Gupta et.al [10], has proposed an smart approach to identifythe water level and purity of water using IOT. The proposedapproach uses ultrasonic sensor and turbidity sensors to mea-surethewaterlevelandpurityrespectively.Thedatareadby the sensors are uploaded in the cloud. The Wi-Fi modulepresentintheraspberrypicontrollerisusedtoremotelyconnecttomotorwhichcanbeturnedonoroffbasedonthewaterlevelthroughmobileapp.

The water level monitoring schemes discussed suffers fromsomeofthemajordrawbackssuchasnotificationtotheconcernedauthority,sincemostoftheprotocolsdiscussedusesinternet enabled alarming mechanisms, there might be chancesthatthosealertsmaynotbetransferredtotheconcernedauthority, if the user is not online. The usage of ultrasonicsensors poses some of the limitations such as limited detection

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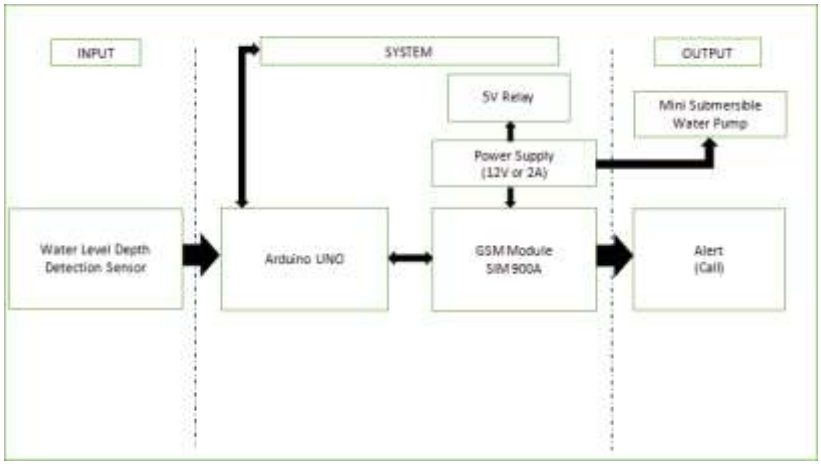

Fig.1.ArchitectureofIntelligentWaterlevelMonitoringSystem.

range, sensing accuracy is affected by soft materials and alsochanges in temperature of 5-10 degrees or more affects thesensoraccuracy.

III. PROPOSEDSYSTEM

The proposed system is named as intelligent water monitoring system based on IoT. The components that are being usedin development of the proposed system model are ArduinoUNO,precisewaterleveldepthdetectionsensors,whichcalculate the increase in water level accurately, submersiblemotorpump,toevacuateexcesswatertostoragetank.

Alerting system is been introduced using GSM technologywhich gives alert call to the user efficiently without any regis-tration or usage of internet. Immediate action like evacuationof water measures are taken with the help of relay and a motorwhich reduces the risk of user about loss of goods or grain.Thearchitectureoftheproposedsystemisshowninfig.1.

IV. HARDWAREANDSOFTWARECOMPONENTSUSEDIN WATERMONITORINGSYSTEM

The following section discusses about the hardware components used in the development of intelligent water monitoringsystem.

A. ArduinoUNO

ItisanATmega328Pmicrocontroller.Itconsistsof14digital I/O pins and 6 analog input pins. It has a flash memoryof 32 KB of which 0.5 KB is used by boot loader. It hasSRAM, EEPROM of 2KB and 1KB respectively. The clockspeed is 16 MHz. All operations are synchronized with theclock. It is an open-source platform, means the boards andsoftwareareeadilyavailableandanyonecanmodifyandoptimizetheboardsforbetterfunctionality.

B. GSMModule900

TheSIM900Aisareadilyavailable GSM/GPRSmodule,usedinmanymobilephonesandPDA.Itisacompactanddefinitivewirelessmoduleusedin IoTandembedded applications.Itworksonfrequencies900/1800MHzandautomatically searches these bands. The data transfer can besetbyATcommands.

C. WaterLevelDepthDetectionSensor

This sensor module has series of parallel exposed traces tomeasuredroplets/watervolumeinordertodeterminethewaterlevel. It is very easy to monitor water level as the output toanalog signal is directly proportional to the water level. Thisoutput analog values can be directly read via analog to digitalconverterandcanalsobeconnecteddirectlytoArduino'sanaloginputpins.Thewaterlevelisdeterminedbasedonthe resistance, if sensor is immersed in more water, results inhigher resistance which indicates the water level is more andviceversa.

D. Relay

A relay is an electrically operated switch that can be turnedon or off, letting the current go through or not, and can becontrolledwithlowvoltages,likethe5VprovidedbytheArduino pins.

E. MiniSubmersibleMotorPump

A submersible pump, also called an electric submersiblepump, is a pump that can be fully submerged in water. It isoperated from a 3 6V power supply. It has max lift 40-110cm, low rate of 80-120 L/H and 500 hours of operation. It issuitable for varieties of water such as city water, ground waterandseawater.

F. Miscellaneous

TheseincludeUSBCables,JumperCables,adaptorsandsimcard,whichareusedforexternalconnectionsofdevices.

Thefollowingsectiondiscussthesoftwarerequirements

G. OperatingSystem

An operating system (OS) is system software that managescomputer hardware, software resources and provides commonservicesforprograms.

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H. DevelopmentEnvironment:ArduinoIDE

The software used for Arduino devices is called ArduinoIDE.It is a cross platform application for Windows, macOS,and Linux. Arduino IDE (integrated Development Environ-ment), means that all the steps that editor, compiler, burner areintegrated in the same software. The programming languageusedbytheArduinoUNOistheC++.TheArduinoUNOI DE has a well-defined function for each task that is easy toremember. The Arduino IDE employs the program to convertthe executable code into a text file in hexadecimal encodingthat is loaded into the Arduino board by a loader program intheboard'sfirmware.

V. Experiment&Result

The input is collected from four water level depth detectionsensorwhicharebeenateachcorneroftheprototypemode las shown in Fig. 2, input data is sent to system which consistof Arduino UNO and a GSM module SIM900 also a powersupplythedatacollectedfromsensorisanalyzedthroughard uinoUNOboardaccordinglyGSMmodulewillbeusedtosendalert calltouserifthereisanyincreaseinwaterlevel and evacuation measures are taken with the help a relaymodule and a mini submersible motor pump. The connectionofcomponentsandcompletesetupisshowninFig.3and Fig.4respectively.

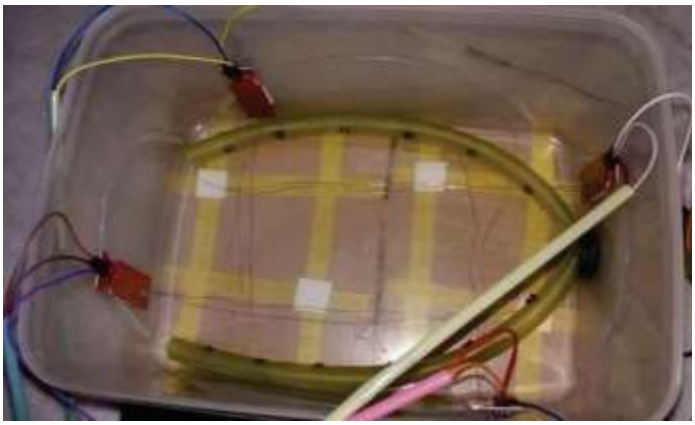

Fig.2.WaterLevelSensorSetup.

Thesystemcontinuouslymonitorsthewaterlevelandworksonth eseconditions:

- If water level is low: No action is taken on GSM or onmotormodules,thesystemjustcontinuestomonitoring.
- Ifwaterlevelismedium:ArduinoUNOsendsinfor-mation to GSM to make an alert call to the user andcontinuestomeasurethewaterlevel.
- Ifwaterlevelishigh:ArduinoUNOsendsinformationto GSM to make an alert call to the user and it also turnsthe submersible motor on which drains the water to thestoragetankandswitchesoffautomatically.pump.

Fig.5andFig.6showsthatthesystemfirstdetectsriski.e,collects datafromsensorsandanalyzethatdataifthereisanyvariationindata itsendsthealerttouserwiththehelp

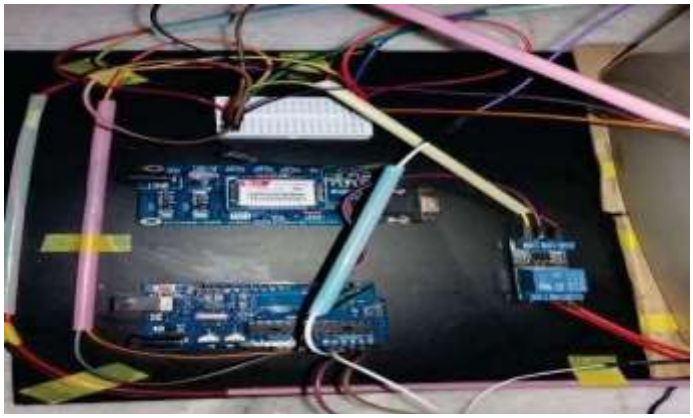

Fig.3.ConnectionofComponents.

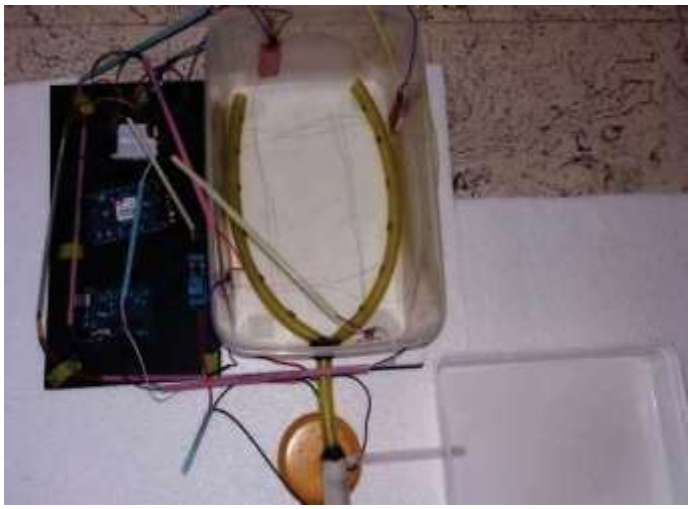

Fig.4.Completesetup.

of GSM technology as shown in Fig. 7.It also turns the motoronwhichdrainsthewaterandturnsoffautomaticallywhenall the water is drained off without giving much risk to userandalsoensuringsafetyofthegoods.

Advantagesofproposedsystemare:

- Itisacosteffectiveapproach.Itusessimpleprocedureto measure the water level with minimal hardware andsoftware resources, which are easy to install and small insize.
- It does not require any human intervention to completetheprocessofwaterleveldetection.
- UsageofGSMModuleenablestheusertoreceivealerts,and user need not register to any android appli-cations to control the motor pump which is used to draintheexcesswater.
- The proposed system has wide range of applications. Itcan be installed in the following areas such as privatehouses, bungalows, apartments, grain storage units, insti-tutionslikeschools,colleges.
- Theproposedsystemalsoaimsatstoringtheexcesswaterintos toragetanksandsamewatercanbeusedtodo

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Fig.5.DatareadingonSerialMonitor.

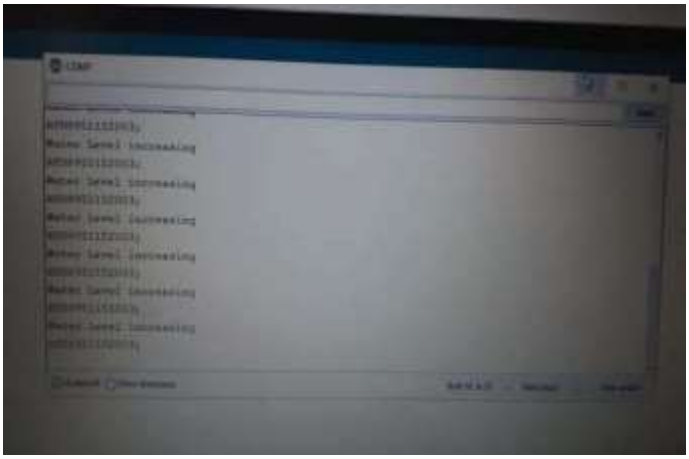

Fig.6.WaterLevelIncreasingonSerialMonitor.

householdchores,thussavingthewaterwhichhelpstocombat withwaterscarcityissues.

Fig.7.GettingCallfromGSMModule.

VI. CONCLUSIONS&FUTUREENHANCEMENTS

Theproposedsystemcanbeimplementedindomesticareas,residential areas, storage rooms, work places very easily, withonly few components, which gives accurate readings of waterlevel and once the water reaches beyond threshold value, italerts the user through phone call. The components that areused in this system are cost effective and have long life timewhen compared to other devices. In this system GSM Moduleisusedtosendalertstotheuserintheformofnormalphonecalls.TheGSMModuledoesnotrequireanyinternetorWi-Ficonnections.Sincetheinternetconnectionsinalltheplacesmaynotbeavailable,usageofGSMmoduleisone of the advantages of this system to send alerts to user.Future enhancement can be done by notifying the maintenanceengineeraboutheleakagesandtotakenecessaryactions.

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