ELSEVIER Scopus® doi

Journal of Vibration Engineering

ISSN:1004-4523

Registered

- SCOPUS
- DIGITAL OBJECT IDENTIFIER (DOI)
- GOOGLE SCHOLAR
- IMPACT FACTOR 6.1

Our Website
www.jove.science

IOTBASEDAUTOMATEDFISHFARMAQUACULTUREM ONITORINGSYSTEM

[1] D.Balaji, [2] N.Amarabalan, [3] D.Muruganandhan

[1,2,3] Assistant Professor,Department ofEEE,ManakulaVinayagarInstituteofTechnology,Puducherry,India.

***Abstract* — In this paper, a smart fish biofloc system for modern fishfarmingisproposed.Biofloc isaninnovativeandcost-effectivetechnology in which toxic materials to the fish and shellfish such asNitrate,Ammoniacanbeconvertedtousefulproduct, *ie*.,proteinaceous feed. It is the technology used in aquaculture systemwith limited or zero water exchange under high stocking density,strong aeration and biota formed by biofloc. The culture of bioflocwill be productive in the case of culture tanks exposed to sun. Thesystem applies the internet of things (IoT) concept to monitor andcontrol water quality in fish ecosystem. The system equipped withtemperature,pH,turbidity,andwaterlevelsensorstomonitorbiofloc parameters. Environmental parameters are uploaded to thecloudandmonitoredviaasmartphoneapplication.Thesmartphoneapplicationequippedwithfeaturesthatsupportcatfishfarmers to collaborate in meeting market needs. The cost of makingthe system is designed to be as minimal as possible so can be appliedby a middle-low scale catfish farmer. The implementation of theproposedsystemprovideseaseinmonitoringbioflocconditions,improvingfishquality,andfarmer'sincome.**

Keywords—Biofloc,InternetofThings(IoT),Sensors,

INTRODUCTION

Fish is one of people's favorite foods all over the world. Fishtaste is strongly influenced by water quality. The farmers need asystem to manage water quality and support the stability of fishstocks in the market. Based on data from the Malang RegencyMarine andFisheries Service, twocommodities of freshwaterfish, namely catfish and tilapia, are still the favorite consumptionof the current poor district community .Fisheries managementrelies totally on water quality monitoring. Yields are also oftenaffectedbyfishdisease.Optimalfishproductionisverydependent on the physical, chemical, and biological qualities ofwater. Therefore, good fisheries management depends on goodwaterquality.Variablesthatdeterminewaterqualityaretemperature, turbidity, carbon dioxide, pH, alkalinity, ammonia,nitrite,nitrate,etc.AmongthemostimportantarepH,temperature, and turbidity. Catfish will growth optimal in watertemperature of 27°C - 31°. Water quality needs to be monitoredandcontrolledtokeepfishgrowingwell.

A lot of researchers have developed water quality monitoring andcontrol systems. Related research has conducted monitoring andcontrolling of water quality, but not included fish marketing. Theproposed system equipped with the ability to display the numberoffishstocksperfarmerbasedonsmartphoneapplications.Farmersmustloginusinganexistingaccounttousetheapplication. Whenthefarmerrunoutofstocktomeetmarketneedthefarmercanseethestockofotherusers.Theycancollaboratetomeetmarketdemandontheapplication'smarketpage.Theproposed system provides convenience for farmers to maintainpond water quality and fish marketing. Fish stocks in the marketwill be more stable, and the fish quality and farmers' income willincrease. In this paper, a new smart fish pond which involves thefarming and marketing process based on IoT via a smart phoneapplication proposed.

RecentlyIoTisreachingtheground levelwithitsapplication tofarmers. Papers In several literature surveys focuses on how theaquatic life will effect due to change in water quality parametersand how IoT technology is used to overcome the problem **[1]**.Some workuses Arduino as micro controller for monitoring theaqua field ,but Raspberry Pi-3 is more advanced when comparedto Arduino as it has inbuilt Wi-Fi module **[2]**. Many of the worksconcentrates on few type sensors like DO, pH, Turbidity etc and asolution to those problems, but the growth of aquatic life dependson many parameters of water like Ammonia, Nitrate, Carbonates,Bi-Carbonates, salt etc**[3]**. The qualityof water is monitoredcontinuouslywiththehelpofsensorstoensuregrowthandsurvival of aquatic life. The sensed data is transferred to the aquafarmer mobile through cloud **[4]**. All these parameters are sensedusing multiple sensors and a feasible solution was given to theaqua farmer. The sensed data will be sent directly to the aquafarmer.Butstoringthedataincloudsdatabasehelpsusforanalyzing thedatausingdataanalyticsparameters**[5]**.Mostofthemodels concentrates on sending the sensor data to the farmer butour model mainly concentrates on providing the solution such aswhich medicine should be applied or necessary action to be takeninthe formofanalertmessagewhenthewater qualityparameters changes**[6]**.

I. EXISTINGMODEL

Intheexistingmethodoftheaquaculturefieldall theparametersuchasthewatermonitoring,qualityof watercheckingandtemperaturemonitoringallaredoneusingthemanual method so the labour cost will increase and at the sametimecontinuousmonitoringcan'tbedone.Manuallabourismandatory in the field .To avoid this, in our proposed system weare using the Automotive &IoT technology which continuouslyupdates to the user.In this all the monitoring noticed by Iot andworkout by manually and we can the block diagram of existingmodelasshown infigure1.

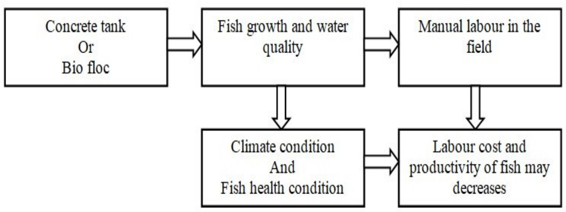

Fig.1Blockdiagramofexistingmodel

II. PROPOSEDMODEL

The proposed system consists of pH level sensor, temperature sensor, Oxygen Saturation Sensor, Turbidity Sensoraswellaswaterlevelsensors.Hence,thisproposed systemmakes more efficient and accurate information and this fetchedreducedworker.BasedonIoTandAutomotiveControltomonitor the Fish growth at any time can be monitoring. Figure 2shows block diagram of proposed system and all the value aremonitoredandcontrolautomatically.

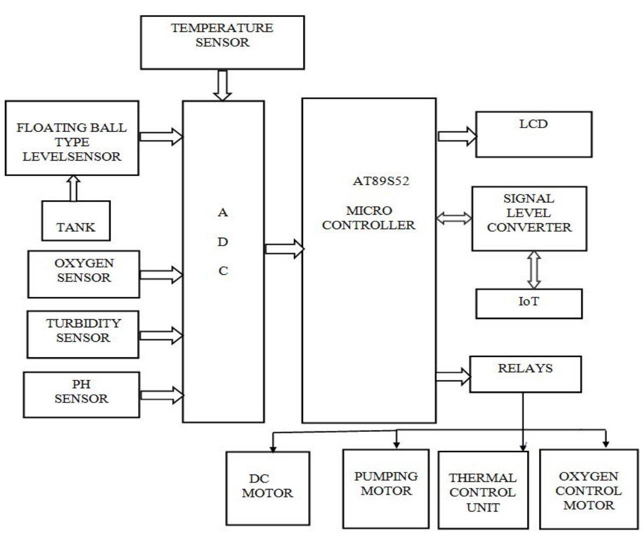

Fig.2Blockdiagramofproposedsystem

III. HARDWAREDESCRIPTION

A.TemperatureSensor

Temperature sensorswith a relatively high degree of insmartantennasystemsforground-based applications (e.g., cellular antennas) and airborne applications(e.g.,airplane orsatelliteantennas).Smartantennasystems,such as adaptive or phased array antennas, combine the outputsof multiple antenna elements with signal processing capabilitiestotransmitand/orreceivecommunicationssign.Withtemperaturesensors,suchantennasystemscanvarythetransmission or reception pattern of the communications signalsin response to the signal environment to improve performancecharacteristics. Temperature sensors are utilized to monitor avariety of automotive systems, including for example coolanttemperature and exhaust gas temperature. These sensors (figure3) typically utilize a wire-type thermistor, which is generallysolderedto hard-wiredleads.

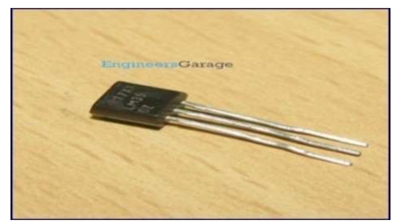

Fig.3Temperaturesensor

B.LevelSensor

Level sensors (figure 4) detect the level of substances that flow,including liquids, slurries, granular materials, and powders. Allsuchsubstancesflowtobecomeessentiallylevelintheircontainers (or other physical boundaries) because of gravity.The substance to be measured can be inside a container or canbeinitsnaturalform(e.g.ariveroralake).Thelevelmeasurementcanbeeithercontinuousorpointvalues.Continuous level sensors measure level within a specified rangeand determine the exact amount of substance in a certain place,while point-level sensors only indicate whether the substance isaboveor belowthesensingpoint.

Fig.4 Levelsensor

C.PHSENSOR:

PH is measured using a setup with two electrodes: theindicator electrode andthereference electrode. These twoelectrodes areoften combined into one - a combined electrode. When thetwo electrodes are immersed in a solution, a small galvanic cell is established. The potentialdevelopedisdependentonbothelectrodes.Idealmeasuring conditions exist when only the potential of theindicatorelectrodechangesinresponsetovaryingpH,while thepotentialofthereferenceelectroderemainsconstant.

ThemeasuredvoltagecanbeexpressedbytheNernstequationinthe following way:

$$E=E_{ind}-E_{ref}=E'_{T}-R\bullet T/F\bullet a_{H+}$$

where

E	=	Measuredvoltage(mV)
E_{ind}	=	Voltage of indicator electrode
E'_{T}	=	(mV)Temperaturedependentconstant(mV)
R	=	GasConstant(8.3144J/K)
T	=	AbsoluteTemperature(K)

Fig.5PHsensor

D.OXYGENSENSOR:

Grove - Oxygen Sensor (ME2-O2-Ф20) is a kind of sensor totesttheoxygenconcentrationinair,whichisbasedontheprincipleoftheelectrochemicalcelltotheoriginalwork.Youcanknow clearly the current oxygen concentration when you outputvoltage values proportional to the concentration of oxygen andrefer to the oxygen concentration linear characteristic graph. It'sverysuitablefordetectingoxygenconcentrationintheenvironment protection. Grove - Gas Sensor (O2) is an organicreaction module, it can provide a little current while putting it inthe air, we don't need to provide an external power to it, andoutputvoltagewillchangeastimecurrentchanges.

Fig.6Oxygensensor

IV. SOFTWAREDESCRIPTION

A. EMBEDDEDC

Duringinfancyyearsofmicroprocessorbasedsystems,programs were developed using assemblers and fused into theEPROMs. There used to be no mechanism to find what theprogram was doing. LEDs, switches, etc. were used to check forcorrectexecutionoftheprogram.Some'veryfortunate'developers had In-circuit Simulators (ICEs), but they were toocostly and were not quite reliable as well. As time progressed,useofmicroprocessor-specificassembly-onlyastheprogramming language reduced and embedded systems movedonto C as the embedded programming language of choice. C isthemostwidelyusedprogramminglanguageforembeddedprocessors/controllers.Assemblyisalsousedbutmainlytoimplement those portions of the code where very high timingaccuracy, code size efficiency, etc. are prime requirements. Asassemblylanguageprogramsarespecifictoaprocessor,assembly languagedidn'tofferportabilityacrosssystems.To overcomethisdisadvantage,severalhighlevellanguages,including C,cameup.SomeotherlanguageslikePLM,Modula-2,Pascal,etc.alsocamebutcouldn'tfindwideacceptance. Amongst those, C got wide acceptance for not onlyembeddedsystems,butalsofordesktopapplications.Eventhough C might have lost its sheen as mainstream language forgeneral purpose applications, it still is having a strong-hold inembedded programming.

B. PROTEUS

Proteusisaninterpretedlanguage:programsareloadedintomemory, pre-compiled and run; since the number of built-infunctions is large, execution speed is usually very good andoften comparable to that of compiled programs. One of themostinterestingfeaturesofProteusisthepossibilityofrunning scriptsas services or ISAPI scripts.Thisisveryuseful to protect critical processes in industrial environments(datacollection,devicemonitoring),ortoavoidthattheoperatorinadvertentlyclosesautility(keyboardemulation).

The ISAPI version of Proteus can be used to create scripts runthroughInternetInformationServicesandisequippedwithspecificfunctionstocooperatewiththeweb server.

C. 51-C51CCompiler

The Keil C51 C Compiler for the 8051 microcontroller is themost popular available today. The C51 Compiler allows you towrite 8051 microcontroller. The 8051C Compiler translates Csource files into locatable object modules, which contain fullsymbolicinformationfordebuggingwiththemicroVisionDebugger or an in-circuit emulator. In addition to the objectfile, the compiler generates a listing file, which may optionallyincludesymboltable andcross-referenceinformation.

V.HARDWAREPROTOTYPEMODEL

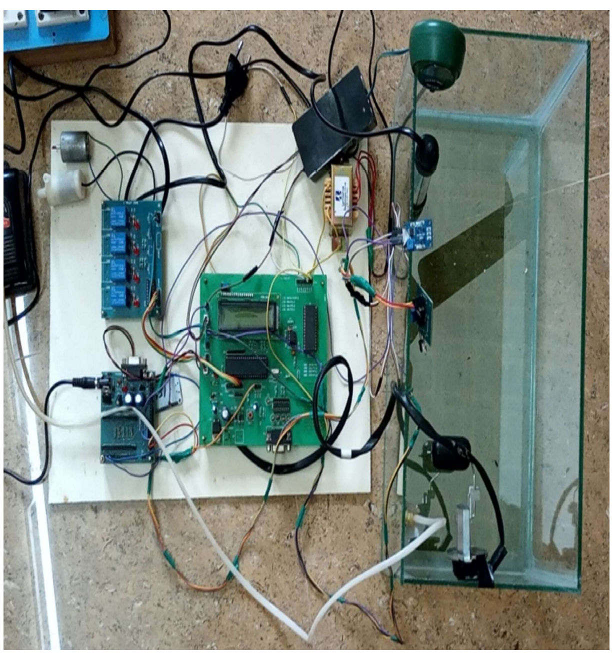

Fig.7Completehardwaremodelofproposedsystem

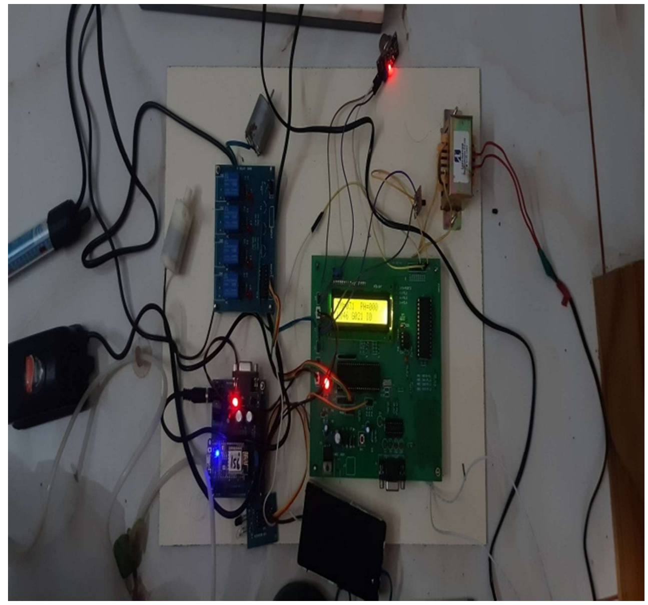

Fig.8Displayunitandcontrolboardofproposedsystem

S.No	Water Quality Parameters	Range
1	Dissolved Oxygen (DO)	(4-10) ppm
2	Ammonia	(0-0.1) ppm
3	pH	(7.5-8.5) ppm
4	Temperature	21^0C-33^0C
5	Salt	(0-2)ppt
6	Carbonates (CO_3^{2-})	(20-40)ppm
7	Bicarbonates(HCO_3^-)	(150-500)ppm
8	Nitrates(NO_2)	(0-0.3)ppm
9	Sour gas (H_2S)	(0-0.4)ppm

Fig.9Standardrangeofvaluesofwaterqualityparametersforaquaculture

Figure 7 shows the complete prototype system model ofautomatedaquaculturesetup.Inthisautomatedprocessweusingthe pHlevelsensor,temperaturesensor,OxygenSaturationSensor,TurbiditySensoraswellaswaterlevelsensors. If PH value goes beyond the threshold value (referfigure9)meansweareusingDCMotorwillSwitchONautomatically to maintain the PH level. If temperature of wateris low (refer figure 9) then we will Switch ON Heating Sensorto maintaintheTemperature.

If water content is very high in the field, Ordinary motorswillswitchONtoremovetheexcesswaterfromthefield.Ifthe Oxygen level is low (refer figure 9), then we will SwitchON Oxygen Saturation Sensor to maintain the oxygen level.Then the Turbidity sensors measure the amount of light (referfigure 9) that is scattered by the suspended solids in water. Andall these parameters can be controland monitor using IoT.Figure8showsdisplayunitsandcontrolunitsofproposed prototypesystemmodel.

VI. HARDWARERESULTS

SENSOR	FUNCTIONS	THRESHOLDVALUE	APPLICATION
Temperaturesensor	It is used to heat thewater,WhenthewaterleveldegreeCelsiusis lessinthewater	(30’C-33’C)	Ifthedegreevalueislessthan30degreeCelsius,the heater is connected to the water tank and it isturnedONandthewatergetsheatedtothe requireddegreeCelsius.
Levelsensor	It is used to detect theleveloftthewaterinthe tank.	Value-(125(mm)height)	Ifthewaterlevelis125ranges,thelevelsensorisconnectedtothe pumpingmotoranditgets turnedONfillsthewaterinthetank.
PHsensor	Itisusedtodetecttheacidic nature of thewaterinthetank.	ValuePHrange(4)	Ifthephvalueisabovethe(4)theACmotorgetsturned ON
IRsensor (Turbiditysensor)	Itisusedtodetectthe clarity(cleanwater)ofthewaterinthetank.	Value(1or0)	Ifthewaterclarityistoodarkitshowsthevalue (1),Andthewaterclarity(cleanwater)iscorrectinnatureit showsthevalue(0)
Oxygen (Gas) sensor	Itisusedtodetectthe dissolvedoxygeninthewaterinthetank.	Value-(140)	Iftheoxygenquantityislessthan(140)inthe water,TheoxygensensorisconnectedtotheoxygenmotoranditgetsturnedON.

Table1Resultsobtainedfromhardwareprototypemodel

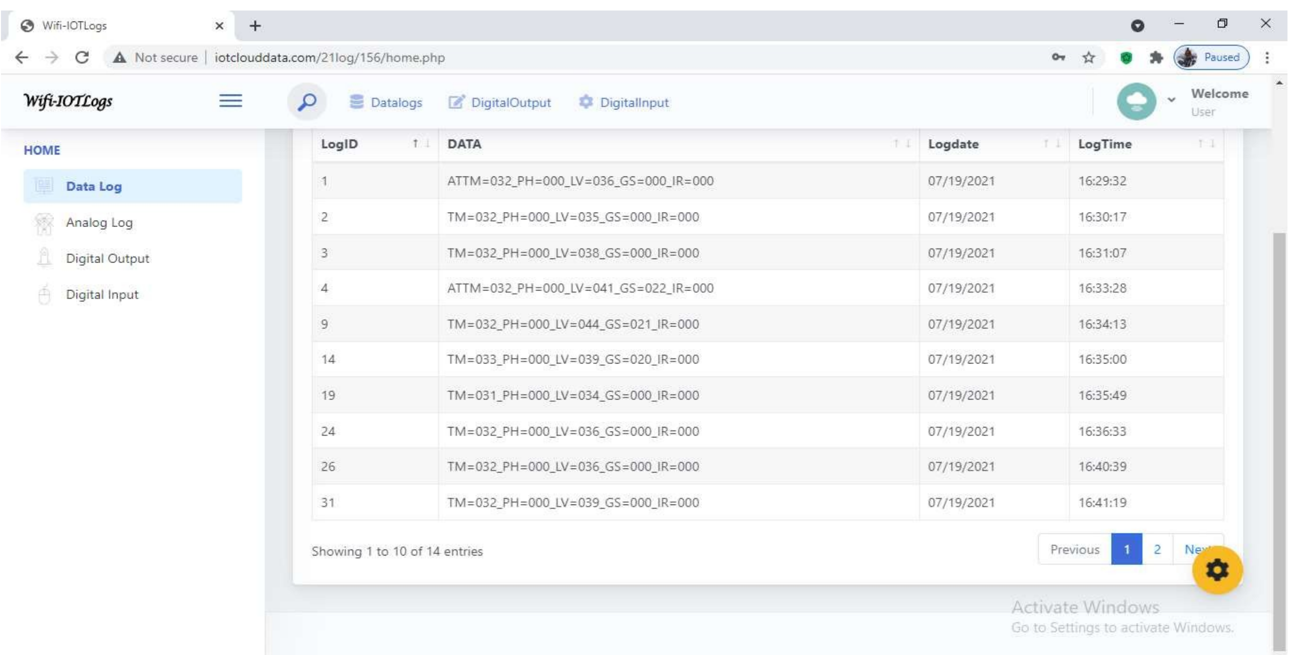

Fig.10IoTdataoutputresults

VICONCLUSION

Thisworkhelpthefarmersforaccurateandreliablemonitoring ofwaterqualityparametersbecausemanualtesting can consume time and water quality parameters mayalterwithtimebeingandithelpstotake pro-activemeasures before necessary damage was done. Though theinitialcostishigh,therewillbenoadditionalcostandmaintenance once it gets installed. Further, there is no needfor manual testing periodically. It saves time and energy.Thus, IoT has reached the farmers for reducing the risk fromclimaticfluctuationsandensuresgrowthandhealthforaquaticlife.Thisincreaseproductivityandhelpsforimproving the foreign trade and increases the GDP of thenation. Further, the collected data can be analyzed using bigdata analytics and preventive measures can be taken beforethe water quality parameter crosses the threshold range. Theaquasystemcanbemadeautomationusinginternetofthings, which reduces the energy consumption, and laborcost.

REFERENCES

[1] S.Kayalvizhi,KoushikReddyG,VivekKumarP,VenkataPrasanthN,"CyberAquaCultureMonitoringSystemUsingArdunioAndRaspberryPi,"InternationalJournal of Advanced Research in Electrical, Electronics andInstrumentationEngineering,Vol.4,Issue5,Pg:2320-3765;May2015.

[2] SureshBabuChandanapalli,SreenivasaReddyEandRajyaLakshmiD,"DesignandDeploymentofAquaMonitoring System Using Wireless Sensor Networks andIAR-Kick,"JouranlofAquacultureResearch&Development,Volume5 •Issue7•1000283

[3] Daudi S. Simbeye and Shi Feng Yang, "Water QualityMonitoring and Control for Aquaculture Based on WirelessSensor Networks," JOURNAL OF NETWORKS, VOL. 9,NO. 4,APRIL 2014.

[4] Changhui Deng, YanpingGao, Jun Gu, Xinying Miao,"Research on the Growth Model of Aquaculture OrganismsBasedonNeuralNetworkExpertSystem,"SixthInternationalConferenceon Natural Computation (ICNC2010);pg.no1812-1815,SEPTEMBER2010.

[5] Wen-TsaiSung,Jui-HoChen,Da-ChiunHuang,Yi-HaoJu,"MultisensorsRealtimeDataFusionOptimizationforIOTSystems,"2014IEEEInternationalConferenceonSystems,Man,andCyberneticsOctober5-8,2014,SanDiego,CA,USA.

[6] WeerasakCheunta, NitthitaChirdchoo andKanitthaSaelim,"EfficiencyImprovementofanIntegratedGiantFreshwater-WhitePrawnFarminginThailandUsingaWirelessSensorNetwork,"ResearchGate,DECEMBER2014.

[7] Jui-HoChen,Wen-TsaiSungandGuo-YanLin,"AutomatedMonitoringSystemfortheFishFarmAquacultureEnvironment,"2015IEEEInternationalConferenceonSystems,Man,andCybernetics.

[8] Mr. KiranPatil,Mr. SachinPatil,Mr. SachinPatil andMr.VikasPatil,"MonitoringofTurbidity,pH&Temperatureof Water Based on GSM,"International Journal for ResearchinEmergingScienceandTechnology,Volume-2,Issue-3,March-2015.

[9] Pradeep Kumar M,MonishaJ,Pravenisha R, Praiselin V,SuganyaDeviK,"TheRealTimeMonitoringofWaterQuality inIoTEnvironment,"InternationalJournalofInnovativeResearchinScience,EngineeringandTechnology,Vol-5,Issue-6,March-2016.

[10] AkankshaPurohit, UlhasKumarGokhale,"Real TimeWater Quality Measurement System based on GSM," IOSRJournal of Electronics and CommnicationEngineering,Vol.9,Issue 3,PP63-67,May-2014.

[11] SharudinMohdShahrulZharif, " IntillegentAquafarmSystemviaSMS,"Diss.UniversitiTeknologiPETRONAS,2007.

[12] SheetalIsrani,HarshalMeharkure,ParagYelore,"Application of IoT based System for Advance AgricultureinIndia,"InternationalJournalofInnovativeresearchinComputerand CommunicationEngineering Vol. 3,Issue.11,November2015.

[13] NikeshGondchawar , Prof. Dr. R. S. Kawitkar, "IoTbased smart Agriculture, " International Journal of advancedresearchinComputerandCommunicationEngineering,Vol.5,Issue.6,June2016.