**IOSR Journal of Engineering (IOSRJEN)** **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Volume 14, PP 72-79

# Smart Classroom: Real Time Feedback Using IOT

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***Abstract—*** *We Live In An Era Where Billions Of Computers Are Interconnected. In The Very Near Future, Not Only Computers But Also Many Different Digital Devices And Other Physical Objects Will Be Seamlessly Connected To Each Other And Be Able To Communicate With Little Or No Human Intervention. These Connected Objects Are Called Smart Devices, And This Perceptionis Called Internet Of Things. In This Paper, The Focus Is On The Application Of Iot In The Smart Classrooms. The Aim Of The Paper Is To Discuss How Intelligent Ambient Can Be Used To Provide Real- Time, Automatic Feedback On The Quality Of The Lecture Based On The Number Of Parameters. To Our Knowledge, This Is The First Attempt To Specify The Problem And Analyze The Requirements. The Parameters Of Interest That Should Be Collected And Analyzed Are Discussed. Finally, The Main Requirements That Such A System Should Comply With Are Presented And Proposed As The Experimental Design.*
***Keywords****; Internet Of Things, Smart Classroom; Wireless Sensor Networks*

## i. Introduction

TheconceptofinternethasbeendramaticallychangedoverTheyears.Fromanacademicnetworkusedtoexchange Messages,Overstaticwebcontent,Todynamicweb2.0weareNowfacingfurtherchanges.Thenetworkconnectingbillio nsofComputerswillsoonbecomenetworkthatseamlesslyconnectsAllkindsofdigitaldevices,Everydayobjects,I.E.Th e“Things“.Thesethings,Oftencalled“Smartobjects”Andtheconcept,Whereallofthemareinterconnectedandcollabor ating,IsCalled“Internetofthings”(Iot).Accordingtotheitu-Internationaltelecommunicationunion,Iotwillenable Connectivityforanyoneandanythingfromanyplaceatanytime[1].Therangeofnewapplicationsbasedontheiottechnolo gyIswideanddiverse.TheseapplicationswilllikelyimprovetheQualityofourlives,Butwillalsobringmanynewchalleng es Relatedtoprivacy,Socialinteractionandtechnology.

InordertomaketheenvisionedapplicationarealityandchieveanendEndcommunicationbetweenthe“Things”,I tIsnecessarytointegrateseveraltechnologiesandCommunicationsolutionsliketelecommunications,Informatics,Electr onicsaswellassocialscience.TheideaofthisconceptisBasedonthepervasivepresenceofthesmart"Things",I.E.Everyday objectsequippedwithadequatecommunicationTechnologyandintelligence(Abilitytoprocessinformation) Suchasrfidtags,Sensors,Actuators,Mobilephones,Etc.Which,ThroughuniqueaddressingschemesareabletointeractW itheachotherandcooperatewiththeirneighboring"Smart" Componentstoreachcommongoals[2].Thesesmartobjects Augmenttheawarenessofacertainenvironmentand,Thus,Act Asabridgebetweenthephysicalandthedigitalworlds[3].In Thispaper,WeaddressthepotentialofusingiottobuildaSmartclassroom,I.E.Aclassroomthatcanprovidereal-Time, Automaticfeedbackonthequalityofalecture,I.E.AbouttheCurrentlevelofinterestoftheauditoriumandthelevelof Satisfactionoftheauditoriumwiththelectureandthelecturer. Such Real-Time Response Will Permit The Speaker ToAcclimateTheLectureduringthedemonstrationinordertoattainthe MaximumcontrolaswellastoadjustthesucceedinglecturesConstructedonthe“Lessonslearned”Fromthepreviouscase s.Therestofthepaperisorganizedinthefollowingmanner.Sectioniidescribestheperceptionofasmartclassroom.Insecti onIII,Relatedworkisdiscussed.Sectionsivandvoriginatesystem NecessitiesanddeliverstudyofvariousconstraintsthatNeedstobefollowed.Insectionvitheexperimentalsystem Designispresented.Sectionviiconcludesthepaper.

## II. Smart Classroom Concept

ThesmartclassroomnotionhasspecifiedTheImprintintheliteratureAsinternetbaseddistanceeducationorganizatio n;OrasintelligentEnvironmentequippedwithanassemblyofmanydifferentTypesofhardwareandsoftwaremodules[4]. IntheprocessofEverydayteaching,Lecturersareusuallytryingtofindoutifthe Students(Ormoregeneraltheauditorium)WeresatisfiedwithThelecture,Whichpartofalecturewasinteresting,Which PresentationtechniquesandapproacheswereremoreattractiveAndeffectivethantheothers.Previousstudieshaveshownt hatApproximatelyafter10minutesstudents’attentionbeginstoDecrease.Attheendofalecture,Studentsremember70% Of Theinformationpresentedinthefirsttenandonly20%Ofthe Lasttenminutes[5]. Joiningtheiottechnologybysocial/PublicandbehavioralExamination,Aregularclassroomcanbeconvertedintoasmart Classroomthatenergeticallylistensandinvestigatesvoices,Exchanges,Schedules,Performance,Etc.,Inordertoreacha Conclusionaboutthelecturers’presentationandlisteners’Satisfaction.Thiswillpermitspeakerstosteadilyconveydecen tdemonstrationsandmakeimprovedinfluence,Whilethespectators Willprofitfromstimulatinglecturesthusmakingtheknowledge Processsmaller,Moreefficientaswellasmorepleasantan dEvenentertaining.Theresearchconductedatmit(Massachusettsinstituteoftechnology)Showsthatitis Possibletomergecomputerandsocialscienceinorderto Analyzehumanbehavior.Allworkisbasedontheoriesthat Statesthathumanshavetwotypesof"Minds":Habitual,WhichIsfast,Parallelandautomatic;Andattentivewhichisslow, Serialandrulebased[6].Newpsychologicalresearches Estimatethatmuchofhumanbehaviorishabitualandthat Mindfuldecisionsplaylittleornorole[7].Therefore,PeopleAremuchpatternedinhowtheybehaveandinsomedegree Repeatableandpredictable.Thepatternedhumanbehaviorcan Beusedforfurtherresearch:Digitalrepresentationofpara meterPatterns(Patternfrequency,Soundlevel,Etc.)Maycertain Featuresthatcanbeutilizedforanalysisofthelecturequality.Inanidealcase,Asmartclassroomshouldnotdifferfroma Standardclassroomenvironment;RespectivelythestudentsareNotobservedinanintrusivemanner,Andhencetheybeha ve Naturally.

## III. .Previous Work

Previousworkisnotdirectlyrelatedtothissubject,AsitFocusesmainlyonenhancinglearninginadifferentmanne r.TheperspectiveoftheexistingworkisorientedforwardDigitalizationoftheambient,Conversionofwrittenmaterials Intoelectronicform,Tele-Education,HumantocomputerInteraction,Webbaseddistancelearning,Interactionina Classroomoraconference,Etc.Toourknowledge,ThisistheFirstattempttospecifytheproblemoflivefeedbackonlecture Qualityandanalyzetherequirements.In[8],AutomatedcaptureOfaudio,Video,Slides,Andhandwrittenannotationdurin galivLectureisproposed.AsystemforlocatingandtrackinglecturerIntheroomusingacousticandvisualcuesisdescribedin [9].MITDevelopedAPlatforWhichCanmeasure ThenumerousfeaturesofInteraction,IncludingnonlinguisticsocialsignalsbyanalyzingTheperson'stoneofvoice,Facial movement,OrgestureUtilizingwearabledevice[10].SimilarresearchwasconductedIn[11]Wherewearablesensorswere usedtocreategroupSocialindexofinterest.ThesedevicesmustbeworninordertoProvideparametersformeasurement.Thi sisnotthemostProminentsolutionastheindividualsarenotbehavingNaturallywhentheyknowthattheyarebeingobserved .Nevertheless,PreviousworkcanbeagoodstartingpointforFurtherresearch.TheproblemofrealTimefeedbackonlecture excellence,Byseeingtheparameters Existinginspectatorsandtheirdigitaldemonstrationintime Scale.

Availableforarealworldbattle.TogetmoreobjectiveMeasurements,TrainingconditionsmustbeassimilarasP ossibletotheconditionsinarealworld.ItisstilldifficulttoExtractcuesfroma"Live"Environment,DuethelimitationsofT hetechnology.***Socialinteractionintegrity:***FromtheSociologicalpointofview,Thestudents'unawarenessofSensorspr esenceisadvised:ThesensorscanbelocatedAnywhereintheclassroom,ButpreferablynotwornbytheStudents.Itisimpo rtantnottoinfluencethesocialinteractionIntegrityasstudentmaynotbehavenaturallywhentheyareKnowthattheyarebei ngobserved.Therefore,ApproachwithLessinvasivesensorsismandatory.***Openarchitecture:*** ObservedparameterscontainvaluableinformationthatcanbeUsedbydifferentplatforms,Orforfurtherresearchesinsoci alAndcomputersciences.ThisrequirescertainopennessoftheSystemarchitecturebasedoncloudcomputingtechnology that Enablesitservicesovertheipandincludesdynamic,Scalable Andvirtualresources.

## i. Parameters Analysis

OurprimaryfocusistocontinuouslymonitorthelevelofSatisfactionoftheaudiencewithanongoingpresentation.TA ccomplishthat,ItisnecessarytofindtheparametersthathaveTobemeasuredandmonitored.AsapartofthisresearchQuest ionnaireisconductedamong230studentsfromtwoDifferentuniversity.ResultsshowsthatfidgetingandnoiseareTwom ostcommonwayofexpressingthelackofinterest.Accordingly,IntableiparametersarepresentedaswellasSensorsthatca nbeusedforobservationofthegiven Phenomenon.

**Table I. Parameters**

TABLE I. PARAMETERS

| Sensor | Parameter | Output |
|---|---|---|
| PIR Sensor | Fidgeting | Motion existence |
| Microphone | Noise | Noise existence |
| Camera | Fidgeting | Motion level |
| Sound sensor | Sound level | Sound level |

IV.REQUIREMENTS

## IV. Requirements

Beforeanalyzingparameters,SystemrequirementsAltogetherwithconcernsrelatedtoasystemrealizationare Presented.***System***shouldbeabletoextractrequiredInformationfromtheambient.Therefore,Itrequiresprocesses

Suchas:Scenecapturing,Motiondetection,Soundrecording,Andinterpretationofextractedparametersinrealtime.SceneImagescapturedwithcamerawillbeprocessedforfidgetingSmalldifferencesbetweenpictureframes;ForavoidingthirdPartyinfluence(E.G.Someonehasenteredtheclassroom),OrMovementsthatarenotfidgeting.SoundlevelwillbeobtainedWithsoundsensors.***Real-Timefeedback***canbegivenasachart Inrealtime;DemandingtimecorrelationanddatafusionofMultimodaldata(Visual,Audio,Environmental,Etc.).Its Existing,Timelydispersedpatternsshouldbesynchronizedand Correlatedintermsofatimescale.***Realvs.Laboratoryworld****:*Experimentalresearchisusuallyconductedinlaboratory Conditions,Thatresultswithasmallarsenaloftechniques

*A.Audienceactivity*

Theobservationalresearchshowsthatdeclineofattention Isfollowedbycertainchangesinabehavior.ResearchersuseBehaviorssuchasfidgeting,Doodling,Yawning,AndlookingAroundasindicatorsofinattentiveness[12].Therefore,AmountOfmotions(Fidgeting)CanhelpusindeterminingtheSatisfactionlevelofaudiencebymeasuringtheactivitylevel. Themeasurementoffidgetingisroughlyindicatorofattention,ButincombinationwithsoundlevelmeasurementsitcanProvidemoreconfidentresults.Socialresearch[13]Indicates ThateachbasicemotionconsistsofoneprocessinthebrainandIsmanifestedasasetofcomponents:Vocalexpression,HandMovements,Facialcues,Etc.Therefore,Certainparameterscan Beindirectlymeasuredthroughmovementtracking,AstheyRepresentsideeffectsofthesecues.Activitylevelofmotion Canberecordedwithcameraandpirsensorwhichisinmore Detailexplainedinexperimentaldesignsection.

*B.Sound*

Thedifferencebetweenactivelisteningandunnecessaryiscussioncanbeidentifiedbythespokenwordsfromthe Audience.Nevertheless,DetectingspokenwordsautomaticallyFromaspontaneousspeechisademandingtechnique,BecauseTheexistingautomaticspeechrecognition(ASR)SystemshaveAnerrorrateescalatingwiththedifferencesinthetrainingandTheexecutionenvironment.Ontheotherhand,Sound(Noise) Levelcanbeeasilytrackedbysensors,AndithasbeenshownThatbackgroundnoiselevelhasasignificantimpacton Students'learningprocess.Jonson[14]ReportedthatnoiseorEchoaffectsastudent'sconcentration,Causing Misinterpretationofthelesson.IncreasingthenoiselevelisFollowedbythestudent'sdeclineofattention.Ontheother Hand,Ifstudentfindsthelectureuninteresting,Theyproduces Morenoise.

## V. .Experimental Design

Inordertopresenttheideaofthereal-TimefeedbackinMoredetail,Inthissectiontechniquesandmethodsaregivenas Theexperimentaldesign.Theproposedsystem(Figure1)Consistsofiotdevicesthatcollectsdataandsenditttowards Thegateway.ThedatacenterisutilizedforstorageandAnalysis,Aswellasforsignalprocessingandtheclassification. Theresponseonlecturesuperiorityisofferedinarealtimeto Theendoperator.Technologiesfordatatransportarehttp,XML.Thealgorithmsforsignalanalysisandclassificationare Implementedinjava.Thepachube[15]CloudplatformisoneWaytopresenttheresults,Visualize,Anddelivertothird-Party.Theparametersfromtablei,Canbesummonedwiththe Followingdevices:Pirsensors,Videocamera,Noisesensors, Andmicrophones.Duringthemeasuredperiod,AllobservedPersonscanexpresstheirinterestlevelbyusing"Rate-It" Interestmeter,Whichenablescomparingcalculatedinterests Withtheprovidedones.

**PIR**(Passiveinfrared)SensorisanelectronicdevicethatMeasuresinfraredlightradiatingfromobjectsinitsfieldof Viewandcanbeusedformotiondetectionwithinrangeof6Meters.Theoutputofthesensoris:0-Ifnomovementis Detected;Or1-Ifanymovementexists.InordertocovertheWholeclassroom,Totalnumberofthesensorsdependsonthe Area.Duringlecturesomestudentswillbemoving,And Discretevaluescanbelinkedtogetherinordertogetcontinuous Function.

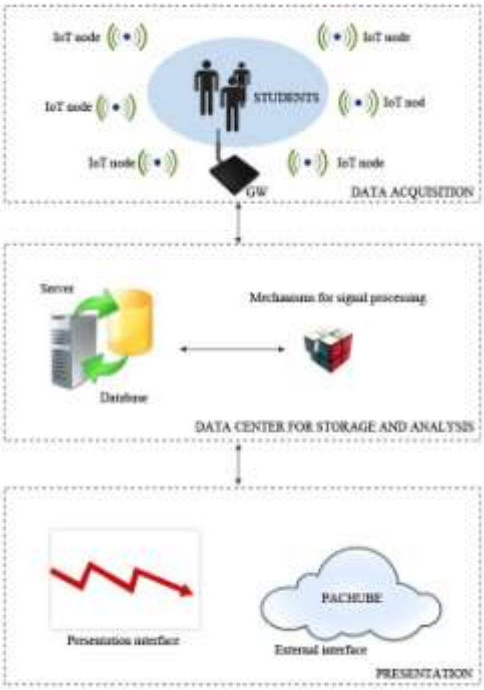


**Figure 1**. System Architecture

**Camera-**ThewholescenecanbecapturedusingoneWide-Anglecamera.Twoframesobtainedindifferenttime FramescanbecomparedandthepercentageoftheirMismatchingcalculated.Inordertoavoidthemostextreme Casesandthird-Partyinfluence(E.G.SomeoneenteredtheClassroom,Lecturer'swalking,Etc);VeryhighdifferenceswillBeignored.Therefore,ThresholdwillbedeterminedandallValuesabovethresholdwillbeeliminated.FrameswillbeCapturedinregular intervals,AndifobtainedvaluefortheObservedintervalisbelowpreviouslydefinedthresholdvalue, ItwillbeusedasdiscretevalueandwillbelinkedwithotherObtainedregulardiscretevalues,Whileextremevalueswillbe Ignored.Again,Itwillproduceanothercontinuousfunction.Theframedifferenceiscalculatedas:

Movementwillbedetectedbythenearestpirsensor.The

$N$diff_Percent($T$,$T$

,$I$)

Stirringleveliscorrelatedwiththenumberofsensorsdetecting

$F(T)=$ ——— 1 2

(2)

Movements.Supposingthatpir$_i$($T$)Istheoutputofthe$i^{th}$ 1

Sensoratagivenmoment$t$,Thefollowingformulashowsthe

$I$=1

Percentageoftotallymovements:

$N$

$(Pir_i(T))$

$F(T)=\frac{I=1}{}*100N$

(1)

Where$t$And$t$Representtimeframes;$I$isthecameranumber

And$n$isthenumberofallcamerasinthedeployment.*F(T)*

Functioniscalculatedforthetimepoint$t$.IfcalculatedDifferenceshaveextremevalues,Thesevalueswillbeignored Asitisdescribedinnextpseudocode:

*If(Diff_Percent(T,T,I))>Threshold*

Wherenrepresentsatotalnumberofpirsensors.AllCalculatedvalueswillbeinrange(0,100);Ifallsensorsdetect Movements,Thevalueofthefunctionwillbe100,AndifnoMovementisdetected,Thecalculatedvaluewillbe0.This Functioncanbecalculatedinregularintervalsanditsobtained

*Thenignorecamerai*
*Elsetakeitsvalueintocalculationprocess*
CalculatingmovementsbypirsensorsandbycameramaySeemredundantatfirst,Butitactuallycontributestheaccuracy Ofthecalculation.CameraalgorithmshowsmovementIntensity,Whilepirsensorgivesonlyinformationof Movementexistence.

**Soundlevel**ismeasuredwithsoundsensorthatoutputs Valuesindbunitsusuallyinrangebetween45dband110db Withaccuracyof±3db.Inordertogetmorepreciseresults,At Leastthreesensorsshouldbeused.Thesensors'locationshould Notbelessthan0.5metersfarfromthewalls,CeilingorfloorAndnotlessthan1meterfarfromtheexternsourcesofnoise (Likewindowsorventilationsystems).Everyvalueobtainedby Thesesensorsisatfirstnormalizedtothescale(0,100),Andits Averageiscalculatedusingthefollowingformula:

$$N \underline{s\,(T) - S}$$

$$I\min * 100$$

## VI. Conclusion

ThesmartclassroomnotionfromaTotallynovelviewpointisdefined:Real-Timefeedbackon Lecturequalitybyusingiot Is Described In This Document.Themaincontributionofthis Paperisaninnovatingapproachtoasmartclassroom Environment,Andnovelmultidisciplinaryresearchsubject.ThiApproachdemandsanunderstandingoftheproblemstatementInordertodefineparameterswithfurtheraimtocreateagoodPrologueforthesystemimplementation.OurpaperfocusesonUseofthesensingandthemonitoringtechnologytoexploreListeners'behaviorinintelligentenvironment.CollectedInformationcanprovideinsightintoauditoriumactivitylevel Bycorrelatingthesoundandthemovement'sexistenceandIntensity.Suchintelligentenvironmentcouldactivelyobserve

$$F(T) = \underline{I=1\; S\;\text{Max} - S\;\text{Min}}\; N(3)$$

Studentresponsetoalecture,AndbeusefultoalecturertoIncreasethelecturequality.Theexperimentaldesignisgivenin Ordertopresenttheideainmoredetails.Digitalrepresentat Where$s_i$representvaluesobtainedbynoiselevelsensors;Whiles$_{min}$ands$_{max}$areminimalandmaximalvaluethatcanbe Registeredbysensors$_i$,And$n$representstotalnumberofSensors.Similarlytocameraandpirsensorfunctions,Discrete ValuescalculatedthroughoutmeasuredtimeperiodcanbeLinkedtogetherformingthecontinuousfunctionthatpresents Noiselevelthroughoutlecture.

**Microphone:**Supposingthatmic$_i(T)$Istheoutputfromthe$I^{th}$microphoneatagivenmoment$t$,Thefollowingformula Showsthepercentageoftotallynumberofmicrophones Registeringanoise:
$K$
$(Mic_i(T))$
Ofauditoriumactivitycanbeprovidedasachartinreal-TimeForabovementionedparameters.PracticalexaminationoftheSmartclassroomsubjectwillpresentnewissuesforresearch Andconsideration.

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$$F(T) = \frac{I=1}{\phantom{xxxxxxxx}} * 100$$

(4)

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Wherekrepresentsatotalnumberofmicrophones.Similarto Previousfunctions,Allcalculatedvaluesareinrange(0,100);If Allsensorsdetectnoise,Thevalueofthefunctionwillbe100, Andifnonoiseotherthanaspeakingisdetected,Thecalculated Valuewillbe0.Aspreviously,Thisfunctioncanbecalculated Inregularintervalsanditsobtaineddiscretevaluescanbe Linkedtogetherinordertogetcontinuousfunction.

*A.Analyzingandcomparingresults*

Usingpreviousformulaseveryparameterisrepresentedby Acontinuousfunctionwhichvaluesarebetween0and100. Therefore,Valuesreceivedfromdifferentsourcescanbe Combinedandcomparedanditscorrelationcanbeusedin Calculatingstudents'attention. Forexample,Ifaveragevalueof Thesethreefunctionsisabovesomepreviouslydetermined Threshold,Itshowsthatstudentsaremovingandfidgetingalot Andareverynoisyinthesametime,Whichwithhigh Probabilitycanmeanthatstudentsarenotpayingattention. The Amountofmotionandnoiselevelcanbeconsideredasan Attentionindicator:Higherthelevelofbothparametersare,The Biggerischancethatlectureisnotinteresting. Nevertheless, "Noise"Incasewhenthereishighlevelofattentionshould Havedifferentpatternthanincasewhentheattentionislow; I.E.Soundandmotionshouldbemoresynchronized. The Synchronizationbetweenpatternsisnotcoveredbythe Experimentaldesignasitrequiresmorepracticalresearch,And Itwillbeconsideredinfuturework.

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