**Smart Classroom: Real Time Feedback Using IOT**

Nida Parkar, Bhavna Arora, Pritirimao, Tejalrachh  
*Computer Department, Aligarh College Of Engineering, Mumbai University, India*

**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 Perception Is 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 Discussede. Finally, The Main Requirements That Such A System Should Comply With Are Proposed And Proposed As The Experimental Design.

**Keywords:** Internet Of Things, Smart Classroom; Wireless Sensor Networks

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**i. Introduction**

The concept of internet has been dramatically changed over the years. From academic networks used to exchange messages over static web content, dynamic web 2.0 has now moved towards more changes. The network connecting billions of computers will soon become networked, thus seamlessly connecting all kinds of digital devices. Everyday objects, I.E. The e-"Things," the things often called "Smart objects" and the concept, where all of them are interconnected and collaborating is called "Internet of Things" (Iot). According to the International Telecommunication Union, Internet of Things is an enabling technology that fosters the pervasive presence of "Smart" Things, i.e., everyday objects equipped with adequate communication technology and intelligence (Ability to process information). Such as RFID tags, sensors, actuators, mobile phones, etc., which through unique addressing schemes are able to interact with each other and cooperate with their neighboring "Smart" Component store in common goals.[2]. These smart objects augment the awareness of a certain environment and, thus, act as a bridge between the physical and digital worlds.[3]. In this paper, we address the potential of using IOT to build a smart classroom, I.E., a classroom that can provide real-time, automatic feedback on the quality of a lecture, I.E., about the current level of interest of the auditorium and the level of satisfaction of the auditorium with the lecture lecturers. Such real-time response will permit the speaker to acclimatize the lecture during the demonstration in order to maintain the maximum control as well as to adjust the success of the lecture. Constructed on the "Lessons learned," from the previous case study, the research was organized in the following manner. Section I describes the perception of a smart classroom. Section II describes related work discussed. Section III covers the experimental design, system necessities, and delivering the study of various constraints that need to be followed. In section IV, the experimental system design is presented. Section V concludes the paper.

**II. Smart Classroom Concept**

The smart classroom notion has a specific need. The Imprint on the literature as Internet-Based Distance Education Organizations; Smart Classroom Environment equipped with an assembly of many different Types of Hardware and Software modules[4]. According to the process of everyday teaching, lecturers are usually trying to find out if the students’ (from the general auditorium) were satisfied with the lecture, which part of the lecture was interesting, which presentation techniques and approaches were more attractive and effective than others. Previous studies have shown that approximately after 10 minutes, students’ attention begins to decrease. The end of the lecture, students remember 70% of the information presented in the first 20% of the last minutes.[5]. Joining the IOT technology by social/Public and behavioral Examination, a regular classroom can be converted into a smart Classroom that energetically listens and investigates voices, exchanges, schedules, performance, etc. In order to achieve a conclusion about the lecture’s presentation and listeners’ satisfaction, this will permit the speakers to steadily convey the content.
Smart Classroom: Real Time Feedback Using IOT

Possible to merge computer and social science in order to analyze human behavior. All work is based on theories that state that human behavior has two "Minds": Habitual, Which is fast, Parallel and automatic; and Attentive which is slow, Serial and rule-based. New psychological researches estimate that much human behavior is habitual and that mindful decisions play a little role. Therefore, people are much patterned in how they behave and to some degree repeatable and predictable. The patterned human behavior can be used for further research: Digital representation of patterns (Pattern frequency, Sound level, etc.) May certain features that can be utilized for analysis of the lecture quality.

III. Previous Work

Previous work is not directly related to this subject, as it focuses mainly on enhancing learning in a different manner. The perspective of the existing work is oriented forward. Digitalization of the ambient, Conversion of written materials into electronic form, Tele-Education, Human-computer Interaction, Web-based distance learning, Interaction in a Classroom or a Conference, etc. To our knowledge, this is the first attempt to specify the problem of live feedback on lecture quality and analyze the requirements. In [8], automated capture of audio, video, slides, and handwritten annotation during live lectures is proposed. A system for locating and tracking lecturers in the room using acoustic and visual cues is described in [9]. MIT developed a Platform for which can measure the numerous features of interaction, including non-linguistic social signals by analyzing the person's tone of voice, facial movement, gesture usability, and wearable devices [10]. Similar research was conducted in [11]. Where wearable sensors were used to create a group social index of interest. These devices must be worn in order to provide parameters for measurement. This is not the most prominent solution as the individuals are not behaving naturally and they know that they are being observed. Nevertheless, previous work can be a good starting point for further research. The problem of real-time feedback on lecture excellence, by seeing the parameters Existing in spectators and their digital demonstration in time scale. Available for a real-world battle. To get more objective measurements, training conditions must be similar as possible to the conditions in the real world. Its still difficult to extract cues from a "live" environment, due to the limitations of the technology. Social interaction integrity: From the sociological point of view, the students' unawareness of sensors presence is advised. The sensors can be located anywhere in the classroom, but preferably not worn by the students. It is important to not influence the social interaction Integrity as a student may not behave naturally when they know that they are being observed. Therefore, an approach with less invasive sensors is mandatory. Open architecture: Observed parameters contain valuable information that can be used by different platforms, or for further research in social and computer sciences. This requires certain openness of the System architecture based on cloud computing technology that enables its services over the peer and includes dynamic, scalable, and virtual resources.

i. Parameters Analysis

Our primary focus is to continuously monitor the level of satisfaction of the audience with an ongoing presentation. To accomplish that, it is necessary to find the parameters that have to be measured and monitored. As a part of this research, a questionnaire is conducted among 230 students from two different universities. Results show that fidgeting and noise are the two most common ways of expressing the lack of interest. Accordingly, table I parameters are presented as well as sensors that can be used for observation of the given phenomenon.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion existence Microphone</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
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<tr>
<td>Noise existence Camera</td>
<td></td>
</tr>
<tr>
<td>Motion level</td>
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</tbody>
</table>

Table I. Parameters

IV. Requirements

Before analyzing parameters, system requirements are presented. System should be able to extract required information from the ambient. Therefore, it requires processes...
Such as: Scene capturing, Motion detection, Sound recording, and interpretation of extracted parameters in real-time. Scene images captured with a camera will be processed for fidgeting. Small differences between picture frames; for avoiding third party influence (E.G. Someone has entered the classroom). Or movements that are not fidgeting. Sound level will be obtained with sound sensors. Real-time feedback can be given as a chart. In real-time; demanding time correlation and data fusion of multimodal data (Visual, Audio, Environmental, etc.). Its existing, timely dispersed patterns should be synchronized and correlated, term-of-timescale. 

Real vs. Laboratory world: Experimental research is usually conducted in laboratory conditions, that result with a small arsenal of techniques.

A. Audience activity

The observational research shows that decline of attention is followed by certain changes in behavior. Researchers use behaviors such as fidgeting, doodling, yawning, and looking around to indicate areas of inattention and its effects. Therefore, a combination of sound level measurement with fidgeting can provide more confident results. Social research [12] indicates that each basic emotion consists of one process in the brain and is manifested as a set of components: Vocal expression, hand movements, facial cues, etc. Therefore, certain parameters can be indirectly measured through movement tracking, as they represent side effects of these cues. Activity level of motion can be recorded with camera and PIR sensors which is more detailed in experimental design.

B. Sound

The difference between active listening and unnecessary discussion can be identified by the spoken words from the audience. Nevertheless, detecting spoken words automatically from spontaneous speech is a demanding technique, because existing automatic speech recognition (ASR) systems have an error rate escalating with slight differences in their training and execution environment. Therefore, sound (noise) level can be easily tracked by sensors, and it has been shown that background noise level has a significant impact on students' learning process. Jonson [14] reported that noise or echo affects students' concentration, causing misinterpretation of the lesson. Increasing the noise level will follow by the students' decline of attention. On the other hand, if the students find the lecture uninteresting, they produce more noise.

V. Experimental Design

In order to present the idea of real-time feedback in more detail, in this section techniques and methods are given as the experimental design. The proposed system (Figure 1) consists of IoT devices that collect data and send it towards the gateway. The data center is utilized for storage and analysis, as well as signal processing and classification. The response on lecture superiority is offered in real-time to the end operator. Technologies for data transport are HTTP, XML, and the algorithms for signal analysis and classification are implemented in Java. The platform is a way of presenting the results, visualizing, and delivering to the third party. The parameters from the table can be summoned with the following devices: PIR sensors, video cameras, noise sensors, and microphones. During the measured period, all expressed persons can express their interest level by using “Rate-It” Interest meter, which enables comparing calculated interests with the provided ones.

PIR (Passive infrared) Sensor is an electronic device that measures infrared light radiating from objects in its field of view and can be used for motion detection within an angle of 60 degrees. The output of the sensors is 0-1. Movement is detected; Or 1-If no movement exists. In order to cover the whole classroom, the total number of sensors depends on the area. During lectures, some students will be moving, and discrete values can be linked together in order to get a continuous function.
Camera - The whole scene can be captured using one Wide-Angle camera. Two frames obtained in different time intervals can be compared and the percentage of their mismatching calculated. In order to avoid themost extreme Cases and third-Party influence (E.G. Someone entered the classroom, lecturer’s walking, etc), very high differences will be ignored. Therefore, threshold will be determined and all values above the threshold will be eliminated. Frames will be captured in irregular intervals, and if obtained value for the observed interval is below previously defined threshold value, it will be used as discrete value and will be linked with other obtained regular discrete values. While extreme values will be ignored. Again, it will produce another continuous function. The frame difference is calculated as:

\[ \text{Movement} = \text{diff} \cdot \text{Percent}(T, T) \]

Stirring level is correlated with the number of sensors detecting movements. Supposing that pir\(_i\)(T) is the output of the \(i\)th sensor at a given moment, the following formula shows the percentage of totally movements:

\[ N_{\text{Movement}} = \frac{\sum_i \text{pir}_i(T)}{100} \]

(1)

Where \(\text{And}\) represents time frames, \(i\) is the camera number, and \(n\) is the number of all cameras in the deployment. \(F(T)\) Function is calculated for the time point \(T\). If calculated differences have extreme values, these values will be ignored.

As it is described in the pseudocode:

\[ \text{If} (\text{diff} \cdot \text{Percent}(T, T)) > \text{Threshold} \]

Where represents a total number of pir sensors, all calculated values will be within range (0,100). If all sensors detect movements, the value of the function will be 100. And if no movements detected, the calculated value will be 0. This function can be calculated in regular intervals and obtained:
Calculating movements by PIR sensors and by camera may seem redundant at first, but it actually contributes to the accuracy of the calculation. Camera algorithms show movement intensity, while PIR sensors give only information of movement existence.

Sound level is measured with sound sensors that output values in the range between 45 and 110 dB. With accuracy of ±3 dB, it is difficult to get more precise results. At least three sensors should be used, and the sensors’ locations should not be less than 0.5 meters from the walls, ceiling or floor, and not less than 1 meter from external sources of noise (like window ventilation systems).

Every value obtained by these sensors is first normalized to the scale (0,100), and its average is calculated using the following formula:

$$ N_s(T) - S_{\text{min}} \times 100 $$

VI. Conclusion

The smart classroom notion from a totally novel viewpoint is defined: Real-Time feedback on lecture quality by using IOT is described in this document. The main contribution of this paper is in an innovative approach to a smart classroom environment and novel multidisciplinary research subject. This approach demands understanding of the problem statement in order to define parameters with further aim to create a good prologue for the system implementation. Our paper focuses on the use of the sensing and monitoring technology to explore listeners’ behavior in an intelligent environment. Collected information can provide insights into auditorium activity level by correlating the sound and movement’s existence and intensity. Such an intelligent environment could actively observe:

$$ F(T) = \frac{\sum_{i=1}^{N} S_{\text{Max}} - S_{\text{Min}}}{N} $$

A student response to a lecture and usefulness of a lecturer to increase the lecture quality. The experimental design is given in order to present the results. Digital representation where each value is obtained by noise sensors while min and max are minimal and maximal value that can be registered by sensors. Similarly, to camera and PIR sensor functions, discrete values calculated throughout the measured time period can be linked together forming the continuous function that presents noise level throughout the lecture.

Microphone: Supposing that $\mu_i(T)$ is the output from the $i^{th}$ microphone at a given moment $t$. The following formula shows the percentage of the total number of microphones registering noise:

$$ K(M\mu_i(T)) $$

The auditorium activity can be provided as a chart in real-time for the aforementioned parameters. Practical examination of the smart classroom subject will present new issues for research and consideration.

References


A. Analyzing and comparing results

Using previous formulas, every parameter is represented by a continuous function, which values are between 0 and 100. Therefore, values received from different sources can be combined and compared, and its correlation can be used in calculating students' attention. For example, if average value of the three functions is above some previously determined threshold, it shows that students are moving and fidgeting a lot and are very noisy at the same time, which with high probability can mean that students are not paying attention. The amount of motion and noise level can be considered as an attention indicator. Higher the level of both parameters are, the bigger is the chance that the lecture is not interesting. Nevertheless, "Noise" in case when there is high level of attention should have different patterns than in case when the attention is low; i.e., sound and motion should be more synchronized. The synchronization between patterns is not covered by the experimental design as it requires more practical research. And it will be considered in future work.
Smart Classroom: Real Time Feedback Using IOT


