IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Special Issue, 5, March 2019 E-ISSN: 2347-2693

SMART CHILD SECURITY SYSTEM BASED ON IoT

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DOI: https://doi.org/10.26438/ijcse/v7si5.275228 | Available online at: www.ijcseonline.org

Abstract—Nowadays child security is an important area of concern. This model is developed to rectify the worries of parents regarding their child security. This paper proposed a model for child safety through smart phones that provides the option to track the location of their children as well as in case of emergency notification is send via E-mail.Mobile phones can be used to enhance student's services. One of these services is taking the attendance. Taking attendance requires a location factor of the student. Hence, iBeacon can be used for this purpose. iBeacon is not only used for marking attendance it is also used for location a child who roaming inside the school campus. The exact location and the time how long he/she spend in that location is transferred to the class teacher.Automated learning analytics is becoming an important topic in the educational community, which needs effective systems to monitor learning process and provide feedback to the teacher and parent. Student affective states such as happy, sad, fear, disgust, surprise, angry, neutral are automatically determined from facial expressions.

Keywords—GPS, iBeacon, Mood Prediction

I. INTRODUCTION

To ensure the safety of children in this project IoT is used. The proposed system describes a low cost comprehensive child monitoring device that tracks the location, adherence to route and schedule and other information. Real time tracking allows the parent to have been informed about the current location instead of waiting for a delayed bus and the notification system ensures the individual safety of each child. The tracking is achieved by reading the geographic coordinates from the GPS module and uploading it to a MySQL database in the remote server. This information can then be accessed bya user base that includes the parents, bus drivers and schooladministration through a mobile application which takes thelocation from the database and plots it on a map.The notification system alerts the parent whocauses the microcontroller to invoke a server script to pushnotifications to the parent's mobile. Thus the bus and the children onboard will be monitored accurately throughout thecommute.

In this project, we will deal with the Bluetooth Low Energy(BLE) technology which can be a very good alternativesupplementing Wi-Fi access points. Their combination willallow more accurate localization. The key advantage of BLE[4] comprises low energy consumption which allows the transmitters called beaconsto be powered continuously frombatteries frommonths to years. This alsomakes it possible toplace the beacons in the spotswhere Wi-Fi access points wouldbe difficult to power.

In the field of instruction, the terms of supported consideration or carefulness are utilized to depict the capacity to keep up focus over delayed timeframes, for example, amid addresses in the study hall. Educational research is regularly centered on keeping up understudy consideration (fixation, watchfulness) amid instructing, on the grounds that supported consideration is perceived as a vital factor of the learning achievement. In any case, following of individual understudies' mindful state in the study hall by utilizing self-reports is troublesome and meddles with the learning procedure, which is likewise the situation for utilizing psychophysical information sensors. Visual perception is a non-nosy technique, and ongoing video recording and encoding can be utilized for manual consideration coding; in any case, for long haul perceptions, programmed PC vision strategies ought to be connected.

Non-intrusive visual observation and estimation of affectiveparameters is commonly using recorded video signal, for example, to estimate student engagement fromfacial expressions, to estimate mood of childrenduring one-to-one tutoring by using facial analysis, andto estimate children's vigilance from his head pose. Machine learningmethods are used to build models for automated estimation of childrenattention from facial features.

The rest of the paper is organized as noted below, Section II highlights on the previous work done in the area, Section III talks about the overall system design, Section IV & V details about the various hardware and software system in place, Section VI elaborates the implementation and feature extraction procedures, Section VII presents the results obtained and the inference made and Section VIII details the conclusion arrived and future scope of the work presented.

II. Related Work

Paper[1] is useful for tracking child and also provides theinformation where the child iscurrently located as well as italso informs the parents how long his child is far away fromhis parents. SMS services used when smart phones do notsupport internet connectivity in this case child is able tosend a text message or exact location to the parents. Thissystem is going to help the parents to track the location oftheir children without informing them because theirmovement is displayed on the parent device throughGoogle maps as well as they received calculated distance oftheir child from themselves. This application is also helpfulfor girls mostly studying or doing a job from far away fromtheir home. In case of any emergency on just one click orshake their mobile they are able to send their currentlocation via SMS to their parents. In this application parentsare able to create a Geo-reference boundary according totheir choice called Geo-fencing, at a single time multipleGeo-fences can be created. This application uses Googlemaps API to show location on map.

Paper[2] focuses on the key aspect that lost child can behelped by the people around the child and can play a significantrole in the child's safety until reunited with the parents. It isintended to use SMS as the mode of communication between theparent and child's wearable device, as this has fewer chances offailing compared to Wi-Fi and Bluetooth. The platform onwhich this project will be running on is the Arduino Unomicrocontroller board based on the ATmega328P, and thefunctions of sending and receiving SMS, calls and connecting tothe internet which is provided by the Arduino GSM shield usingthe GSM network. Also, additional modules employedwhich will provide the current location of the child to the parentsvia SMS. The second measure added is SOS Light indicator thatwill be programmed with Arduino UNO board to display theSOS signal using Morse code. The different modules stayenclosed in a custom designed 3D printed case. In thescenario, a lost child can be located by the parent could send anSMS to the wearable device which would activate the SOS lightfeature on the wearable. Therefore alerting the people around thechild that the child is in some distress and needs assistance asthe SOS signal is universally known as the signal for helpneeded. Additionally, the wearable comes equipped with adistress alarm buzzer which sets to active by sending the SMSkeyword "BUZZ" to the wearable. Hence the buzzer is loud andcan be heard by the parent from very considerable distance. Alsothe parents via SMS can receive accurate coordinates of thechild, which can help them locate the child with pinpointaccuracy.

Paper[17] presents the design and implementationof an Internet of Thing (IoT)based system for indoor localizationusing Bluetooth Low Energy (BLE) technology. Solution consists of two main systems: an acquisition systemand a central server, under the Client-Server paradigm andthe IoT philosophy. Report the development of differentmodules: measurement (Bluetooth beacons), data aggregationand transmission, storage, web-interface and cloud services fordata, and results visualization. The localization mechanism ofthe proposed system is based on a simple location algorithmstemming from the Received Signal Strength (RSS) footprintingmethod, which allows us to detect reference zones inside closedenvironments.

Paper[5] is used to determine the location of a child, the child is given a RFIDwristband before he/she enter the playground. The user identity(UID) of the wristband will be entered into a database along withthe mobile phone numbers of parents / nanny before the wristbandis given to the child. The wristband is used by the child at the timeof entry and exit by the room. Parents / nanny need to install theapplication required into the smart phone to see the room that is entered by their child. The location will be shown in real time process.

Idea of paper[10] is to utilize advanced capabilitiesof Kinect One sensor to unobtrusively collect behavioraldata ofmultiple students during attending traditionallectures in the classroom. We propose a methodology tocompute features from the Kinect data corresponding tovisually observable behaviors and to apply machine learningmethods to build models to predict attentive state ofthe individual students.

Paper[14] introduces an interactive system that discovers students’ daily moods and classroom emotions toenhance the teaching and learning process using heterogeneous sensors. The system is designed to enable detecting student’s daily moods and classroom emotions using physiological, physical activities, and eventtags data coming from wristband sensors and smart-phones, discovering association/correlation betweenstudents’ lifestyle and daily moods, and displaying statistical reports and the distribution of daily moodsand classroom emotions of students, both in individual and group modes. A pilot proof-of-concept study wascarried out using Empatica E4 wristband sensors and Android smart-phones, and preliminary evaluation andfindings showing promising results are reported and discussed.

III. Methodology

A. System Design

This system tracks the location of child using SIM 800C present in IoT. The latitude and longitude value obtained from IoT is stored in server. Authorised person can retrieve the data and view in google map. This system also gives notification to the parent in case of delayed arrival. This system also locates the indoor position of the children using iBeacon. iBeacon has two units transmitter and receiver as shown in fig.1. Receiver read RSSI value from transmitter and calculates the distance. If the distance is within the range, states child is available inside the class room. Otherwise trace the location where the child is present.

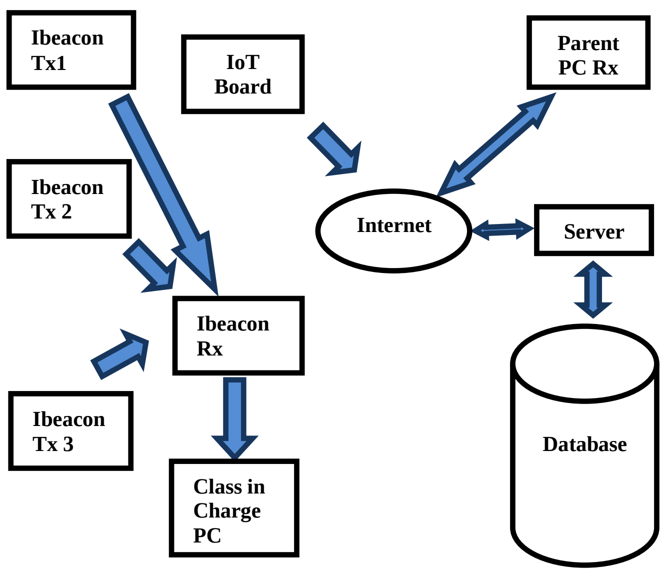


Figure 1. Architecture Diagram

B. Hardware Sysyem Design

B.1 PIC Microcontroller

PIC devices are popular with both industrial developers and hobbyists due to their low cost, wide availability, large user base, extensive collection of application notes, and availability of low cost or free development tools, serial programming, and re-programmable Flash-memory capability. The hardware capabilities of PIC devices range from 6-pin SMD, 8-pin DIP chips up to 144-pin SMD chips, with discrete I/O pins, ADC and DAC modules, and communications ports such as UART, I2C, CAN, and even USB. Low-power and high-speed variations exist for many types.

B.2 Global Positioning System

GPS is a multiple – satellite based radio positioning system inwhich each GPS satellite transmits data that allows user toprecisely measure the distance from the selected satellite tohis antenna and to compute position, velocity and timeparameters to high degree of accuracy. GPS delivers withhigh sensitivity and accuracy with low power consumption.GPS module design is flexible to accommodate various RFinterference.

B.3iBEACON

iBeacon differs from some other zone based headways as the telecom device reference point is only a 1-course transmitter to the tolerant PDA or getting contraption and requires a specific application acquainted on the device with speak with the aides. this ensures only the presented application not the iBeacon transmitter can pursue customers perhaps without needing to as they inertly walk around the transmitters.iBeacon impeccable transmitters land in a collection of structure factors including little currency cell devices USB sticks and regular Bluetooth 4.0 capable USB dongles.

C. Software System Design

C.1 PHP

Hypertext Pre-processor (or simply PHP) is a server-side scripting language designed for Web development, and also used as a general-purpose programming language. PHP code may be embedded into HTML code, or it can be used in combination with various web template systems, web content management systems, and web frameworks. PHP code is usually processed by a PHP interpreter implemented as a module in the web server or as a Common Gateway Interface (CGI) executable. The web server combines the results of the interpreted and executed PHP code, which may be any type of data, including images, with the generated web page. PHP code may also be executed with a command-line interface (CLI) and can be used to implement standalone graphical applications.

C.2 JAVA

Java is a general-purpose computer programming language that is concurrent, class based, object-oriented, and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere"(WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation. Java applications are typically compiled to byte code that can run on any Java virtual machine (JVM) regardless of computer architecture. As of 2016, Java is one of the most popular programming languages in use, particularly for client-server web applications, with a reported 9 million developers.

C.3 Java Script

JSP licenses java code and certain pre-portrayed exercises to be interleaved with static web mark-up content for instance HTML with the consequent page being joined and executed on the server to pass on a report. The amassed pages similarly as any poor java libraries contain java byte code rather than machine code. Like some other java program they ought to be executed inside a Java Virtual Machine (JVM) that teams up with the server's host working system to give a dynamic organize fair-minded condition.

D. Implementation

Proposed system consists of three units like IoT board unit, iBeacon unit and Attention analysis unit.

D.1 IoT BOARD Unit

This IoT board is utilized to discover the area utilizing GPS. It return scope and longitude esteem which is put away in server database. The GPS idea depends on schedule and the known position of GPS [13] particular satellites. The satellites convey entirely stable nuclear timekeepers that are synchronized with each other and with the ground tickers. Any float from genuine time kept up on the ground is redressed every day. In a similar way the satellite areas are known with extraordinary accuracy. GPS collectors have tickers too however they are less steady and less exact.

GPS satellites consistently transmit information about their present time and position. AGPS collector screens various satellites and illuminates conditions to decide the exact position of the recipient and its deviation from genuine time. Something like four satellites must be in perspective on the recipient for it to register four obscure amounts.

Every GPS satellite persistently communicates a flag that incorporates; a pseudorandom code (arrangement of zeros) that is known to the beneficiary; by time-adjusting a collector produced adaptation and the recipient estimated rendition of the code, the season of landing (TOA) of a characterized point in the code grouping, called an age, can be found in the beneficiary clock time scale. A message that incorporates the season of transmission (TOT) of the code age (in GPS time scale) and the satellite position around then; thoughtfully, the beneficiary estimates the TOAs (as indicated by its own clock) of four satellite signs. From the TOAs and the TOTs; the recipient shapes four time of flight (TOF) values, which are (given the speed of light) around proportional to beneficiary satellite extents. The recipient at that point registers its three-dimensional position and clock deviation from the four TOFs.

In practice the receiver position (in three dimensional Cartesian coordinates with origin at the Earth's centre) and the offset of the receiver clock relative to the GPS time are computed simultaneously, using the navigation equations to process the TOFs.As in fig.2, the receiver's Earth-Centred solution location is usually converted to latitude, longitude and height relative to an ellipsoidal Earth model. The height may then be further converted to height relative to the GEOID (e.g., EGM96) (essentially, mean sea level). These coordinates may be displayed, e.g., on a moving map display, and/or recorded and/or used by some other system (e.g., a vehicle guidance system).

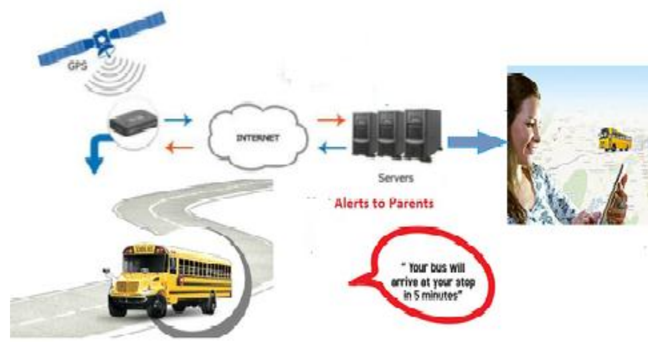


Figure 2. IoT Board Unit

D.2 *iBEACONUnit*

Indoor positioning is monitored by iBeacon. Once student enter inside the class room attendance is automatically marked as present.BLE communication consists of two main parts: advertising and connecting. Advertising is a one-way discovery mechanism. Devices which want to be discovered can transmit packets of data in intervals from 20 ms to 10 seconds. The shorter the interval, the shorter the battery life, but the faster the device can be discovered. The packets as shown in fig.3 can be up to 47 bytes in length and consist of:

- 1 byte preamble
- 4 byte access address
- 2-39 bytes advertising channel PDU
- 3 bytes CRC

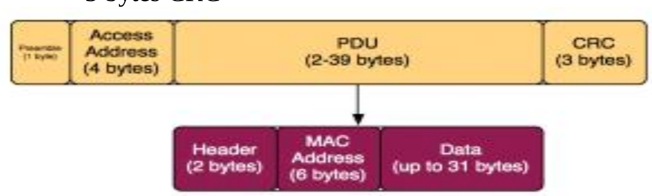


Figure 3. iBeacon Packet Format

For advertisement communication channels, the access address is always 0x8E89BED6. For data channels, it is different for each connection.The PDU in turn has its own header (2 bytes: size of the payload and its type – whether the device supports connections, etc.) and the actual payload (up to 37 bytes).Finally, the first 6 bytes of the payload are the MAC address of the device, and the actual information can have up to 31 bytes.

BLE devices can operate in a non-connectable advertisement-only mode (where all the information is contained in the advertisement), but they can also allow connections (and usually do).After a device is discovered, a connection can be established. It is then possible to read the services that a BLE device offers, and for each service its characteristics (this is also known as an implementation of a GATT profile). Each characteristic provides some value, which can be read, written, or both.

Beacons use only the advertisement channel. As the “beacon” name suggests, they transmit packets of data in regular intervals, and this data can be then picked up by devices like smartphones. Hence iBeacons are simply a specific usage of BLE advertisements, with some additional support on the iOS side.

D.3AttentionAnalysisUnit

This unit is composed of facial feature extraction stage, and emotion detection stage. The features for emotion detection are extracted from facial component in facial feature extraction stage. In emotion detection stage, the Random forest[12] algorithm is adopted to recognize emotion from extracted features and analyse the attention of children.

E. Feature Extraction for Emotion Recognition

The feature extraction method is most important key point in emotion recognition problem. The facial feature extraction stage divide the whole image into three feature region: eye region, mouth region, and auxiliary region. Several information are extracted from each region: geometric and shape information.

Table 1 shows the specific features of eye region. Eight features are extracted from eye region. Fig. 4 shows the location for features in eye region. First four features represent geometric information of eye and eye brow. Remained four features represent shape information of eye. This shape information is acquired from comparing with template. Fig. 5 shows the template for comparison.

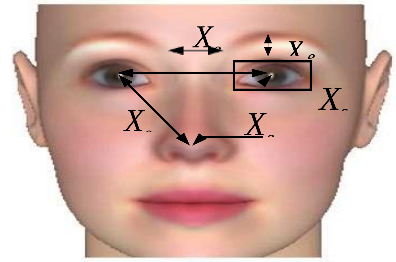


Figure 4. Position of Features in Eye Region

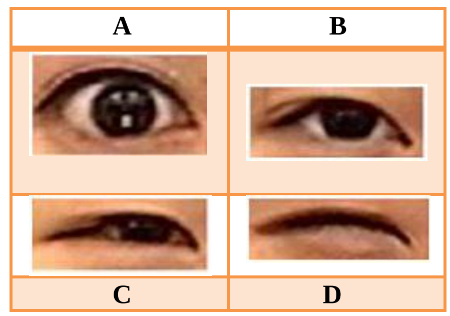


Figure 5. Eye Template for Comparison

Table 1. Featuresin Eye Region

Features	*Description*	*Size*
$Xe1$	Distance between two eye brow	1×1
$Xe2$	Distance between eye and eyeBrow	1×1
$Xe3$	Distance between nose andeye(left side)	1×1
$Xe4$	Distance between nose andeye(right side)	1×1
Xse	Error between eye and template	4×1

Table 2 shows the features in mouth region. Figure 6 shows the position of features in mouth region. There are two features for geometric information and six features for shape information. The template for comparison is shown in Figure 7.

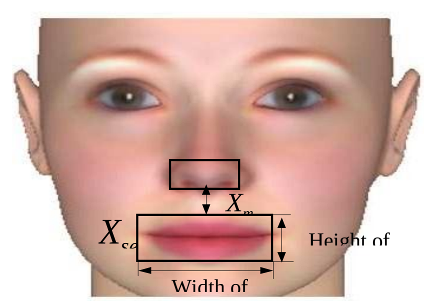


Figure 6. Position of Features in Mouth Region

Figure 7. Mouth Template for Comparison

Table 2.Features in Mouth Region

Features	Description	Size
$Xm1$	Width of mouth Height of mouth	1 × 1
$Xm2$	Distance between nose and Mouth	1 × 1
Xse	Error between mouth and template	6 × 1

Table3 shows the features in auxiliary region. If winkles exist, features have one. If winkles do not exist, features have zero. Fig. 8 shows the auxiliary region and corresponding features.

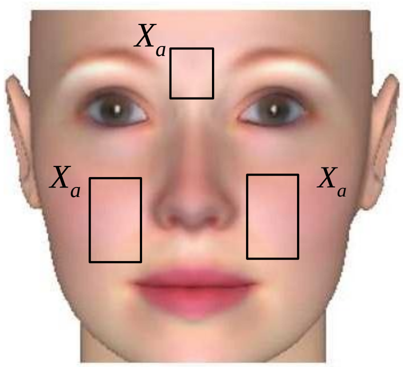


Figure 8. Position of Feature in Auxiliary Region

Table 3. Features in Auxiliary Region

Features	Description	Size
$Xa1$	Existence of winkles betweenEyes	1 × 1
$Xa2$	Existence of winkles in left Cheek	1 × 1
$Xa3$	Existence of winkles in left Cheek	1 × 1

The extracted facial features are given as input to random forest algorithm. The random forest algorithm[7] will classify into various emotions like happy, sad, neutral, disgust, surprise, angry and fear. Based on the classification attention of the student inside the class room is analysed.

In feature extraction to compare facial component image with template the following mathematical function is used.Let X_w, X_h, and Xpare width, height, and the number of pixel in image. The similarity S can be calculatedas

$$S = |X_w - T_w| + |X_h - T_h| + (X_w/X_h - T_w/T_h) + |X_p - T_p| \quad (1)$$

Where T_w, T_h, and Tpare width, height, and the number of pixel in template.

IV. Results and Discussion

Fig.9 illustrates IoT board .PIC controller on the board filters the incoming GPS data which holds repeated six packets and forwards only the latitude and longitude values (i.e.) current position of the child to database of server.

Figure 9. IoT Board

Output of IoT Board phase is obtained from server and displayed on Google Map as shown in Fig.10.

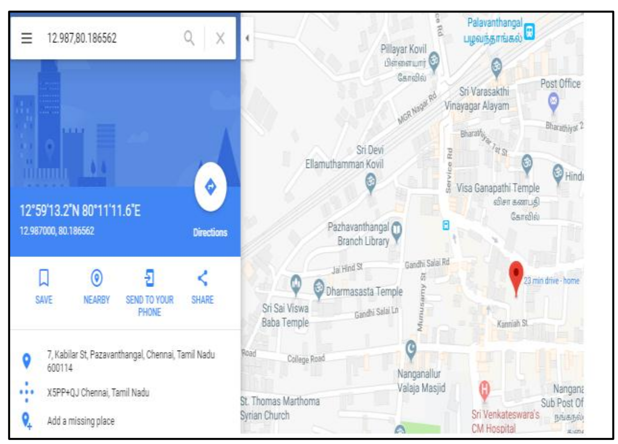


Figure 10. Google Map

In case of any delay notification is forwarded to the parent via maid id and information like distance from school and home and the time of arrival will be send to the parent.

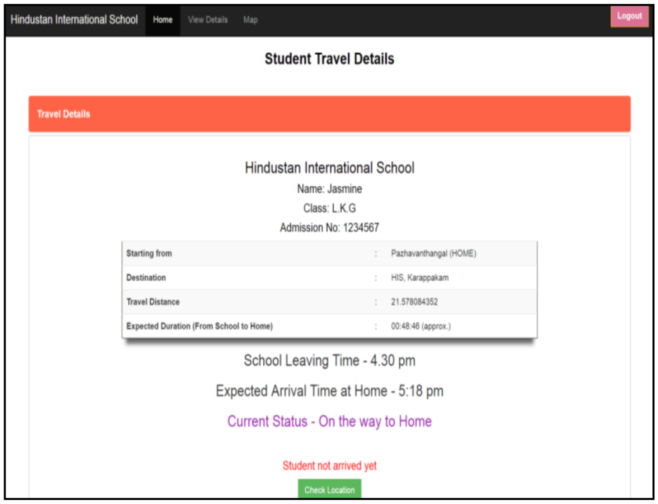


Figure 11. Notification

Attendance status and the indoor position of the children is displayed on the teacher's computer as given below in Fig. 12 and 13.

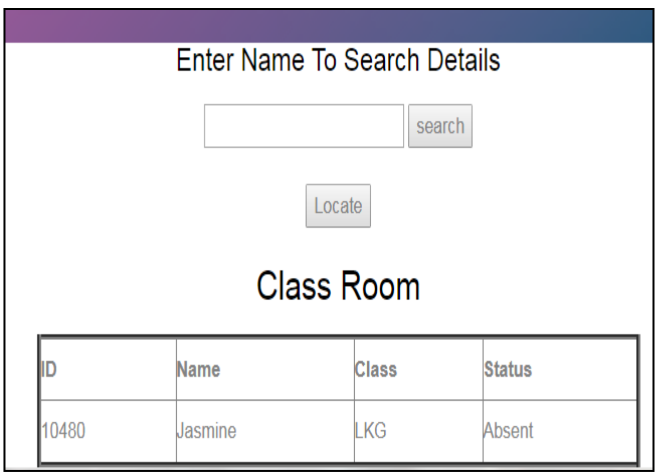


Figure 12. Attendance Status

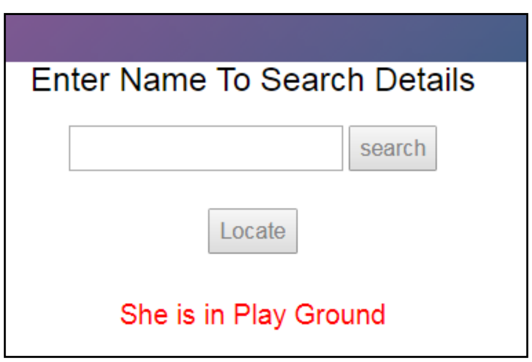


Figure 13. Indoor Location

Children emotion like happy, sad, fear, disgust, and surprise, angry and neutral during each tutoring session can be displayed as in Fig.14.

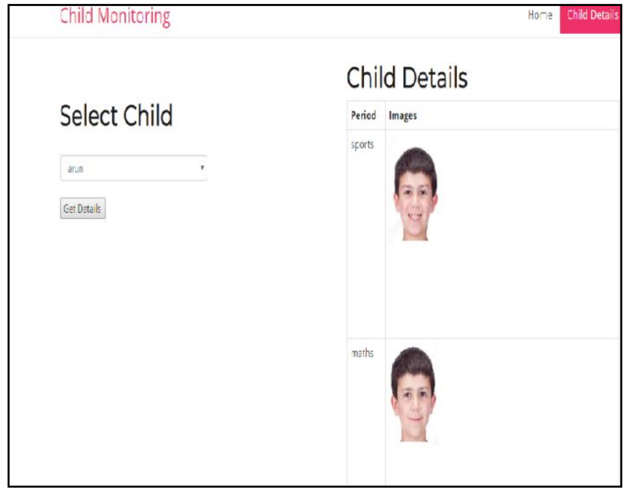
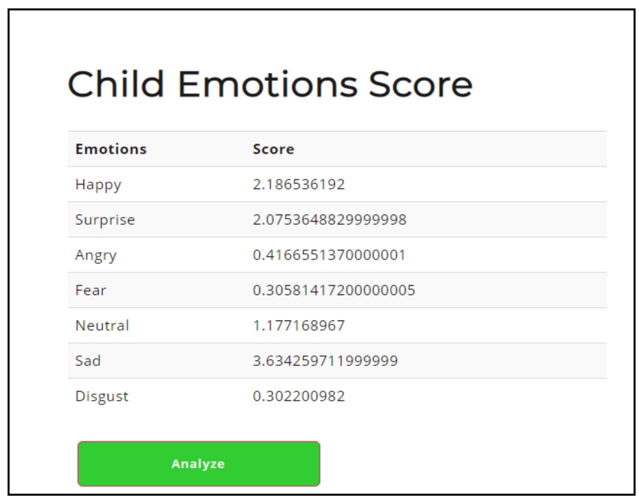


Figure 14. Children Emotion

Emotion score (Fig.15) of the children is calculated and based on this score children interested subject and not interested subject can be identified.


Child Emotions Score

Emotions	Score
Happy	2.186536192
Surprise	2.0753648829999998
Angry	0.4166551370000001
Fear	0.30581417200000005
Neutral	1.177168967
Sad	3.634259711999999
Disgust	0.302200982

Analyze

Figure 15. Emotion Score

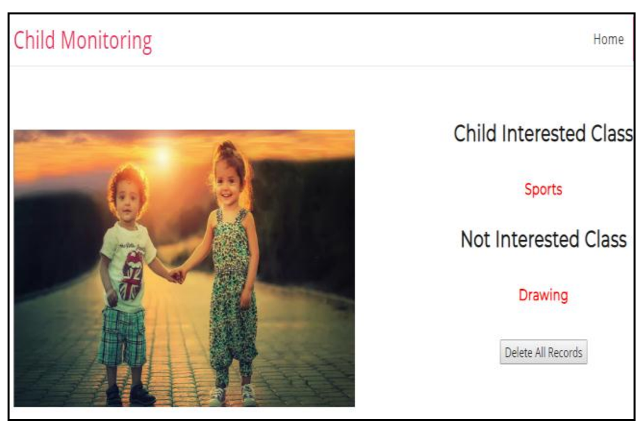


Figure 16. Attention Analysis

V. CONCLUSION AND FUTURE SCOPE

This proposed system aims at enhancing the safety ofchildren during the daily transportation to and fromschool. It sends instant notification withthe relevant data from the school database server viainternet. The parents can log into the Application andmonitor the details of their children and track thelocation of the bus. This system also focuses on the design, implementation and evaluation of an IoT-based system for indoor location using BLE technology. The general architecture proposed was composed by a data acquisition system, in charge of identifying and transferring of sensed data to a central server for further computation, .A central server is responsible for consolidating the data, transferred into a SQL database and allowing the query of historical information and location results, through a web interface. The Attention analysis provides a data visualizationfor lecturers to track classroom emotions in real-time,to enable adjusting lessons' activities in order to improvestudents positive emotions.

Like anysoftware product or design, there is still room forenhancement. Features can be added to enhance the system by sending notification based on voice. We recognize that our current experimental setupis limited to a small uncontrolled study, and in the futureit is important to address this issue in order toreliably conclude if the use of this system reflectspositively on the teaching-learning process. Besides,it will be interesting to further analyse the academic performance of the student.

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