Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 13586 - 13593
Received 05 March 2021; Accepted 01 April 2021.

Transformation of Education Rooms into Smart Environments in Post Pandemic Period using IOT

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ABSTRACT

Covid-19 pneumonia is rapidly spreading in India after America and other Western countries. Its rapidness is exponential that few of the states in India have highly been affected especially the western and southern parts. The furiousness of this pandemic has not omitted even the rural areas. Besides providing safety guidelines the government also follows mechanisms to safeguard people. The virus is asymptomatic that the spread couldn't be easily identified without testing. Due to this severity, effective classroom learning becomes a major concern. This work provides a proficient methodology during post Covid period to conduct classroom teaching through new tracking methods. The paper proposes a novel approach using Internet of Things (IoT) that can be applied in educational institutions. The work encompasses an easy tracking system of students who do not follow safety mechanisms when they are in classrooms.

Keywords
Covid-19 pneumonia, Internet of Things, Post Covid Classroom

Introduction

The Covid-19 has rapidly progressed and their causes are widely proliferated. The wide spread is mainly because of over-crowding in public areas such as markets, road side shops etc., and the movement of COVID positive cases people from one place to another place. This panic situation imposed lockdown of schools, colleges and public areas. Based on an assessment of risks to education, the schools and colleges remain closed from March 2020 after the announcement from central government countrywide shutdown. The classes are now conducted through online. Online classes pave a successful alternative to provide continuing education if it has reached every target individual. Also the classes are accessible to all part of the students who own a smart phone with proper internet connectivity. These online classes face more challenges than face to face peers. Doubts clarification, special attention to specific students, behavioral maintenance is important factors missing from online class learning. Teachers, students and parents wish to reopen the educational institutions. Prolonging lockdown cannot be extended further; hence conduct of classes with safety measures is the need of the hour.

Internet of Things (IoT) endows with a solution to this existing issue. IoT enables better connectivity and promotes better information access. It aid in performing useful analysis and is considered to be a boon in technological advancements. IoT based smart classroom can aid to conduct classes in the post Covid-19 period. The approach provides a key to college return. This entire new infrastructure offer safety classroom teaching. The classrooms are structured to handle classes for about minimum strength of students. This promotes teaching and learning with existing infrastructure and available faculty requirements for all students at a time [1].

Literature Review

Andre Gunther et. al. [2] introduced an approach to measure distance between nodes in wireless LANs using the round trip times. An extraordinary investigation was made on computing the difference in time between sending and receiving a data packet. The distance was estimated based on the delay incurred on propagation of data packets. Statistical methods were used to resolve low time resolution time issues.

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Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 14105 - 14112
Received 05 March 2021; Accepted 01 April 2021.

Hosik Cho et. al [3] contributed a work on measuring calculating the distance between a mobile hand set and an internet enabled device using Bluetooth Low Energy profile. RSS based distance estimation was performed with the help of iBeacon that could offer away the status as near or far. A self correcting beacon was proposed to alleviate minor errors in calculating distance that occur due to other factors such as noises and environmental disturbances.

Masaaki Namekata et. al. [4] developed a method for finding the distance between two mobile devices. Though RSSI provide a descent solution, it cannot yield an optimal value due to transmission delay. The authors proposed a new approach that calibrates distance based on angle of placement of the devices and relocation distance. The provided a heuristics method of arriving the distance with very less error.

Douglas J. Leith et. al. [5] proposed a proximity detection of corona virus contact tracing using Bluetooth low energy signal strength. The paper evaluates the Bluetooth low energy signal strength and arrives a scenario based approach in detecting proximity. The authors chose orientation of mobile device, absorption or reflection of radio signals as attributes and measure the signal strength. While the distance increases between mobile handset, the signal need not decrease. Beacon technology is used in estimation of distance is based on the location of the handset. Machine learning techniques help in deducing the distance data based on signal strength received.

Meryem Saadoune et. al. [6] developed a model that could compute distance in ad hoc networks. The approach performs route discovery process between source nodes and sink nodes, finds alternate routes and deletes undesired routes. The paper focused on evaluating the mobility of nearby nodes and thereby improvising the decision of every node. The evaluation of distance was carried out using (Received Signal Strength Indication) RSSI algorithm based on the transmission and receiving power, gain of the antennas, distance between the antennas and wavelength.

Proposed Methodology

In this “Live with COVID era”, people undergo an unpredictable tough situation to tackle their needs. Though government imposes several guidelines to restart every sector during this pandemic, Education sector remains passive. Several video conferencing ICT tools like Google Meet, Zoom and Webex applications aid in facilitating the students to attend classes through online. Government has also launched many radio and television channels to perform uninterrupted learning. Though several alternatives are available as stated above, online education have failed miserably in making every individual student understand the concepts delivered. It becomes a critical issue of making the student attend online classes at home. Besides the educational institutions provide teaching and learning facilitations, it is the responsibility to provide edification. Social relationships and peer-to-peer interactions promote good culture and well being [7].

IoT based Post Covid Classroom Design

To implement classroom teaching during post COVID-19, student safety enabled smart classroom becomes needy. To start with, students of a class are divided into two groups namely, A and B. To tackle the infrastructure based issues, the groups attend classroom teaching on a day and online teaching on the other day. Thus, a group visits the institution on alternative days of the week. We propose a novel classroom management system to facilitate teaching without the spread of the pandemic as given in figure 1.

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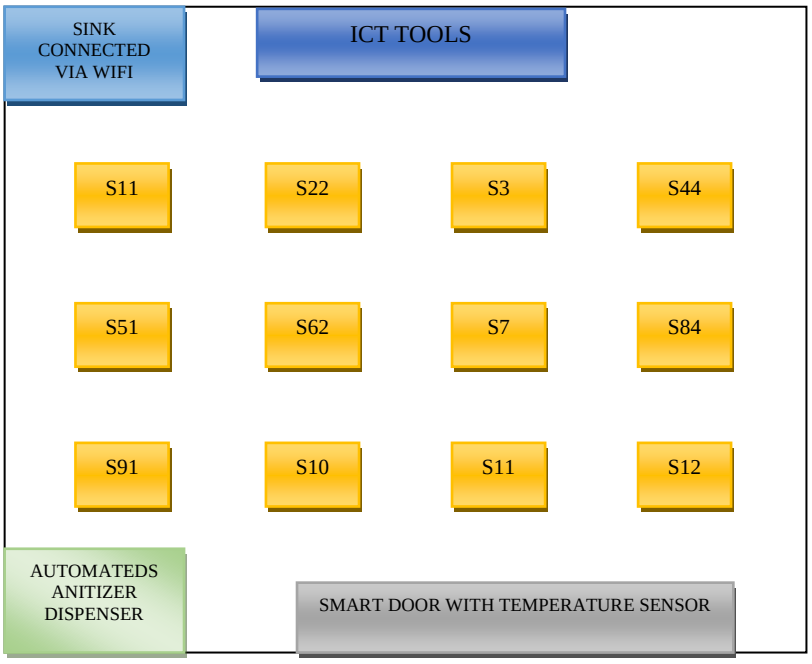

Figure 1. Notion of smart-classroom

We model the proposed smart classroom using wireless sensor networks with Internet of Things. The classroom is managed with a temperature sensor embedded in the smart door. A proximity sensor based sanitizer dispenser is provisioned at the entry point of the classroom. Seating is arranged for students with proper social distancing of about 1 to 2 meters apart.

Classroom Entry Module

Once a student gets in the sensor reads his temperature and performs a conditional decision making using fuzzy logic. A camera implanted in the smart door recognizes the face of the student. The output of the camera is fed to the face mask detector application that identifies whether the student wears a mask or not using its trained data set.

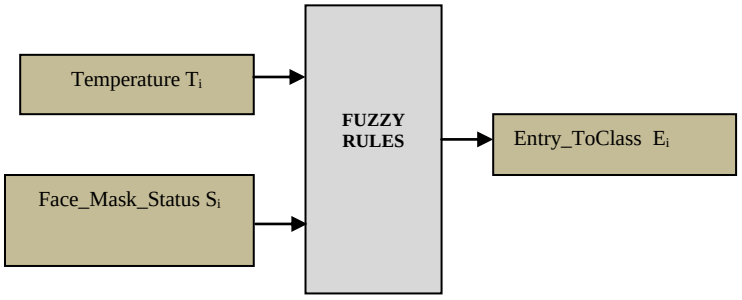

Figure 2. Fuzzy System

Based on the output of face mask detector and the LM35 temperature sensor data, fuzzification take place as shown in table 1 and 2. With the data available in table 2, a student with normal temperature and wearing mask shall be allowed to enter the class.

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Table1. Input Function to Fuzzy System

Variables	Values	
Temperature, T_i	Normal	High
Face_Mask_Status, S_i	Yes	No

Table 2. IF...THEN rules for Entering the Class

Temperature, T_i	Face_Mask_Status, S_i	Entry_ToClass, E_i
Normal	Yes	Yes
Normal	No	No
High	Yes	No
High	No	No

Automatic Sanitizer Dispenser module

After entering the class, the ward is supposed to wash hands using automatic sanitizer dispenser developed using proximity sensor. The Ultrasonic Distance Sensor Module HC-SR04 enables the dispenser to flush out the hand rub if an object (hand) is present at a distance of within 20 cm from the dispenser. To expel optimal quantity of sanitizer, a 12V peristaltic pump is utilized, just below the sensor. The sensor and pump are attached to an Arduino UNO board to enable a centralized control as shown in Figure 3.

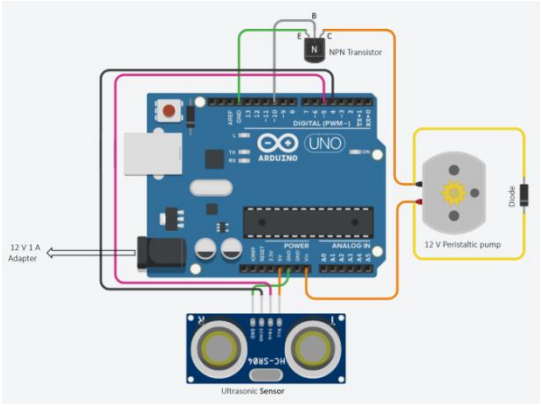

Figure 3. Sanitizer Dispenser using Arduino UNO Board

The proximity sensor module sends IR waves to detect an object. The sensor is connected with the sanitizer that it dispenses sterilizer liquid upon detecting the hands underneath.

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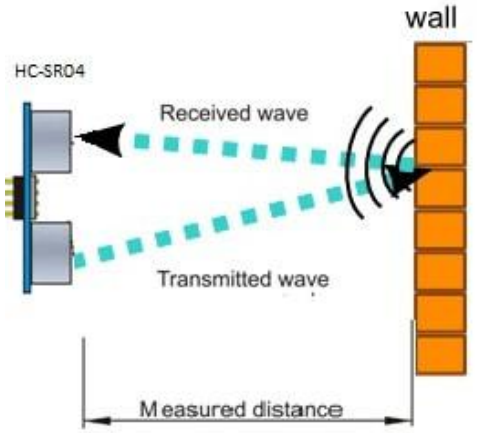

Figure 4. Proximity Sensor – HC-SR04

Code to enable Automatic Hand Sanitizer Dispenser

```
int distance;
long duration;
void setup()
{
  pinMode(4,INPUT);        // defining pin modes
  pinMode(5,OUTPUT);
  pinMode(10, OUTPUT);
}
void loop()
{
  digitalWrite(5,LOW);
 delayMicroseconds(2);
  digitalWrite(5,HIGH);
  delayMicroseconds(10);
  digitalWrite(5,LOW);
  duration=pulseIn(4,HIGH);
  distance=(duration*340/20000);
  if(distance<=20)
  {
    digitalWrite(10,HIGH);
    delay(250);
    digitalWrite(10,LOW
    delay(2000);
  }
  else
  {
    digitalWrite(10,LOW);
  }
}
```

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Social Distancing Detector Module

The social distancing detector module uses Bluetooth signal in the handheld device of the student to compute the distance with any other students. A student gets exposed with an infected person based on the distance with the infected one. As social distancing module detects the distance between students and will notify through a message, when the students are not in a distance of 1metre or 3 feet apart.

Based on inverse square law, distance is inversely proportional to signal strength of electromagnetic signals [8]. In free space, the relation between distance and signal strength is determined using equation 1.

$$d = 20^{(RSSI + a)} \text{ -- (1)}$$

where, RSSI is received signal strength indication and a is To calculate the distance between two devices we use equation 2.

$$\boldsymbol{d} = \sqrt{\frac{P_t G_t G_r \lambda^2}{4\pi^2 L P_r}} \text{ -- (2)}$$

where, P_t and P_r denotes the transmitting and receiving power of the antennas of two devices, G_t and G_r being the Gain of the transmitting and receiving antennas, λ being the wavelength of the signal and L is the loss factor of the system. Once the distance is found to be less than 1 meter, a notification is send to the self and the class tutor indicating the distance violation parameter in attending class.

Implementation

Arduino IDE is used to implement the aforesaid scenario using C++ programming. To implement the social distancing module, RSSI value is required. To measure RSSI, the following code is used.

```
//For Bluetooth
#include <ArduinoBLE.h>
.
.
.
BLE.scan();
BLEDevice peripheral = BLE.available();
if (peripheral)
{
   rssi_value = peripheral.rssi();
}
//For WiFi
#include <WiFiNINA.h>
#include <SPI.h>
#include <Vector.h>
.
.
.
const int SSID_COUNT = 25;
Array<int,SSID_COUNT> rssi_array;

int num_ssid = WiFi.scanNetworks();
for (int i = 0; i < num_ssid; i++)
{
   rssi_array.push_back(WiFi.RSSI(i));
}
```

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Using the measured RSSI value, distance can be computed using equation 3.

$$d = \mathbf{10}^{((\mathbf{A} - \mathbf{RSSI}) / \mathbf{10} * \mathbf{P})} \text{ -- (3)}$$

where,
d is the distance to be computed,
A is the signal strength received and
P is the path loss index.

The Arduino code is as below.

```
const int trigPin = 9;
const int echoPin = 10;
int distance;
char smsNum[20];
void setup()
{
Serial.begin(9600);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(11,OUTPUT);
pinMode(12,OUTPUT);
}
void loop()
{
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
float r = (M_Pwr - RSSI)/(10 * N);
Distance = pow(10,r);
Serial.println("Distance: ");
Serial.println(distance);
if(distance < 100)
{
  char txtMsg[200];
  readSerial(txtMsg);
  Serial.println("Message:");
  Serial.println(txtMsg);
  sms.beginSMS(smsNum);
  sms.print(txtMsg);
}
}
```

Conclusion and Future works

In this proposed work, a smart post Covid classroom design is exhibited. Here, we first introduced a novel approach using Internet of Things to conduct classes to students physically in classrooms. The work portrayed a new picture on easy tracking mechanism among students who don't follow social distancing. We obtained distance between two mobile devices using RSSI technique. Arduino IDE enables detection of distance and verifies it with threshold value, say less than 1 meter. When the threshold limit is reached, a message is notified to the class tutor. In future, a better distance tracking mechanism for distributed environment is to be found out.

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