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IoT-based Smart Campus Monitoring Based on an Improved Chimp Optimization-Based Deep Belief Neural Network

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ABSTRACT

The application of IoT in monitoring the smart campus is an inevitable one to monitor the attendance of students and monitoring other activitieson the campus to protect the students and improve the education standards. Most education institutes use smart classrooms to achieve the aforementioned quality and we propose a Bluetooth-enabled IoT smart system for the positing of students with low energy utilization to automatically record the students' attendance in the cloud environment by the Received signal strength indicator (RSSI). To achieve this we propose a novel IoT-based Deep Belief Neural Network (DBN) based Improved Chimp Optimization algorithm (ICO) for positioning of the students'. An experimental study is conducted on Raspberry Pi with the deployment of Python and shows that our proposed approach provides better accuracy even with high interference signals.

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1. INTRODUCTION

The environment that carries the information by the electronic devices [1] such as sensors carries numerous information by using the wireless network to execute the application from the networked system decreasing the isolated systems. The networked system carries the information from a pair of wireless networks [2] directly communicating with the sensor network and processes and manages the data. In this world, communication enables the selector to manipulate sensors with smart, physical, and connectivity terms for communication purposes [3]. The selector collects the information from electronic devices such as physical devices, sensors, microcontrollers, and processors to contribute to the fundamental changes to execute different industrial and business functions. Various applications implemented by the Internet of Things [4] are retail, transportation, supply chain management, healthcare, automotive, and aerospace. The wireless objective can detect the tags to link with digital objects and store the data to share the tag as the reader. The multiplicity, size, and applications are the classic network for the evolution of the Internet of Things to elaborate the communication system of both individual-to-machine and machine-to-machine systems [5]. The networks that connect the computer with an arithmetic connection transmit the network system wired and wireless networks. Nowadays smart campuses [6] are popular and executed to form an isolated array and the information is separated to form an information island to assemble the information by the smart campus system.

The construction of the campus is increased and also the usage of mobile applications is increased by elaborating the structure and features of the campus system in construction in a wide area. The new age of generating the digital system [7] in various organizations is identified and developed by monitoring and tracking the network. The most essential part of campus management is the smart campus to execute the campus more interesting in the disciple of lessoning the class in the campus management to listen to the disciple in an attentive manner. All the disciples are very much attentive in listening to the class on the smart campus in the digital format with more interest and satisfaction. The technology [8] brings a conditional vault in implementing the education industry to generate a constant campus, intelligent model. The infrastructure in the smart campus is well organized for future generation educational systems. The infrastructure produced for global cities provides the basic feature for implementing smart cities. The growth of the smart campus is increased to transfer the entire campus in digital format. The disciples can able to interact with the organization to modify the study of nature in implementing the campus in a digital system. The advanced digital system [9] is connected to support and encourage the smart system and maintain the technology to construct the system to a certain extent. The digital system is developed in various organizations for service, management, information, and effects of multiple teaching processes. The education system is executed all over the world and now the education system is completely changed by digital format for campus portal, network, finance, management, research, and information management. The applications are practical in constructing the information system in an effective manner in various organizations, schools, and infrastructures. The electronic system accumulates massive data and is applied in the communication networks to execute the smart campus information. It can adjust the system by modifying the educational system to learn and develop by interacting with the disciple to learn with smart organization. The efficiency, experience, and education are enhanced.For the smart campus, it is necessary to track the location of the students to avoid malpractices. Hence in context with this, we exploited BLE technology which consumes low energy for indoor tracking by obtaining the RSSI value. However, achieving error-free service is difficult indoors due to the large interference and hence we proposed IoT based approach which combines both the fingerprint algorithm and DBN-based ICO algorithm. The recording of attendance can be accomplished with the aid of the server module and the position tracking can be acquired by the DBN-based ICO algorithm, in which the ICO is used to optimize the exact location of users obtained after the DBN approach. the major contributions of our approach are listed below,

- The attendance of the students is recorded by receiving the RSSI value of the students' devices. Based on the strength of the signal also we can identify the location of the students.
- The collected data are stored in the cloud database so that only the authorized user can edit or make changes and others can access the data and are permitted to make any variation and thus enabling the trusted environment.
- The DBN approach is used to track the positioning of the students and the outcomes are optimized with the adoption of the ICO algorithm.

The rest of the work is organized as follows, in section 2 the literature review of the relevant works is made and highlighted the important points regarding it. The background of the technologies is elaborated ins section 3. The proposed system model is stated in section 4. The proposed location tracking framework based on the DBN-ICO is elucidated ins section 5. The result and discussion section along with the experimental setup are explained in section 6. Finally, the work is summarized in section 7.

2. LITERATURE SURVEY

Zhou et al. [10] have described wireless video surveillance systems based on the internet of things. The devices are network congestion suppression, codec rate coordination, and zero-copy buffer devices. The processing power is increased and the terminal load is decreased becomes the zero-copy buffer devices. The multi-camera fusion is the optimization of tracking wireless video surveillance systems. The flexibility is increased and also decreases the complexity, redundancy, and optimized amount of data. However, the quality and performance should be achieved for other different types.Shahroz et al. [11] have presented a smart shopping cart based on the Internet of Things utilizing Radio Frequency Identification. The product's information is efficient to tag and reads every single product appearing in mobile applications. The needs of the customer are satisfied by preferring the required list of the product and within a period the information is carried to the server to schedule the product. The proposed method is flexible, easy to shop the product within the required money, and efficient. Thus, it is implemented on an industrial scale in this real-life structure.

Spachos et al. [12] have implemented Bluetooth Low Energy (BLE) Beacons to provide cultural content based on smart museums. The location of the museum is evaluated by a strength-based technique for receiving the signal. The guidance is provided to the user to accumulate useful information for analyzing the distance in developing the application. The errors are reduced to enhance the estimation for the entire application in distribution areas. It is simple and scalable, the installation cost is simple, and the cost is less for various sizes in the museum. Hence, the guidance regarding various collections should be improved.For security defenses, Lounsis et al. [13] highlighted short-range communication technology based on the Internet of Things. The technology used for wireless communication is Bluetooth, ZigBee, Wi-Fi, and Radio Frequency Identification. The proposed method is considered the wireless technology to detect the attacks. A numerous number of attacks are reduced while the authentication is implemented by the security services. Moreover, a long-range wireless technology is classified for large-scale applications. Sadowski et al. [14] suggested a Received Signal Strength Indicator (RSSI) for indoor localization based on the Internet of Things. Indoor localization is compared with various wireless technology such as long-range wide-area networks, Wi-Fi, Zigbee, and low-energy Bluetooth. An online facility is available for the proposed system to receive every modality for localization. The accuracy is more, reduces errors, and uses lower power. However, the optimized performance has not been obtained. Feng et al. [15] have demonstrated a design of an intelligent bus system based on the Internet of Things to increase bus operations and dispatch and also generate a smart campus system. The application, network, and perception layers are the three-tier layer to implement the proposed method by using the technology it can detect, find, and the path of the buses. The bus stops are computerized to declare the information where the user remains and when the bus reach. It is efficient, and attentive, suitable, and the quality is enhanced in the bus system. However, the scheduling of bus issues is solved by another multi-task system. Liang et al. [16] describe a real-time monitoring system for medical data based on a smart campus to detect and transmits correct medical data. The information is accumulated to use the cache technology and the protocols are used to format, transmit, and convert the data from the system client. The Android and PC clients execute the real-time detection for the environment to capture the required information. The infected management level is enhanced and identified in each hospital based on a smart campus. Moreover, the quality should be increased in medical services.Guo et al. [17] have presented a campus-based automatic settlement control system based on the Internet of Things. The components are computer access, consumer management, and library detection for automatic construction. The system of each organization executes and structures the systems. The proposed method is flexible, reliable, safe, and efficient. Thus, digital campus construction is verified for other control systems. For the education system, Revathi et al. [18] have described the Internet of Things based on the integration of the cloud in the teaching process. Online portals are helpful to write exams and assignments for the disciple and digital devices can identify the disciple not attending the class and regular activities done by the disciple. It is effective, economic, and efficient in traditional education. Hence, network technology should be enhanced for data transmission in smart education.

3. BACKGROUND

This section presents the background of the proposed attendance monitoring system in the smart campus environment. It also provides better details about indoor positioning, and adoption of Bluetooth technology. Tracking students' location inside the classroom is one of the important tasks while monitoring attendance and several approaches are available to achieve this. GPS, RFID, Magnetic sensors, Wi-Fi, and Bluetooth Low Energy (BLE) [23]. Of these, BLE is cost-effective and user-friendly and anyone can handle it with little technical knowledge [24]. The energy-saving features of BLE can provide long-lasting services with personal devices. Hence we adopted BLE technology for the positioning tracking of the students. The reasons behind the utilization of the Bluetooth system are [25]:

- It is a commonly available service in smartphones, wearable devices, smart watches, and Bluetooth tags.
- With the utilization of low power, the data are transmitted.

4. SYSTEM MODEL

The system model of our proposed IoT-enabled Bluetooth-based smart campus includes two parts (i) The prototype that includes general classroom attendance, and (ii) the Integration of IoT-based supporting measures which operate daily for the proposed smart classroom. The former one relies on the smart classroom project and is designed as per our prototype. The latter one is to design the smart classroom along with the suitable rules that are to be implemented. Our study utilizes Bluetooth signals and the devices are connected technically and form IoT nodes. The user devices are connected to the main device and by accessing the signal from Bluetooth it will track the location and identity of the IoT user. The IoT smart devices are used as positioning systems in the BLE indoor area. The information of IoT node locations is automatically upgraded to the system. The collection of IoT users i.e., students' location is the main aim to monitor attendance and our proposed system automatically evaluates the location of the students available in the smart classroom. The collected information is directly transferred to the interface that is used by the professor/teacher to make decisions and examinations. With this approach, we can register the attendance of students at any time with their exact location. The main application of this type of system is to record the attendance and location mapping in a large classroom with more students. The proposed system model is illustrated in Figure 1. The students' identities are defined with the Bluetooth signals from the IoT devices of students along with the identification details (Media Access Control address).

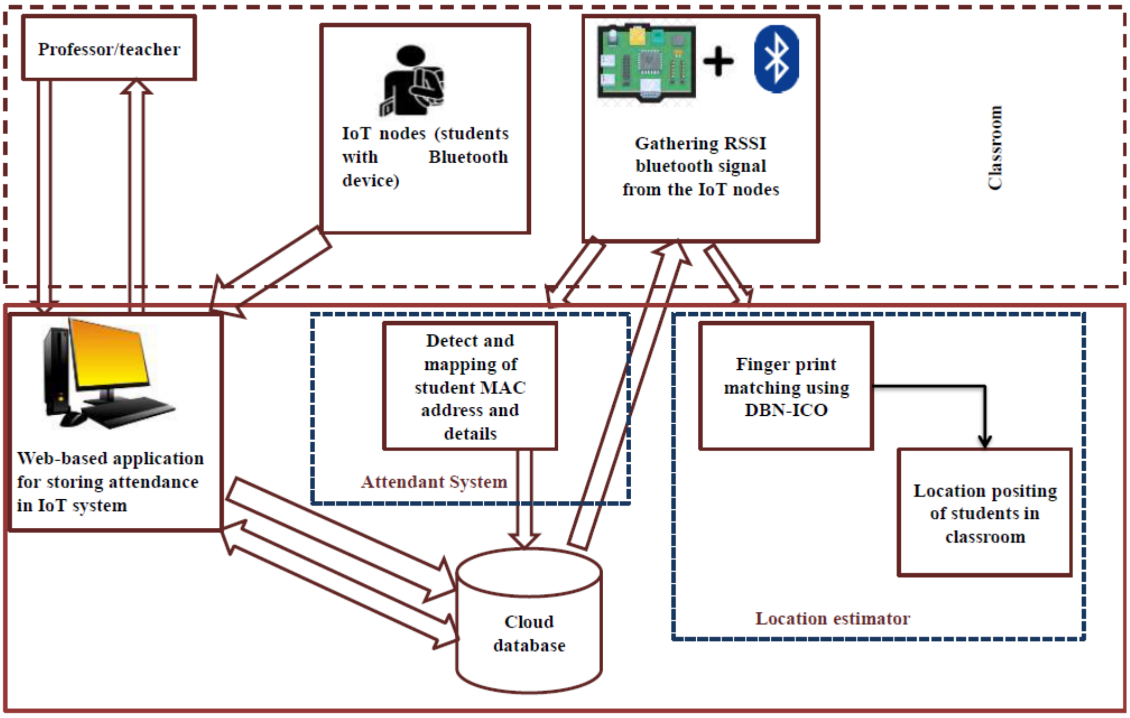


Figure 1. IoT-based smart attendance monitoring system

The sensors employed in this work are based on Raspberry Pi-based BLE Bluetooth stations which are used to gather the RSSI signals from student IoT nodes. the received signal can be utilized to find the location of the student IoT node. Based on the collected MAC address of the student the messages are forwarded. The registered IoT nodes of the students are recognized while it enters the classroom. The Bluetooth station node forwards the MAC address to the cloud system where the data get stored for further use. Prior to this process, the location is predicted based on the signal strength. The proposed system model includes, (i) server-side IoT module, (ii) Bluetooth station module, and (iii) client-side IoT module.

4.1. Server-side IoT module

The Bluetooth station module that is a Bluetooth sensor is installed in the smart classroom as per our design system. with the help of HTTP (hypertext transfer protocol) the RSSI signals are accessed. Moreover, the attendance system follows two major modules such as (i) the attendance recording module and (ii) the positioning calculation module. The former uses the web application and the latter uses python for the training of DNN for the estimation. This module is designed using the Raspberry Pi (RPI3 Model B with Raspbian kernel 4.4.38-v7) with the python programming embedded with the Bluetooth USB dongles. The RSSI signals from the IoT student nodes are gathered periodically along with the MAC address and the strength of the signal prior to the submission in the server module. followed by the positioning of students in the classroom. The client-side IoT module consists of the mobile phones of students with enabling and visible Bluetooth services. the attendance of a particular student can be registered by scanning the nearby devices and accepting the RSSI value.

4.2. Proposed IoT-based Attendance mechanism

Based on the signal strength of the Bluetooth the students' attendance is registered on the cloud platform [26]. The RSSI signal from the user node can be read in the inquiry or discovery mode. Hence there is no need to connect the source IoT node and destination node and the Bluetooth devices that are in the range of the IoT system are connected and access its RSSI value. Moreover, Python programming is used to deploy the Bluetooth station module. The working mechanism iselucidated in Figure 2.

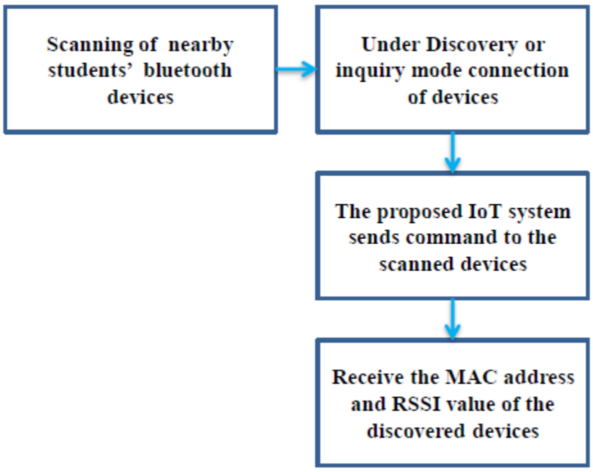


Figure 2. Working mechanism of proposed attendance recording

5. Proposed Structure for the estimation of the position based on DBN-ICO

This section presents the structure for the estimation of the location of the students from the received RSSI value. Since there are numerous signals and occurs interference, we need a deep learning approach to differentiate the positioning of students. For this, we adopt a novel DBN-based approach, however, to achieve better location positioning we have adopted an optimizer known as ICO which enhances the parameters of the DBN.

5.1. DBN

The generative technique DBN is composed of stacked RBMs that can be used for layer-wise training and hence used for the unsupervised learning approach [19]. in our approach, the location of the students can be positioned with respect to the RSSI value that is obtained from the IoT-based Bluetooth stations installed in the classrooms. The adopted DBN follows fingerprint localization since managing the interference environment is difficult and this method provides a better estimation of locations. Meanwhile, there is no need to provide reference IoT node locations in the indoor environment to the positioning system. the gathered information from the fingerprint database can be interpolated by the IoT-based system to map the coordinates from the IoT nodes and available multi-dimensional fingerprint space. The proposed approach followings two stages of pattern matching (i) designing of radio map (signal strength analysis over the classroom) and (ii) positioning phase (estimates the area of the transmitter to be reported in the database). The former one takes place offline and the second is a real-time application i.e, online. The second stage can be performed by using our proposed DBN-based ICO approach.

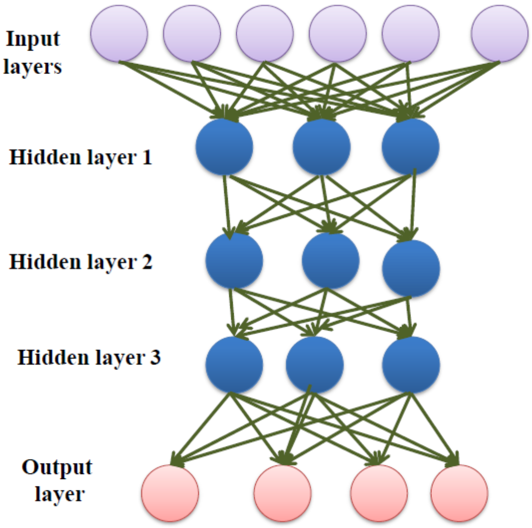


Figure 3. Location estimator structure using the proposed DBN

The estimation of correlation between the RSSI samples and locations is made by our proposed approach. the structure of the location positioning by the proposed DBN-based ICO is illustrated in Figure 3. We have taken six RSSI values as input that are received from the reference points of Bluetooth and the RBMs show the hidden layers and the output (location of the users) is obtained from the output layer.
The Proposed DBN approach access better correlation between the RSSI samples and locations, however, it is arduous to achieve optimized correlation, and hence for this purpose, we adopted the ICO algorithm which is elucidated in the following section.

5.2. Improved Chimp Optimization (ICO) algorithm:

Khishe and Mosavi et al. [20] suggested the metaheuristics algorithm-based swarm intelligence called Chimp Optimization (CO) algorithm, which is working on the principle of chimp hunting behavior. The following section displays the mathematical model of the CO algorithm. The chimp position updating is delineated as follows:

$$Y_1(i+1) = Attac\,ker(Y(i)) - A_1 \cdot Attac\,ker_D \tag{1}$$

$$Y_2(i+1) = Barrier(Y(i)) - A_2 \cdot Barrier_D \tag{2}$$

$$Y_3(i+1) = Chaser(Y(i)) - A_3 \cdot Chaser_D \tag{3}$$

$$Y_4(i+1) = Driver(Y(i)) - A_4 \cdot Driver_D \tag{4}$$

$$Y\_Chimp\ (i+1) = (Y_1 + Y_2 + Y_3 + Y_4)/4 \tag{5}$$

From the above equations, the current iteration is represented as$i$. Where, $Attacker(Y)$, $Barrier(Y)$, $Chaser(Y)$ and$Driver(Y)$ are the four kinds of positions, which updates the chimp position. Equation (6) to (9) expresses the vector *D* and the dynamic coefficient *A* [21].

$$A_1 = 2 \cdot F_1 \cdot R_1 \cdot F_1, Attac\,ker_D = |C \cdot Attac\,ker(\,i) - M \cdot Y(i)| \tag{6}$$

$$A_2 = 2 \cdot F_2 \cdot R_1 \cdot F_2, Barrier_D = |C \cdot Barrier(i) - M \cdot Y(i)| \tag{7}$$

$$A_3 = 2 \cdot F_3 \cdot R_1 \cdot F_3, Chaser_D = |C \cdot Chaser(i) - M \cdot Y(i)| \tag{8}$$

$$A_4 = 2 \cdot F_4 \cdot R_1 \cdot F_4, Driver_D = |C \cdot Driver(i) - M \cdot Y(i)| \tag{9}$$

Normally decrease the coefficients *F* from 0 to 2.5. Where, $C = 2 \cdot R_1$or $C = 2 \cdot R_2$in which the value of [0, 1] is the random interval of R_1andR_2. Let us assume, the position updating is performed using the chaotic model when the probability δ is a random number interval of [0, 1] or$\delta \geq 0.5$.

$$Y_{Chimp}(i+1) = ChaoticValue \tag{10}$$

(i) Polynomial mutation based on extremely disruptive:

When the variable is on the boundary, the mutation contains no effect, common mutation operators, for the traditional polynomial mutation [22]. The following equation expresses the model of the operator.

$$Y_{New} = Y + \chi_K \cdot (B_u - B_l) \tag{11}$$

Based on the search space, the upper and lower bounds are $B_u$and B_l. The offspring and their parents are Y_{New} and Y. The below equations calculate the coefficientχ_K.

$$\chi_1 = \frac{Y - B_u}{B_u - B_l} \tag{12}$$

$$\chi_2 = \frac{B_u - Y}{B_u - B_l} \tag{13}$$

$$\chi_K = \begin{cases} [2R + (1-2R)\cdot(1-\chi_1)^{\eta_M+1}]^{\left(1/\eta_{M+1}-1\right)}, if R \leq 0.5 \\ 1 - [2(1-R) + 2(R-0.5)\cdot(1-\chi_2)^{\eta_m+1}]^{\left(1/\eta_m+1\right)}, Else \end{cases} \quad (14)$$

The mutation index η_M and the random number *R*. The candidate solution diversity maintenance is a major advantage.

(ii) Correlation coefficient Spearman's rank:

The statistical correlations among the two series are measured with the help of a non-parametric index called Spearman's rank correlation coefficient. The series dimension is *N*.

$$\vartheta = 1 - \frac{6\sum D_j^2}{N\cdot(N^2-1)} \quad (15)$$

(iii) The operator of the beetle antenna:

The below equation explains the normalized model of random vector direction $\vec{A}$.

$$\vec{A} = \frac{R(SD,1)}{\|R(SD,1)\|} \quad (16)$$

Where $\vec{A}$ is the search space dimension and based on the antennas, the right and left areas that are explored via the beetle, are simulated via two search behaviors.

$$Y_R(i) = Y(i) + D(i)\cdot\vec{A} \quad (17)$$

$$Y_L(i) = Y(i) + D(i)\cdot\vec{A} \quad (18)$$

The beetles' original position is *Y* in which the right and left areas of position explorations are Y_R and Y_L. The distance between two antennas is *D*.

$$D(i) = \frac{\chi(i)}{D} \quad (19)$$

Where $D = 2$. The attenuation and the step size are *D* and χ. The below equation calculates χ.

$$\chi(i) = K\cdot\chi(i-1) \quad (20)$$

Equation (21) expresses the new position updating model depending upon the above search behaviors.

$$Y(i+1) = X(i) + \chi(i)\cdot\vec{A}\cdot Sign\left(F\left(Y_R(i)\right) - F\left(Y_L(i)\right)\right) \quad (21)$$

The sign function is $Sign()$. Furthermore, the flowchart representation of the ICO algorithm is illustrated in Figure 4.

6. RESULT AND DISCUSSION

This section evaluates the reliability, validity and performance of the proposed method. Various kinds of techniques are used to determine the efficiency of the proposed model. Both hardware specifications such as Raspberry Pi (RPI 3 Model B V1.2) and equips the Student mobile phone with Bluetooth and Tags and also software specifications such as Google Excel Sheet that resides in the cloud are used. The peripheral device with the computer needs a particular I/O port. In the classroom, install the Bluetooth sensors and the user contains smart devices and the indoor environment is BLE. The model of the hardware setup is displayed in Figure 5.

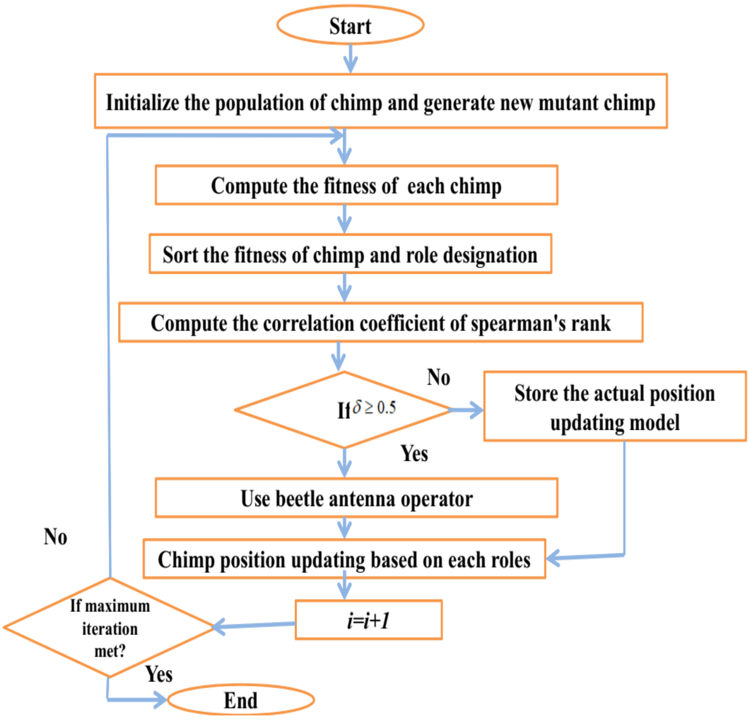
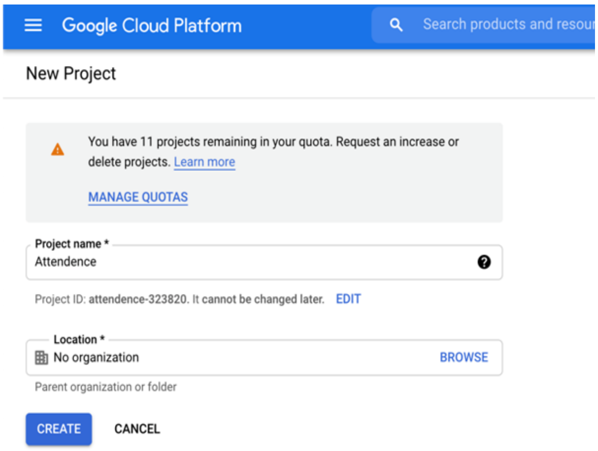


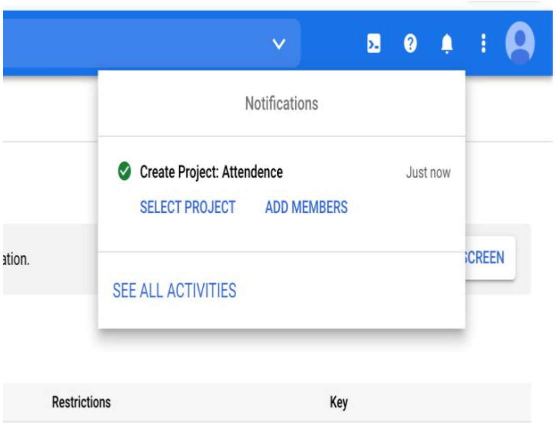
Figure 4. Flowchart representation of ICO algorithm for the optimization of location estimator

Figure 5. The model of hardware setup

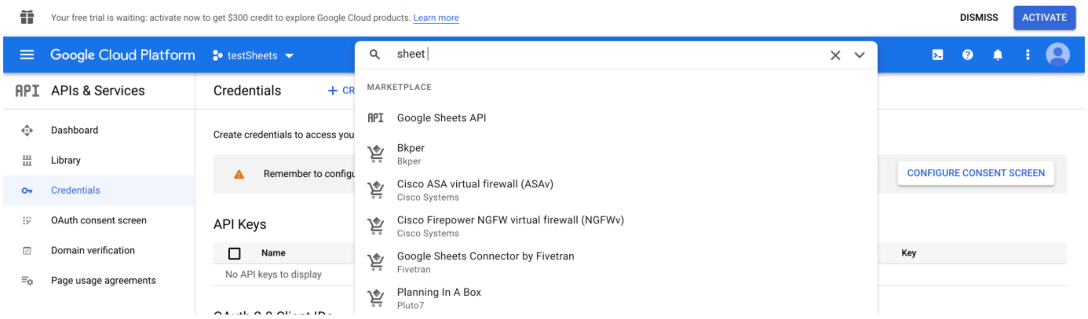
The designed methodology can use position mapping to track student attendance. The student's mobile phone based on the MAC address will be utilized to identify the student. Bluetooth terminals based on BLE and Raspberry Pi are available. The sensor system is a Bluetooth station module and the Raspberry Pi over Python program language performs the experimental outputs. In the target area, the mobile device required signal strength and Bluetooth address. The tools integrate the integrated development environment or IDE. The debugger, compiler and code editor are the developer platform. The source code involved IDE and there will be reliable tools, code analysis and code completion. To store data capturing based attendance system, The Google sheet as a database is used for the final project implementation. Generate the Google sheet and go to https://console.cloud.google.com/apis/credentials?project=testsheets-321114&supportedpurview=project and create a new project from this page. Figure 6 expresses the process of project creation. Figure 6 (a) to (e) shows the screenshots of Project development in the Google cloud platform, Notification of project creation, Google sheet searching and enabling, Google sheet API enabling and Google Drive API enabling process.



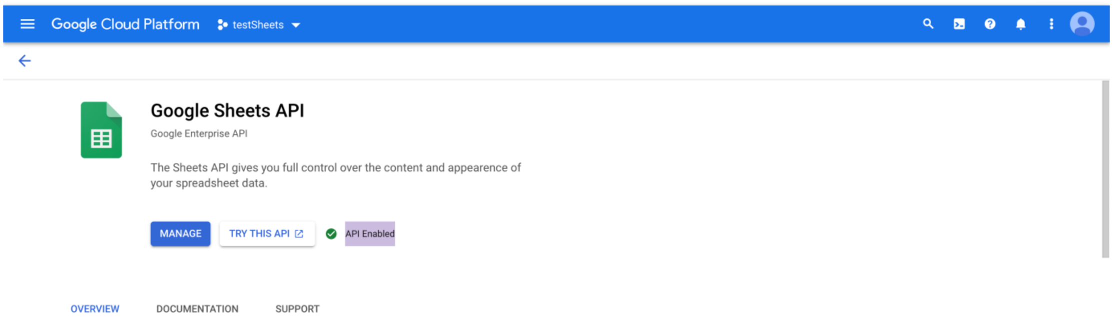
(a)



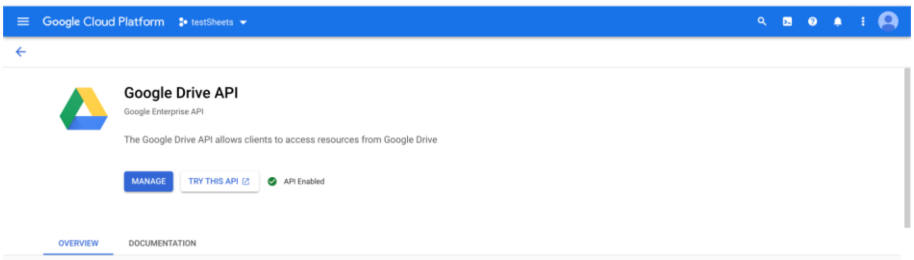
(b)



(c)



(d)



(e)

Figure 6. Project creation process, (a) Project development in Google cloud platform, (b) Notification of project creation, (c) Google sheet searching and enabling, (d) Google sheet API enabling and (e) Google Drive API enabling

Figure 7 displays the credential creation process. The python code is used to generate the credential that permits to access the sheet. Furthermore, the role of Python code editing is delineated in Figure 8.

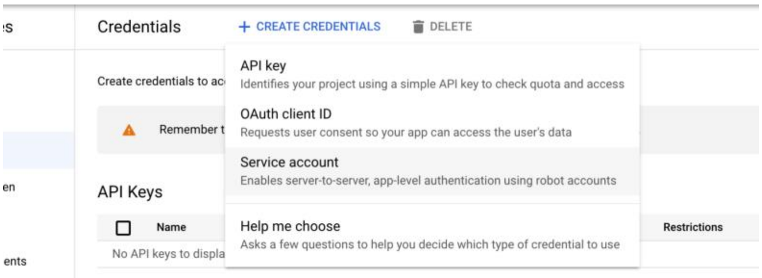


Figure 7. Credential creation process

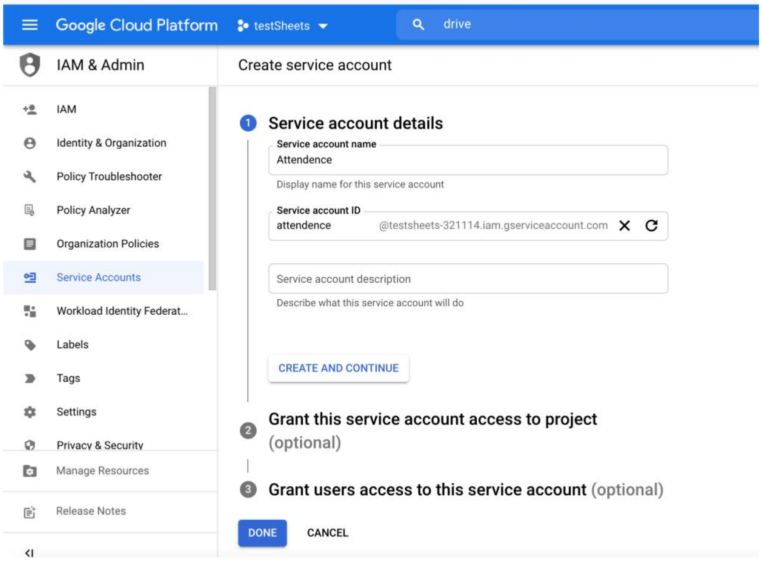


Figure 8. Role of Python code editing

The creation of key based on the service accounts is displayed in Figure 9. After that, researchers must generate a key that will be used to allow access towards the attendance monitoring system to upload information to the Spreadsheet. Press the service account for generating keys.

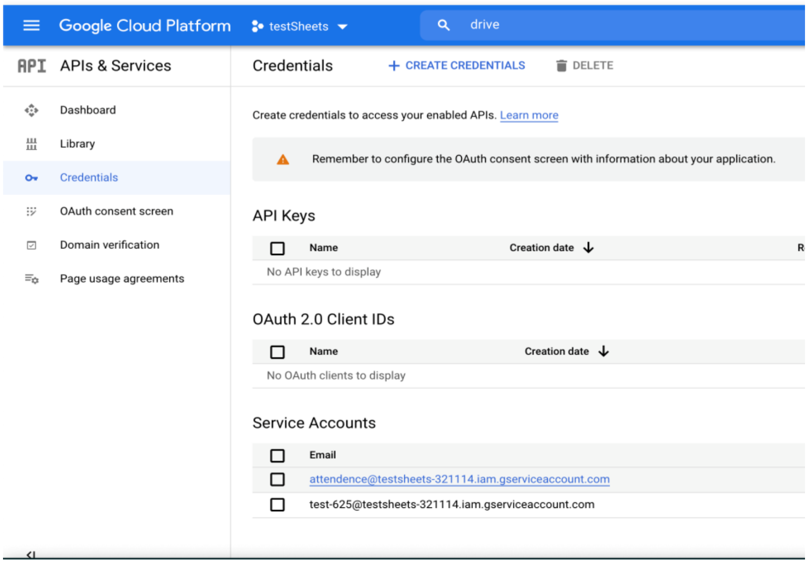


Figure 9. Create a key based on the service accounts

The screenshot of the python code is delineated in Figure 10. Based on the Python code, download the file after generating the private key. This code shows the copy of “client_email’.

Figure 10. Screenshot of python code

Figure 11 shows the screenshot of Google Sheets that share email addresses. From the python code next, copy the client email information and the email based on the Google spreadsheet is shared. After that, the spreadsheet is opened and send these to the email address. The sheet is edited via Python code. The python code uses the files and the spreadsheets are connected.

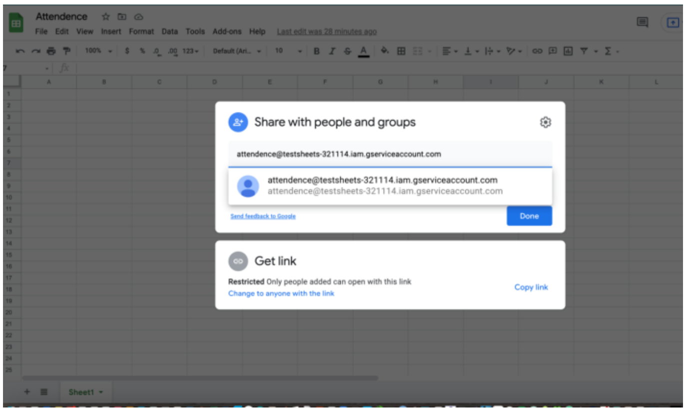


Figure 11. Illustration of Google sheet that shares email addresses

The student's details registered sheet is delineated in Figure 12. Initially, the Bluetooth Mac address details of the student's phone are entered to start the process. For the student (second sheet), the name and ID of the student are presented. In Google drive, create the excel sheet for tags (third sheet). The data on the second and third sheets is fetched via Python codes and the attendance is marked.

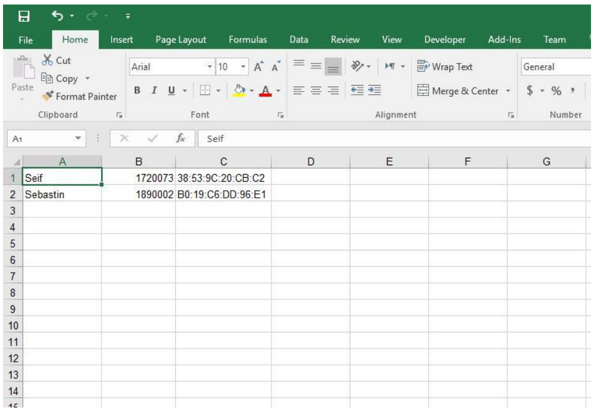


Figure 12. The student's details registered sheet

Figure 13 delineates the process of Bluetooth connectivity. Enable the student requirements to make sure the student's Bluetooth devices the Google excel sheet performs registration based on the Google cloud platform.

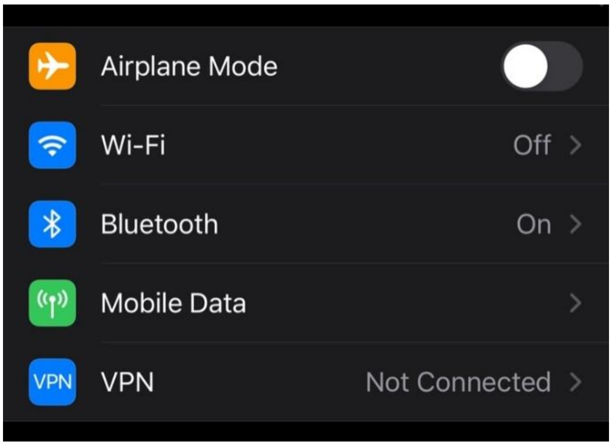


Figure 13. The process of Bluetooth connectivity

The IDE running procedure is displayed in Figure 14. The Bluetooth in his/her mobile phone is switched via students and based on IDE, a Raspberry Pi server run the code. The student phones with all the registered Bluetooth Mac addresses are detected.

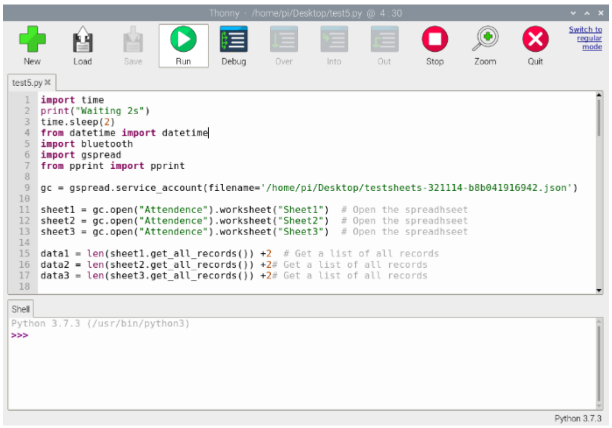


Figure 14. IDE running procedure

Figure 15 displays the recognition of the Mac address. Sheets 2 and 3 lists the MAC addresses and the code begins to search for a match among the obtainable surrounding Access points.

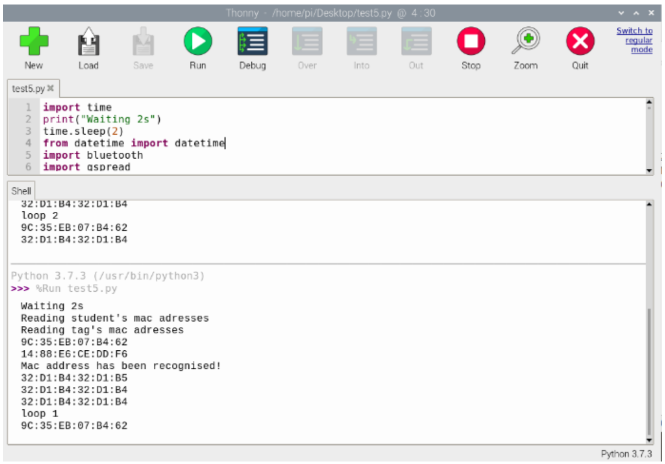


Figure 15. Recognition of Mac address

The data displayed on the spreadsheet is shown in Figure 16. The available in sheet1 and upload the raspberry pi that determines the MAC address. Detect if there are any tags and use the Bluetooth tags to run another search of code.

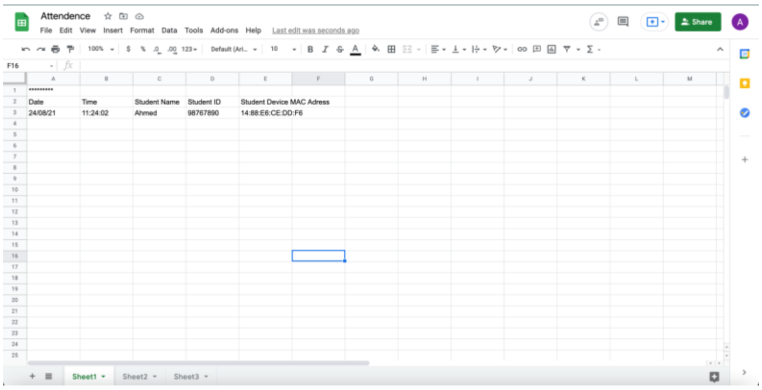


Figure 16. Data displayed on the spreadsheet

7. COST ANALYSIS

The long-term investment considers the proposed automated system. Check the manual attendance with 30 students in 10 min. per class. The three parameters like teacher and support staff, student's time and location with attendance, are recorded via an automated proposed model in which the attendance is recorded with the help of a manual system. During each session, record multiple attendances at various times and the system management programs the attendance scheduled.As a result, in terms of saving a significant amount of time, there is more data ability to analyze student behavioral patterns like class attendance percentage, every student with sitting location preference and the behavior based on walking in and out. Over one year period, distributing the system cost 0.38 USD. After the first year, the framework is now free, save for a small amount of servicing and electricity usage because it is a low-energy device.

8. LOCATION PREDICTION OF STUDENTS

The detection of MAC and RSSI by the students in the classroom can be achieved with Bluetooth functionality devices. The process carries scanning and matches the MAC and RSSI addresses with the names of the students. For further processing, the information is forwarded to the server. For the location prediction root-mean-squared error (RMSE) is evaluated for both the DBN and DBN-ICO and displayed in Figure 17. The RMSE of the proposed DBN-ICO is lesser than the DBN approach and mitigates the positioning of students' devices.

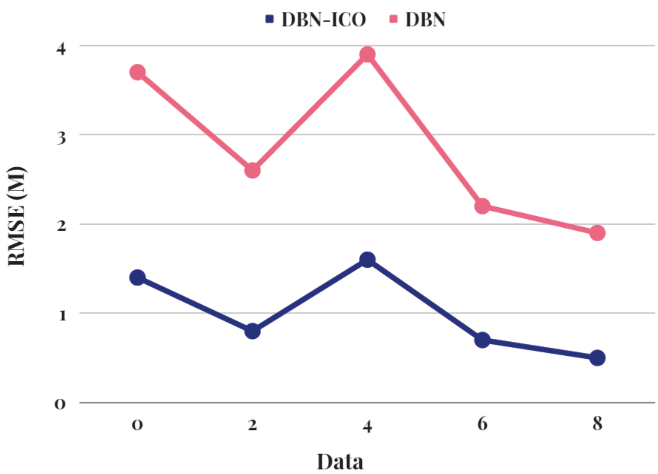


Figure 17. RMSE of both DBN and DBN-ICO

Meanwhile, the position accuracy of students' devices with errors less than 0.5 meters, between 0.5 to 1 meter, and greater than 1 meter are analyzed for both DBN separately and DBN-ICO and illustrated in Figure 18. The performance of DBN-ICO is superior to the DBN approach.

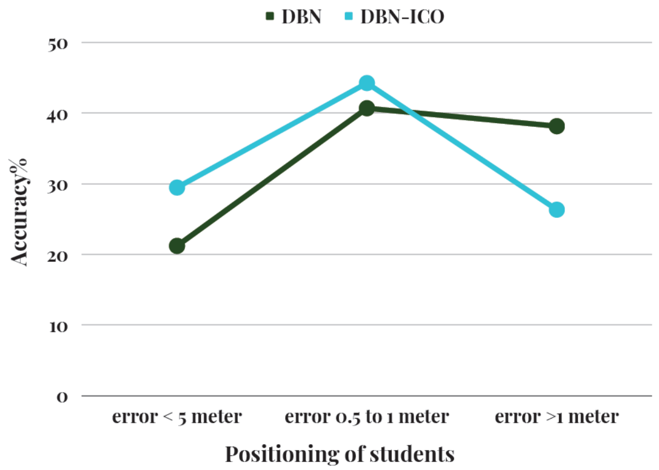


Figure 18. Accuracy of positioning of students for errors mentioned in the graph for both DBN and DBN-ICO

9. CONCLUSION

This paper presented Bluetooth-enabled IoT smart systems for a student placement with the consumption of low energy. The Received signal strength indicator can record attendance in the cloud environment.For monitoring student attendance and positioning, a novel IoT-based Deep Belief Neural Network (DBN)-based Improved Chimp Optimization algorithm (ICO) is presented. An experimental study on Raspberry Pi with Python deployment demonstrates that our proposed approach provides improved accuracy even with high interference signals. Position mapping can be used in the designed methodology to track student attendance. The MAC address of the student's mobile phone will be used to identify the student. Bluetooth terminals based on Bluetooth Low Energy (BLE) and Raspberry Pi are available. The sensor system is a Bluetooth station module, and the experimental outputs are generated by the Raspberry Pi using the Python programming language. The proposed automated system is taken into account in the long-term investment. Examine the manual attendance with 30 students per class in 10 minutes. Distribute the system cost as 0.38 USD over a year.

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