Detecting Unauthorized Access to a Location Using Lloyd’s Algorithm

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ABSTRACT

Every Organization has some place which has limited access for the employees. This paper proposes a method to detect the person in a restricted area where he is prohibited. For this purpose we will be a reference map is being build based on the location co-ordinates. The Restricted area will be marked in the reference map. The location of a particular Employee will be found using GPS System. Lloyd’s algorithm is used to condense the computation throughput and hence complementing the cutting of time complexity as well as power. An Authentication model is provided using the biometrics such as of fingerprint. This prototype will be built on Android Operating system.

KEYWORDS: GPS, Lloyd’s, Fingerprint, Android, Authentication, Location.

INTRODUCTION

The Usage of smart Phones and Tablets have grown to a greater heights in the past few years. The Low cost availability of mobile devices and the ease to access the mobile through touch screen and user friendly mobile apps have lead to increase in usage of mobiles phones in all the sectors of the society. Due the presence of GPS navigation in mobile phone continuous location tracking is becoming a feasible aspect on technical ground. Based on this concept, a system Unauthorized Entry Detection System (UEDS) is proposed which can identify an unauthorized person in a restricted area of an organization. Every organization has locations that are only restricted to particular employee, such that this area may contain important and confidential documents or these may be places of important discussions which should not be eaves dropped. These areas can be traditionally restricted by a guard in person or by means of biometric authentication system. But this involves an extra cost, since a personal security as well as biometric system needs extra equipment as well as fortifications need to be constructed. UEDS will overcome all above mentioned problems.

A. Location Tracking:

The use of Google maps is more prevalent in General GPS tracking systems. But UEDS has a new concept of reference map. Reference map is a map that will be built for an individual organization. This reference map is unique for a respective organization.

A sample reference map is shown below:

The above figure shows a reference map for an organization the map has different color representation. The overall population of employees can be grouped as Level 1, Level 2, Level 3 and Level 4 Employees. The most used colors are red, green, blue and yellow. Each area is described as below.
Red-Entry Restricted for Level 4 Employees.
Green-Not a restricted area. All level employees are allowed to access this area.
Yellow-Only Level 1 Employees are allowed to access.
Blue-Level 1 and level 2 employees are allowed to access.

![Reference Map](image)

**Fig. 1: Reference Map.**

UEDS will grant access to the employees who are authorized and will be grant permission to enter into a area. Each employee while entering their area will be prompted to switch on the GPS in the smart phone, as well as the fingerprint will be scanned through their own devices. Based on the Unique Mobile Id of the phone(UMI) and the co-ordinates found via GPS the proposed system will compute the authentication.

To reduce the computation throughput on the mobile phone and hence to increase the battery life of the mobile phone, the computation for tracking will be performed on the computer system. To increase the speed of the authentication, the location finding will be determined with the help of Loyd’s Algorithm.

To ensure that the employee is an authorized person to use the mobile phone a biometric authentication via fingerprint scanner will be provided. For this purpose fingerprint verification of the particular employee will be used. The continuous monitoring of interest points or interest objects while the mobile user is on the move is an important criteria of mobile navigation usually, in continuous monitoring, when interest points or interest objects are changed due to the movement of mobile users, the mobile users are notified of these changes. These are known as split nodes. Therefore, existing work have been much focused on processing split nodes efficiently. Different kinds of approaches have well been explored in the last two decades. As a result, numerous conceptual models, multidimensional indexes and query processing techniques have been introduced.

### B. Authentication:

Secure user authentication is a very important factor for majority of systems. A common methodology for verification is entry of username and password by the user, which is verified by the system. No checks are performed while the user is using the application or the system, until the user logs out explicitly. Since web based systems are more vulnerable to attacks, biometric techniques is suggested as one of the solutions for the increasing amount of problem. The username and password can be replaced by biometric data.

### II. Related Works:

The related works based on this concept are on Finding a location of device in road networks. Noureddine Lasla [2] have given An Effective Area-Based Localization Algorithm for Wireless Networks, which uses geometric areas such as ring triangle and circle as area of computation. Rinku Dewri etal [3] have worked in Exploiting Service Similarity for Privacy in Location-Based Search Queries.

### A. Area-based localization:

Applications like asset tracking, search and rescue and digital battlefield require the knowledge of node’s location in order to achieve the design goal. On the other hand, wireless sensor networks (WSNs) have gained popularity in recent years due to the growing list of applications. Noureddine Lasla, etal[2] have given An Effective Area-Based Localization Algorithm for Wireless Networks, which uses geometric areas such as ring triangle and circle as area of computation.

### B. Reference Maps:

The above mentioned algorithms use only the position of some reference nodes called anchors, to estimate the residence area of the remaining nodes existing algorithms use a triangle, a ring or a circle as the geometric shape that defines the node’s residence area. However the existing algorithms suffer from two major problems, in some cases, they might make wrong decisions about a node presence inside a given area, or they require high anchor density to achieve a low location limitation error and high ratio of localizable nodes. RM further employs Lloyds diagram in order to boost the percentage of locating a device. Arlind etal[5] in their paper
"Organizing Search Results with Reference Map" have used the concept of RM for archiving of newspaper article.

C. \( K \) nearest neighbours:
Distributed wireless mobile network that allows information exchange and information services to be delivered, is required for digital ecosystems. An application that utilizes such a technology is the information service to mobile devices and users through mobile networks. One of the most prominent and growing applications of mobile information services is mobile navigation. Yinan Jing et al [1] have used \( k \) Nearest Neighbor Query on Road Networks.

D. Continuous \( K \) nearest Neighbor:
Yinan Jing, Ling Hu, Wei-Shinn Ku, and Cyrus Shahabi [1] have used \( \text{k Nearest Neighbor Query on Road Networks. If there are too many intersections on the path, there will be many segments, and consequently, the processing performance will degrade. These are the obvious limitations of the current Continuous } \( K \) \text{ nearest Neighbor approaches. The most common spatial query } \( \text{K-nearest Neighbour search Continuous K-nearest Neighbour approaches was also attracted by some researchers. In order to find split nodes, all existing Continuous K-nearest Neighbor approaches divide the query path into segments, find K-nearest Neighbour results for the two terminate nodes of each segment, and then, for each segment, find the split nodes. One segment of the path starts from an intersection and ends at another intersection.}

E. Biometric Session Management:
Andrea Ceccarelli etal[4] have addressed the problem that continuous authentication can be problematic in case of the biometric device theft and hacking of the device. Their authentication approach gets biometric data transparently which also implements a adoptive time out management .The user session is open and secure without considering the idleness of the user while potential misuses are detected by continuously confirming the presence of the proper user.

III. Existing System:
In the current scenario the widely used system is the barcode authentication system. As per this system every restricted area has a physically built wall around them and a door entry. Each door entry has a barcode scanner. When a employee enters the restricted area room, the employee has to scan his permit card (Something like a identity Card). This code is send to the server and the computation is done in the server and token is returned which has the message whether the employee is allowed in the area or not. Based on this token an alert will be created.

IV. Algorithm:
UEDS will include Location Tracking for Authentication Using Smartphone’s where the location of the device which can be considered as a node that can be found with respective to the reference point. The reference point is a particular point on the location whose co-ordinates are already determined. Based on this the reference Map will be built. When the user enters the location in the reference map, the location of the device is found using his current located co-ordinates. The devices current co-ordinates are searched with respect to the nearest reference point in the reference map. Our Aim is to search a reference which will be less time consuming, more accurate and the computation should be less compared to the existing algorithm. One such algorithm of the proposed system is Lloyd's algorithm. This Lloyds algorithm is based on the concept of K mean clustering algorithm and Voronoi diagram. The technical details are explained in detail as follows.

A. Voronoi Diagram:
A Voronoi diagram is a special kind of decomposition of a metric space determined by the distances to a specified discrete set of objects in space. Given a set of points S, the corresponding Voronoi diagram will be determined. Each point s has its own Voronoi cell \( V(s) \), which consists of all points closer to s than to any other points. The border points between polygons are the collection of points with equations of distance to the shared generators.

Fig. 2 shows an example of a Voronoi diagram based on Euclidean distance. \( P_i \) represents the interest points, and the lines are the shared border edges between polygons. There are some basic properties associated with a Voronoi diagram, which are explained below

Property 1:
The Voronoi diagram of a point set \( P \), i.e., \( V(P) \), is unique.
**Property 2:**
The nearest generator point of \( p_i \) (e.g., \( p_j \)) is among the generator points whose Voronoi polygons share similar Voronoi edges with \( V(p_i) \).

**Property 3:**
Let \( n \) and \( n_e \) be the number of generator points and Voronoi edges, respectively; then, \( n_e \leq 3n - 6 \).

**Property 4:**
From Property 3 and the fact that every Voronoi edge is shared by exactly two Voronoi polygons, we notice that the average number of Voronoi edges per Voronoi polygon is at most six, i.e.,
\[
2(3n - 8)/n = 8 - 12/n \leq 8.
\]
This means that, on average, each generator has eight adjacent generators. Using the Voronoi diagram to find the nearest neighbour, let the algorithm perform more efficiently as all distances between borders and generators can be precalculated and stored.

**Fig. 2:** Voronoi Diagram.

**B. Network Voronoi Diagram:**
The Voronoi diagram mentioned previously is the Voronoi diagram based on Euclidean distance. In the real world, when there is a need to search the nearest neighbor or to generate an appropriate moving path, we use network distance method instead of Euclidean distance. The network Voronoi diagram is the Voronoi diagram that uses network distance to generate the diagram instead of Euclidean distance. In a typical Voronoi diagram, the shared borderline is the mid perpendicular of the links connected with two corresponding generators. However, in a network Voronoi diagram, the borderline consists of discrete points. Which are the middle points of a network road connected with two corresponding generators. A polygon in a network is the set of nodes and edges, which are closer to one generator than to any other. This is the principal difference between a Voronoi diagram and a network Voronoi diagram.

**C. Lloyd’s Algorithm for Location Tracking:**
Lloyd’s algorithm also known as Voronoi iteration or relaxation, is an algorithm for finding evenly-spaced sets of points in subsets of Euclidean spaces and partitions of these subsets into well-shaped and uniformly sized convex cells. Like the closely related k-means clustering algorithm. It repeatedly finds the centroid of each set in the partition and then re-partitions the input according to which of these centroids is closest. However, Lloyd’s algorithm differs from k-means clustering in that its input is a continuous geometric region rather than a discrete set of points. Thus, when re-partitioning the input, Lloyd’s algorithm uses Voronoi diagrams rather than simply determining the nearest center to each of a finite set of points as the k-means algorithm does.

Although the algorithm may be applied most directly to the Euclidean plane, Lloyd’s algorithm can be used to construct close approximations to centroidal Voronoi tessellations of the input, which can be used for quantization, dithering and stippling.

Lloyd’s algorithm starts by an initial placement of some number \( k \) of point sites in the input domain. In our Application \( k \) are the reference points may be placed at random, or by intersection of areas.

Because Voronoi diagram construction algorithms can be highly non-trivial, especially for inputs of dimension higher than two, the steps of calculating this diagram and finding the centroids of its cells may be approximated by a suitable discretization in which, for each cell of a fine grid, the closest site is determined, after which the centroid for a site’s cell is approximated by averaging the centers of the grid cells assigned to it.

*It then repeatedly executes the following relaxation step:*
1. The Voronoi diagram of the \( k \) sites is computed.
2. Each cell of the Voronoi diagram is integrated and the centroid is computed.
3. Each site is then moved to the centroid of its Voronoi cell.

The Lloyd’s algorithm using iterations on Voronoi diagram is shown in the following figure.
In the Fig.3, the points are very near the centroids of the Voronoi cells. A centroidal Voronoi tessellation has been found. Since Voronoi diagram construction algorithms can be highly non-trivial, especially for inputs of dimension higher than two, the steps of calculating this diagram and finding the centroids of its cells may be approximated by a suitable discretization in which, for each cell of a fine grid, the closest site is determined, after which the centroid for a site's cell is approximated by averaging the centers of the grid cells assigned to it.

D. Location Tracking Model:

The use of Google maps is more prevalent in General GPS tracking systems. But in this work, we have proposed a new concept of reference map. Reference is a map that will be built for an individual organization.

Some limited distance for the areas that are limited that are restricted and the employees who are authorized will be granted permission to enter into a restricted area. Each employee while entering their area will be prompted to switch on the GPS in the smart phone, as well as the fingerprint will be scanned live via the camera. Based on the Unique Mobile Id of the phone (UMI) and the co-ordinates found via GPS the proposed system will compute the authentication.

To reduce the computation throughput on the mobile phone and hence to increase the battery life of the mobile phone, the computation for tracking will be performed on the computer system. To increase the speed of the authentication, the location finding will be determined with the help of Lloyd’s Algorithm.

To ensure that the employee is an authorized person to use the mobile phone is provided a biometric authentication. For this purpose fingerprint verification of the particular employee will be used. The continuous monitoring of interest points or interest objects while the mobile user is on the move is an important criteria of mobile navigation usually, in continuous monitoring, when interest points or interest objects are changed due to the movement of mobile users, the mobile users are notified of these changes. These are known as split nodes. Therefore, existing work have been much focused on processing split nodes efficiently. Different kinds of approaches have well been explored in the last two decades. As a result, numerous conceptual models, multidimensional indexes and query processing techniques have been introduced.

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V. Implementation:

While Implementing UEDS the study of the entire organisational structure has to be first carried out. For more details study the static as well as dynamic structure of the organization is equally important. Since UEDS has to work successfully in a dynamic environment the study of dynamic behavior of the system has to be conducted first.

An activity can be described as operation involved in the entire system. The main activity in the UEDS are device ingress, track location, match device id and fingerprint match. Based on these activities it has to be finalized whether a person is authorized or not to enter into a area.

The implementation of UEDS can be explained using UML Diagram. This UML activity diagram helps in understanding the dynamic behaviour of the system. The flow of message from one activity to another can be well represented in this diagram. The UML activity of the UEDS shows the Modeling work flow by using activities. This diagram models the business requirements of the organization. The business requirements is grouped as functionalities UML Activity diagram helps in high level understanding of the system's functionalities. After completion of the modeling the UML Activity diagram investigates business requirements at a later stage. The UEDS UML activity diagram is shown in Fig 4.1
Assuming the employee enters the restricted area using his smart phone device which is described in the diagram as device ingress. In the next level there are two activities simultaneously happening i.e the device is tracked by finding the co-ordinates of the device’s current location.

Simultaneously the device id is compared with the allowed device id’s in the area that present in the database. If the device is allowed to be located in the acquired co-ordinates the next step goes for a fingerprint match alternatively if there is a mismatch an alert is created.

The fingerprint match is performed on the user’s device the device will already have a permitted user fingerprint if the fingerprint is matched with the permitted fingerprint then the user is authenticated. Alternatively if there is fingerprint mismatch an alert is generated.

Figure 4 illustrates the UML activity diagram of the proposed project.

A. Entity Relationship:
The ER model for Location Tracking for Authentication Using Smartphones defines the conceptual view of a database. It works around real-world entities and the associations among them. At view level, the ER model is considered a good option for designing databases. Figure 5 shows the Entity relationship diagram of the proposed project.

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**Fig. 4:** Unauthorized Entry Detection System Activity Diagram.

**Fig. 5:** Entity Relationship Diagram.

a) **Entity:**
The entities in the proposed system are Employee and Restricted area.

b) **Attributes:**
The main Attributes used are Employee Id, Employee Name, Mobile Id, Area of Mobility, Area Co-ordinates, Permitted mobile Id’s, Gender, Phone, DOB, Email, Admin, Department Name.
B. Sample Database in MySql:

The database for UEDS will be implemented in MySql the sample database is as shown in the figure. All the above mentioned attributes are inserted into this database.

![Mysql Database for The UEDS.](image)

The entities used and their relationships are shown in Table I.

### Table 1: Entities attributes and data types in the entity relationship model.

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Entities</th>
<th>Attributes</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Employee</td>
<td>Employee Id</td>
<td>Int</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Employee Name</td>
<td>Var Char</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mobile Id</td>
<td>Var Char</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Area of Mobility</td>
<td>Var Char</td>
</tr>
<tr>
<td>2</td>
<td>Restricted Area</td>
<td>Area Co-ordinates</td>
<td>Var Char</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permitted mobile Id’s</td>
<td>Var Char</td>
</tr>
</tbody>
</table>

C. Employee Registration:

The entire system has to first begin with the registration of the employee in the system database. The main values that are required for the database are:

- Name of the employee, email and phone number for notifications and some other general details like gender and date of birth.

The admin will login in to the system using his own authentication credentials.

VI. Performance Analysis:

A. Comparison of Performance Analysis Results of UEDS with the Existing System:

To show the effective performance of UEDS we have compared our system with the existing bar code system. The parameters that we have considered are as follows:

- Number of Clients
- Server overhead
- Database overhead
- Total response time

In order to make a effective comparison we have taken six clients for each of the systems to be compared. In case of UEDS we have considered the employee with the mobile handset as a clients while in the Bar Code Scanning System we have taken the employee with permit card as a client.

Table II, Table III and Table IV shows the values used for database response time, server response time and total response respectively.

![Database Response Time](image)

The Figure 7, Figure 8 and Figure 9 shows data for six mobile clients based on database overhead, server overhead and total response time respectively.
Fig. 7: Database Response Time.

Table 3: Parameters for Server Response Time.

<table>
<thead>
<tr>
<th>Client</th>
<th>Bar Code System</th>
<th>UEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 8: Server Response Time.

Table 4: Total response time.

<table>
<thead>
<tr>
<th>Client</th>
<th>Bar Code System</th>
<th>UEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120</td>
<td>69</td>
</tr>
<tr>
<td>2</td>
<td>118</td>
<td>61</td>
</tr>
<tr>
<td>3</td>
<td>123</td>
<td>69</td>
</tr>
<tr>
<td>4</td>
<td>116</td>
<td>51</td>
</tr>
<tr>
<td>5</td>
<td>111</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>109</td>
<td>61</td>
</tr>
</tbody>
</table>

B. Performance Analysis of Lloyd’s Algorithm:

To Build an effective system, effective performance of the database is considered to be very important. A database is more effective if the database contains no redundant data. UEDS used Lloyd’s Algorithm to increase the performance of the system by reducing the number of sites to be entered in the database which might be sufficiently high in the case of absence of the algorithm.

Figure 10 shows the all the sites that has to be considered in case of direct GPS system without using the Lloyd’s Algorithm.
Fig. 9: Total Response Time.

Fig. 10: Sites to be used in absence of Lloyd’s Algorithm.

The number of sites can be reduced compared to direct GPS tracking system. Some of the comparison results are stated in Table II.

Table 5: Comparison Chart for number of sites used.

<table>
<thead>
<tr>
<th>No of sites in the absence of Lloyd’s Algorithm</th>
<th>No of sites after usage of Lloyd’s algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>100</td>
</tr>
<tr>
<td>900</td>
<td>63</td>
</tr>
<tr>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

The reduced number of sites from 1000 to 100 is shown in figure 11.

Fig. 11: Sites Used After Lloyd’s Algorithm Usage.
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