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Towards Reducing Covid-19 Spread: A Geo-Location Based Attendance Monitoring and Navigation System for Institution

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Abstract- The current pandemic caused by covid-19 has come to stay and has changed many things, including the education sector of the whole world. However, institutions must resume, and academic activities must continue under the precautionary measures for students and staff to stay safe. The question is, how will precautionary measure be observed? This paper provided a geo-location approach in tackling the aspect of attendance management of students and staff in the classroom to maintain social distancing while marking attendance sheets for a large class and minimize time wastage for another lecturer. The developed software also focused in campus area navigation for outsiders or newly admitted students. This research was carried out using smart phones due to its built-in global positioning system (GPS) and can be afforded by all. The developed system was tested online with different smart phones connected to it, 93 feed-backs with 63% correctness were gotten from the system prediction.

Keywords: *geo-location; attendance system; navigation system; COVID-19; GPS.*

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I. Introduction

The act of taking attendance in the classroom has been the norm in almost every institution or school as it helps to know how regular students are and as a yardstick to measure their performance during examination. Typically, attendance systems are of two types: manual and automated. A Manual system uses sheet of papers or books in taking attendance where students fill out, and lecturers oversee for accuracy [1]. This method is prone to error because sheets could be lost or damaged. The extraction of relevant data and the manual computation might take a lot of time. A Lecturer may use extra time to complete checking the attendance of all the students that came for his/her lecture and this might delay another lecturer from entering for his/her own class period, especially when same venue has been assigned to both lecturers. This can create an overhead cost for such an organization [1]. Not only that, the pursuit of reducing the rate at which people contracted the covid-19 virus may not be realizable after resumption if attendance could continue this way. There will not be social distancing (one of the pre-cautionary measures) while taking attendance of the students, and this may increase the spread of the virus.

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An automated attendance system, however, uses electronic tags, barcode badges, magnetic stripe cards, biometrics (hand, fingerprint, or facial), and touch screens in place of paper sheets [2]. In these techniques, students touch or swipe to provide their identification, entering, and leaving time to know whether they were around for the class or not. As this is an improvement over manual, in this paper, we introduce the use of smart phones for attendance tracking purposes considering the wide popularity of smart phones which virtually all lecturers and students could afford, and is a form of an automated system. The attendance tracking system is based on the concept of web services on an Android mobile application that communicates with the database on a remote server via internet connectivity (Wi-Fi/4G). This system does not require any peripheral device other than a smart phone due to its built-in GPS. Any user can be tracked automatically via the smart phone's GPS value.

While considering attendance management, another objective of this research is to ease routing on campus for visitors. This is achieved by defining the destination place on campus, and creates a route that leads to the destination point.

The research was carried out at Achievers University Owo where a lot of captured areas were trained both for attendance management and navigation.

II. Literature Review

A desktop application for daily attendance of students was developed in [3] to store information of students in a particular class. The technology used for the application was VB.NET, and database management system used was MS-Access. On startup of the application, the name of all registered students for a particular course were displayed. Each student marks attendance by clicking the checkbox against his/her name, and click a button to submit the attendance. The application was a stand-alone compared with the proposed application.

In [4], a cost-effective computer-based embedded attendance management system was proposed, the system uses an improvised electronic card to monitor students' attendance for verification. The card after inserted in an electronic machine, shows the record of time and other information about an individual before attendance processing was done. The issue with electronic card or password based system is that it allows for imposture since cards or passwords can be shared. A better way to tackle this problem is by using a biometric recognition system which includes finger print or iris recognition.

Fingerprints had also been used to identify and calculate the attendance number of individual in [5]. The system was used to generate the reports after a fixed time duration. Smaili and kadry in [6] also solved attendance management problem by proposing a wireless system where iris of an individual was used for authentication. It was like fingerprint where no two persons can be same. Although, iris is more preserved from the external environment whereas a fingerprint is not. Both a fingerprint and iris recognition-based approach need some extra devices or scanners which can be connected to the server computation system. Also, based on the circumstance of the covid-19 pandemic, the fingerprint approach may instigate the risk of contracting the virus; hence this approach may not be fit to be used now. We proposed a geo-location-based approach for attendance management to reduce the risk of contracting covid-19.

Researchers have discovered that hardware integrated with Global Positioning System (GPS) receivers can add geospatial information to web content, photographs, audio, and video automatically [7]. Katie in [8] stated that routing on campus is easier, more accessible, and of course, be a tool to empower the next generation of outdoor advocates via a geographical coordinate approach.

Another survey of literature and the inference drawn was summarized in Table 1 as follows:

Table 1: Review and inference drawn

Author(s) with publication details	Title of the paper	Techniques used	Limitation
Mohammad and Durga Prasad [9]	Design and Implementation of Mobile Phones based Attendance Marking System	WAMP, SQ Lite,	It can be altered by other physical attacks and is prone to hacking.
Jun [10]	Attendance Management System using a Mobile Device and a Web Application	Monaca-application	No feedback from users.
Mahesh et al. [11]	A Smart Phone Integrated Smart Classroom	Face recognition, Android	Automatic switching of profile to airplane mode in Android versions 4.1 i.e. Jelly Bean and above are restricted by Android due to security reasons.
Ekta et al. [12]	Survey on Student Attendance Management System		Not automated.
Milon et al.[13]	Development of Smart phone - based Student Attendance System	Eclipse Android ADT bundle as IDE, SQLite and MySQL.	Can be used only in Android devices.
Karwan et al.[14]	Student Attendance Management System		Past attendances are not stored.

III. Research Site

This research was done at Achievers University Owo (AUO) campus area. The University has many different buildings, with most of the buildings connected; some of them had different offices and walkways. Many visitors come around to enquiry; some come for business purpose and the likes. The geographical coordinates of eleven (11) classrooms, with about thirty-four (34) locations where newly admitted students do visit were captured and tagged appropriately for easy navigation within the campus. The classrooms comprise selected lecture theatres,

Designated Students' reading Rooms (DSR) for departments, and lecture halls. Since the existence of Achievers University, no mapping system that can enable a new person on the campus to get to their destination with little or no guidance has been developed. This research focused on helping incoming visitors via their smart phone or GPS-enabled device. Figure 1 shows the Google map of Achiever University, Owo.

Figure 1: Achievers University Owo Google map

(Source: https://www.google.ro/maps/place/Achievers+University@7.198851,5.593239,15z/data=!4m5!3m4!1s0x0:0xebce36c85f04d296!8m2!3d7.198851!4d5.593239

IV. Architectural Design of the Software

In the architectural design shown in Figure 2, the users (students, lecturers, and visitors) have access to smart phones with the GPS feature enabled. The phone camera is used as the input medium to get the snapshot of the area of interest-whether for attendance or navigation purposes. The Exchangeable Image File Format (EXIF) information is stored automatically by the camera after the snapshot. Cameras with a built-in GPS receiver add the GPS data (in numerical format) to the EXIF, which comprise latitude, longitude, and elevation.

Photo GPS extract can read those numbers and visualize them on Google Maps. The coordinates point expressed in the form of latitude and longitude are the position or location of any place on Earth's surface. The combination of meridians of longitude and parallels of latitude establishes a framework using the exact positions. This can be determined using the prime meridian and Equator. For instance, a point described as 40° N, 30° W, is located at 40° of arc north of the Equator and 30° of arc west of the Greenwich meridian.

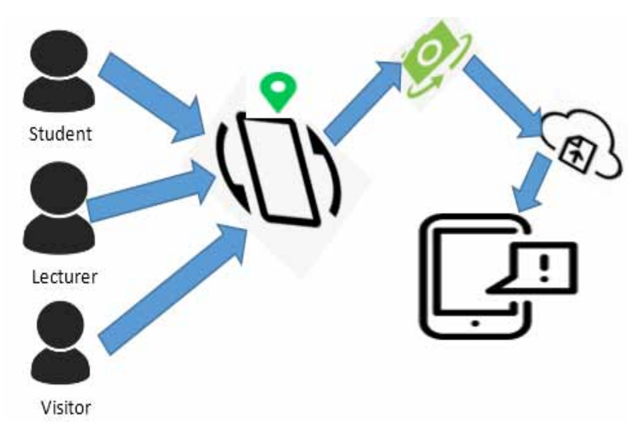

Figure 2: Architectural design of the software

V. Research Method

The approach used in the development of the system was in two stages: the training and testing stage. In the training stage, the coordinates of places of interest used were captured three times in a day, both for classroom attendance and route on-campus navigation. This will ensure a good approximate value during testing. The input, process, and output (IPO) flow of the training stage is shown in figure 3, while the flowchart is shown in Figure 4.

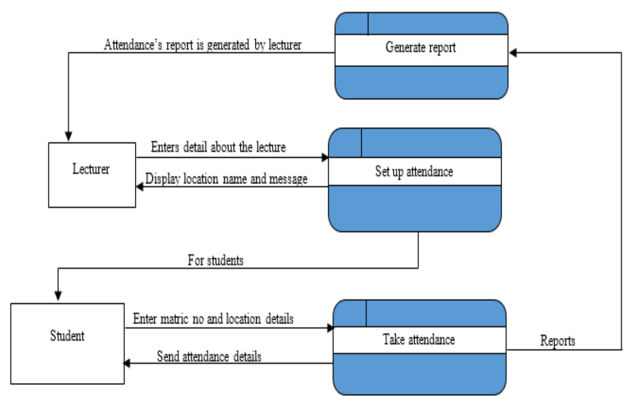

Figure 3: IPO chart for the software

In the testing stage, the approach is different. In attendance management, after the area has been captured and correctly displayed the tagged name, the lecturer then input the following parameters: staff number, current semester and session, and course code. These information are to initiate the venue of the lecture for such course. Students after that will capture the area using their respective smart phone. If the captured area name is the same with the lecturer's already captured area, the student proceeds by entering their matric number to mark the attendance register. The data flow of the attendance system is shown in Figure 5. However, in the case of navigation of routes on campus, the approach is different. Once the visitor captures the current area (source area) where they are, the tagged name is displayed, and then proceeds to input their destination place. A route is displayed from the source area to the destination area automatically. Figure 4 shows the flow chart of the navigation system.

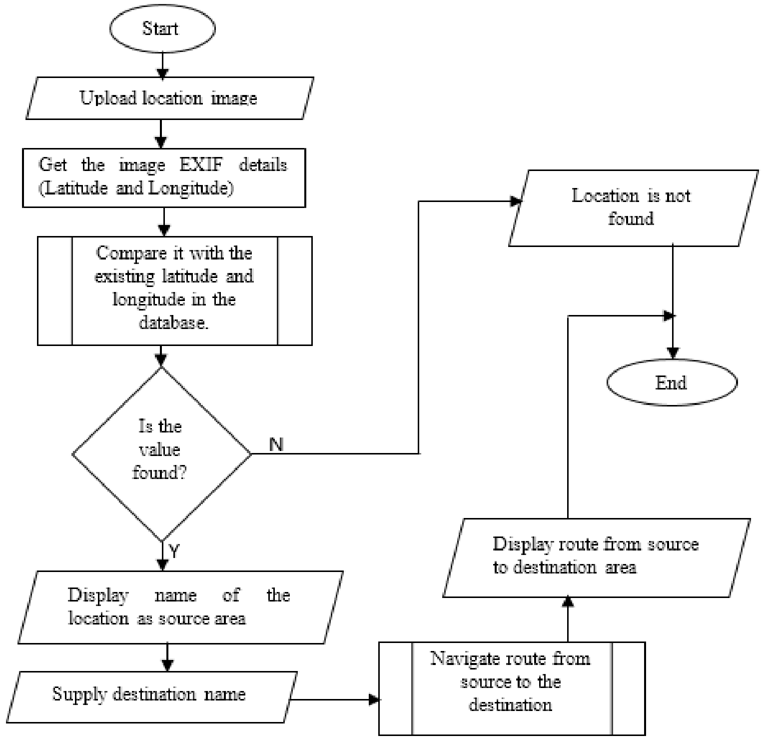

Figure 4: Flowchart for route navigation

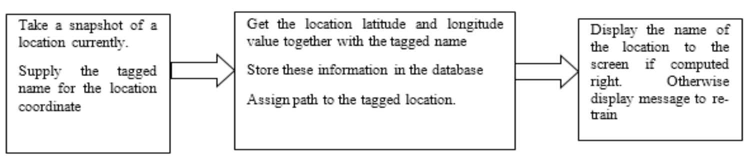

Figure 5: Data flow diagram of attendance management system

a) *Data Smoothening*

During the training section, the coordinates were captured with different decimal places. Normalization and feature selection methods were employed for data smoothening. A decimal scaling method was used to move the decimal point to a scale value range of -1 and 1 while still maintaining the original digit value. The decimal scaling is shown in equation (1) as follows:

$$w'(i) = w(i)/10^k \qquad (1)$$

where $w(i)$ is the value of the feature (in this case, it is the coordinate value) w for case i and $w'(i)$ is the scaled value. k is the length of the integral part of the coordinate value which can be represented as

$$k = |int(w(i))| \qquad (2)$$

The resultant value is further smoothened by rounding it to a precision value of four (4)

Furthermore, to ensure the quality of data and improve the performance of reduced data sets (scaled coordinates), a subset feature selection type was adopted. This sieves out relevant geographical coordinates of the current location has a precision value of 4. The algebra expression for getting relevant data is shown as follows:

$$\pi_{X,Y,Z}\sigma_{X\ LIKE\ ('x_i\%')\wedge Y\ LIKE\ ('y_i\%')}coordinate\_table$$

where $X, Y\ and\ Z$ are the latitude, longitude value and location name respectively. $x_i\ and\ y_i$ are the current latitude and longitude value meant for querying the database table (coordinate_table).

b) *Predicting the Location*

The problem of attendance monitoring system was a classification problem where when one or more inputs is (are) given, a classification model will try to draw some conclusion from the observed value(s). Bayes theorem is used in the classification. To compute the posterior probability for all values of c using the Bayes theorem,

$$P(c|x) = \frac{P(x|c)P(c)}{P(x)} \quad (3)$$

where $P(c|x)$ is the posterior probability of class (c, target) given predictor (x attributes). $P(x|c)$ is the likelihood which is the probability of predictor given class. $P(c)$ is the class prior probability and $P(x)$ is prior probability of the predictor.

$$P(c|X) = P(x_1|c) \times P(x_2|c) \times \ldots \times P(x_n|c) \times P(c) \quad (4)$$

The highest posterior probability class shows the predicted outcome. This is the basis of Bayes theorem.

VI. Result, Discussion and Analysis

A typical example of how the Bayes theorem works in the developed application was shown in Table 2. After the EXIF details of a snapshot of a particular location have been captured via the application using Smartphone with its GPS-enabled, the latitude and longitude readings were then retrieved from the EXIF details and used to query the coordinate table as discussed in the previous section.

Table 2: Latitude and longitude readings of some locations in Achievers University

Latitude	Longitude	Location
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Chancery Office
0.716748522	0.558483833	Chancery Office
0.716748522	0.558483833	Mgt Staff Parking Slot
0.716748522	0.558483833	Conas
0.716748522	0.558483833	ICH Lab
0.716748522	0.558483833	Mgt Staff Parking Slot
0.716748522	0.558483833	Conas
0.716748522	0.558483833	MLS Lab
0.716748522	0.558483833	Cosmas
0.716748522	0.558483833	ICH Lab
0.716748522	0.558483833	ICH Lab
0.716748522	0.558483833	Libarian Office
0.716748522	0.558483833	Libarian Office
0.716748522	0.558483833	Library
0.716748522	0.558483833	Library
0.716748522	0.558483833	Chancery Office
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Lecture Hall Area
0.716748953	0.558484406	Geology Lab
0.716749525	0.558484978	Admin Office
0.716749525	0.558484978	ICT Lab
0.716749525	0.558484978	Geology Lab
0.716749525	0.558484978	Lecture Hall Area
0.716749525	0.558484978	Histology Lab
0.716749525	0.558484978	Conas
0.716748522	0.558483833	Admin Office
0.716748522	0.558483833	Chancery Office

The attribute used with the class "location" in the computation is the latitude. The frequency of each location is calculated based on each distinct latitude value as shown in Table 3. The likelihood, which is the probability of predictor given class, is then calculated to determine the class with the highest posterior probability.

Table 3: Frequency with likelihood table of distinct latitude value

	Frequency Value				
Location	0.716748522	0.716748953	0.716749525	Likelihood Value	
Admin Office	5		1	= 6/29	0.206896552
Chancery Office	3			= 3/29	0.103448276
Mgt Staff Parking Slot	2			= 2/29	0.068965517
Conas	2		1	= 3/29	0.103448276
ICH Lab	3			= 3/29	0.103448276
MLS Lab	1			= 1/29	0.034482759
Cosmas	1			= 1/29	0.034482759
Libarian Office	2			= 2/29	0.068965517
Library	2			= 2/29	0.068965517
Lecture Hall Area	1		1	= 2/29	0.068965517
Geology Lab		1	1	= 2/29	0.068965517
ICT Lab			1	= 1/29	0.034482759
Histology Lab			1	= 1/29	0.034482759
GRAND TOTAL	22	1	6		
	= 22/29	= 1/29	= 6/29		
	0.75862069	0.034482759	0.206896552		

The outcome of this computation shows that the class (location) with the highest likelihood value is "Admin Office". With this approach, lecturers can be certain of the location name where their lecture is taking place, and students can mark their attendance in the same location. Also, visitors can know where they are and navigate to where they are going within the campus. Figure 6 shows a demonstration of a navigated place.

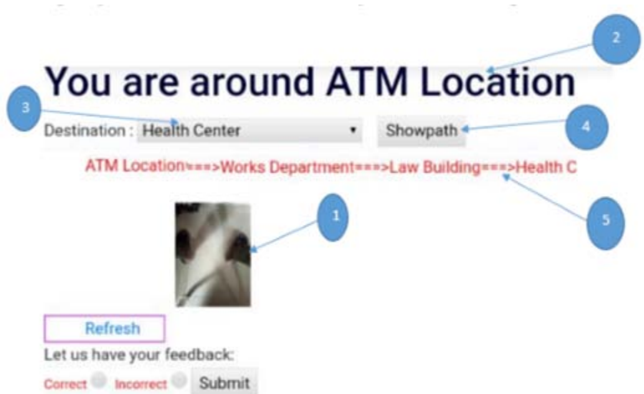

Figure 6: Route navigation page

Figure 7 shows the graph of the number of rightly-predicted locations out of 93 inputs from different smart phones

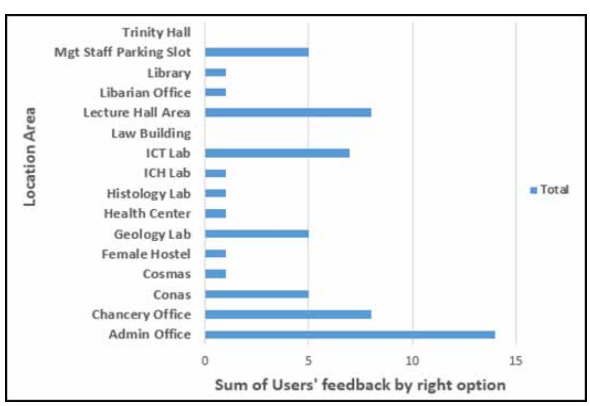

Figure 7: Count Chart of right predicted location area

The pie chart of the predicted frequency in terms of correctness is shown in Figure 8.

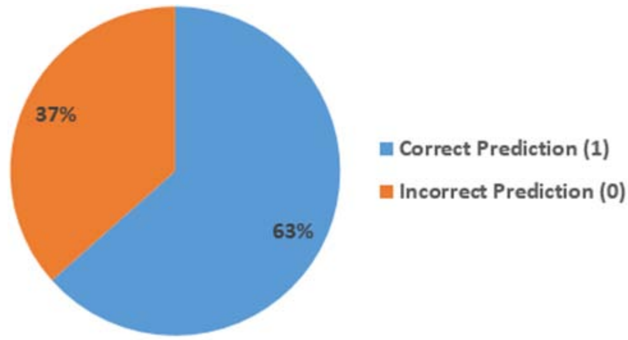

Figure 8: Pie chart representation of predicted frequency.

VI. Conclusion

The development of a geo-location-based attendance and campus navigation system is a novel system and an attempt to solve the issue of social distancing in the education system. Smartphone was the tool used to collect images at the training and testing level, due to its built-in GPS that provides an option to automatically attach geospatial information to captured media. In the attendance phase, two major modules were involved, which include the lecturer's attendance and the students' module. The lecturer module is first initialized for the student module to connect. All teachers and students within the campus can associate with the system and easily understands its way of operation. The system solves the problem of using a manual approach in taking attendance and reduces waste of time while monitoring the attendance of students. In the campus navigation phase, visitors on campus can navigate easily with little or no guidance. This research is hope to be advanced with the use of biometric.

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