mManagement: Wi-Fi Hotspot based Attendance Application using Android Smartphone

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***Abstract*—mManagement is new area for managing the business and human resource tasks that offers services by advance communication technologies and smart devices. Attendance is a hectic and time-consuming process in our daily lives. To resolve this, we proposed and developed a fully automated android smartphone application. It marks and tracks attendance as mManagement solution with an additional Wi-Fi hotspot feature. The objective of our application is to optimize the performance of taking attendance in an efficient and effective way. It reminds the students/attendees about timings of upcoming class via broadcasting a notification to attendees of that specific class. The app not only notes the attendance, but also track the presence of attendee, by automatically marking their attendance at predefined intervals. To evaluate our application, we tested the app in small conference halls, and it out-performed many existing android applications, especially applications based on Bluetooth connectivity. Our app works over the coverage area of maximum 24.5 meters radius in closed area, by marking attendance of 10 attendees simultaneously.**

Keywords—attendance, smartphone, Wi-Fi hotspot, mManagement

I. INTRODUCTION

Digital transformation has evolved the world in health and social care, agriculture, commerce, communication, and management. The advancement in technology transforms the management services into eManagement but with the advent of smartphones and cloud computing services, it significantly replicates the existing eManagement into new mManagement services and system. Enforcement and implementation of eManagement became the mainstream in 21st century [1], and now transforming into mManagement. It enables the managers to oversee the business objectives, effortlessly manage the operations, and optimize the business. Thus, reduces the cost by employing advance technologies and applications. These applications manage events, file sharing, accounts, attendance monitoring and many more.

As smartphone users are increasing enormously, tech research companies invested $1.3 trillion on digital transformation technologies in 2017, and estimated to surpass $2.1 trillion globally in year 2021 [2]. Among smartphone's operating systems, Google Android is most widely used around the world due to its open source platform. Smartphone applications (commonly referred as "apps"), are acknowledged as fastest growing trends in Information Systems industry [3]. As smartphone platform continue to improve, it provides vast features that ease the workload. Therefore, programmers have developed millions of applications, covering vast domains such as healthcare, interactive games and social networking, communication and management.

Among different management issues, attendance is the vital component of any business or schooling. Attendance plays a pivotal role in student's success and its management distinguishes between the regular and absentees. On the other hand, employees' attendance record matters a lot in preparation of pay slip and annual leaves. To deal with the attendance record efficiently and correctly different techniques and methods have been evolved with the passage of time.

Most of the approaches mentioned in next section of this paper demand manual work or extra infrastructure. Therefore, we developed an android-based attendance application that does not rely much on manual effort. It not only keeps the record of attendees (students) but also broadcast a notification message to them about upcoming lecture timing.

The main aspect of the proposed and evolved application is to optimize the performance of attendance marking task. The primary objective achieved by this application is incorporation of the remarkable Wi-Fi Hotspot feature. Therefore, it no longer requires any extra infrastructure.

The rest of paper constitutes four more sections. In next section, we outlined the related applications and their significance. Section 3 defines the proposed architecture while section 4 describes the implementation details and some testing results. The paper ends with the concluding remarks in last section.

II. RELATED WORK

As interaction with business via smartphone applications becomes more appealing, programmers developed a vast number of eManagement applications and solutions for smartphone users. Google app store provides platform to developers to build application and place it on store for customers and users. Majority of the present applications available for attendance automation either require manual work or based on Bluetooth connectivity.

As per our research regarding smartphone attendance applications on Google Play store, we found very few based on automatic attendance system. Table 1 lists top most rated (in descending order, based on Google Play store user rating) applications on Google Play store related to attendance tracking and process.

Most of the apps listed on Google Play store based on manual attendance while only few of those take attendance automatically via Bluetooth connection or QR-code scanning feature such as "Bluetooth Attendance". Others like "Attendance Keeper" and "Attendance Tracker" target the enterprise and business attendance system by tracking the location of employees through internet and with the help of

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Global Positioning System (GPS) chip, installed in smartphone, thus requiring expensive internet connection all the time. Apps as "Home Office" mark off the attendance of employees when pre-registered device of employee connects to specific router, installed at office, thus needs extra infrastructure.

TABLE I. LIST OF SIMILAR ANDROID APPLICATIONS

Serial No.	Android Application Details	
	Application name	*Developed by*
1	Attendance Manager	Vipul Gupta
2	Attendance Taker	Ferid Cafer
3	Attendance Register (Student/Staff)	Rudra Nirvan
4	SAM – Scan Attendance Manager	ShmoopySoft
5	EMS – Attendance Manager	SR Group
6	Bluetooth Attendance	Mihar Dhakan
7	EMS: Attendance Manager	Droid Tech
8	Attendance Tracker – Helpika	Geekstairs Tech
9	Attendance Tracker for Students	CrossNibble Tech
10	Attendance	PeterMan Apps
11	Attendance Tracker	PeterMan Apps

Despite many features such as importing students list, exporting attendance sheets, and statistical view of attendance record, it is worth noting that large portion of these smartphone applications involve much human interaction, specially the apps with the feature of manual attendance. The major drawback of these apps is that few of them ask for expensive internet connection all the time, while others need extra hardware.

Apps with Bluetooth connectivity limits the slave nodes to seven (number of simultaneous connections at one time) and also work in shorter coverage range around nine meters [4]. As the research suggests that, none of the above-mentioned apps exploited the Wi-Fi hotspot feature for conducting the attendance.

III. THE PROPOSED APPROACH

After investigating the laggings and shortcomings in attendance applications and techniques mentioned above, we proposed the architecture of attendance application as depicted in Figure 1. Keeping in view the hardware requirements, communication, processing, and smart phone development platform demands, we sub-divided the architecture into three components (teacher/manager, student/attendee, and cloud computing).

A. Students/Attendees

The attendees shown in Figure 1 are students with smart phones that receive notification alerts about the specific course class in which they are enrolled. Firstly, the attendee registers him/herself with proposed attendance application named as Smart Attendance. In order to receive course class alerts, student needs to subscribe at cloud computing services by specifying the course details. Once the student becomes valid attendee, he/she can mark the attendance while sitting in class with the click of a button. We outlined the attendance marking procedure in next section.

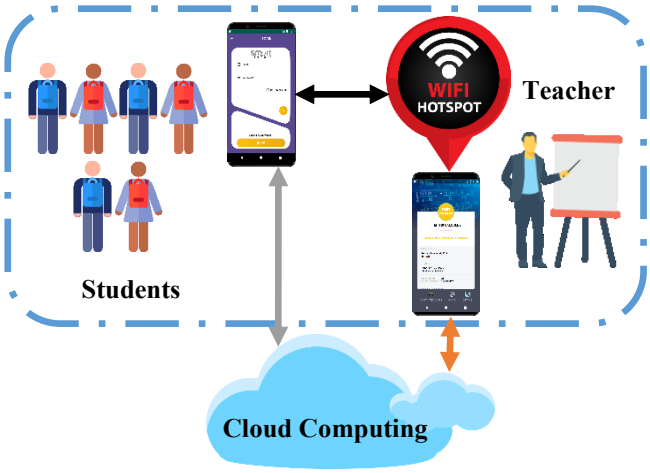

Fig. 1. The proposed arhitecture

B. Teacher

In architecture depicted in Figure 1, the teacher (component) is core of the system. A teacher requires signing up with developed mManagement platform. Afterwards, for one time only, at the start of each term, the teacher has to specify the details of course such as course title, course name, course delivery days, and list of students from which attendance is required. The proposed application provides three difference options to specify the details: (1) manually enter the course details and each student of that class, (2) import file in predefined format from smart phone's local memory, (3) or download from cloud storage service, and proposed mManagement application takes care of the rest.

Once the course details are added, and students (attendees) are subscribed to that course using free cloud-computing services, the application will notify all attendees about upcoming class, so that they do not miss it.

In first class, the teacher shares the Wi-Fi hotspot name and password with the students, so that students can connect with teacher's smartphone to mark attendance. At time of class, proposed smart attendance application reminds the teacher regarding attendance. Once the teacher press the button in application to start taking attendance, the Wi-Fi hotspot of teacher's smart phone turns-on automatically. On other hand, student's smartphones connects with the teacher's smart phone over Wi-Fi hotspot and tags his/her attendance, and disconnects on its own.

C. Cloud Computing

In the world of technology, now a days, cloud computing is amongst the most powerful solution that lends the dynamically scalable and virtualized resources as a service. The cloud computing solution served in pay-as-you-go manner [5]. Top leading tech giants such as Google Cloud Platform, Microsoft Azure, Amazon Web Services, and IBM Cloud provide cloud computing solutions and resources among which intelligent resource pooling can reduce the cost but increases the utilization.

We incorporate the Infrastructure as a Service (IaaS) of cloud computing with our proposed attendance application to utilize the storage space and processing power. The cloud services store the user's information (both teacher and

students) which can be retrieved while sending the course notification alerts. The service handles user's registration, authentication, notification broadcasting, and updating the attendance record or downloading the course details (such as course code, course title, course class delivering days and times, course duration) if requested by teacher via our smart phone application.

IV. Implementation

This section covers the workflow and implementation of proposed architecture, its usage and methods employed. Biyodata Teknoloji San. Tic. Ltd., Turkey, supported in the development of this application as a part of research thesis [6]. We developed this Smart Attendance application in Android Studio, an open source development tool provided by Google [7]. While designing and developing the application, we targeted 94.8% of Android smart phone users [7], by setting the minimum Software Development Kit (SDK) to Application Program Interface (API) 16, which is Android 4.1, Jelly Bean.

The developed application is fully automatic that marks the attendees' attendance by establishing connection over teacher/manager's Wi-Fi hotspot. It marks the attendance over data communication channel via socket programming. The application interacts with users in two modes: (1) Teacher/Manager mode, and (2) Student/Attendee mode. Initially, in both modes, application requires name, email address, teacher/student identity number and password.

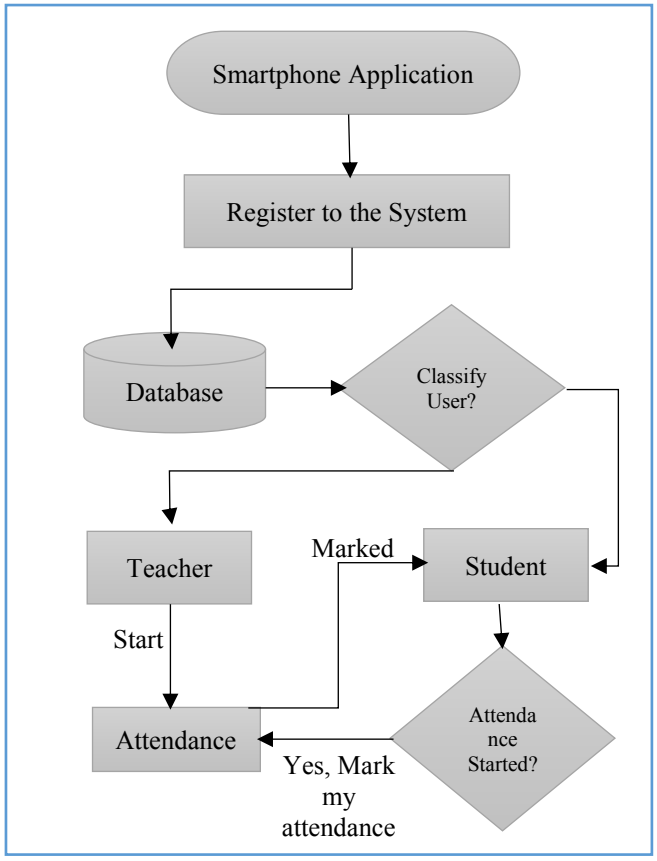

Fig. 2. Flow chart of application

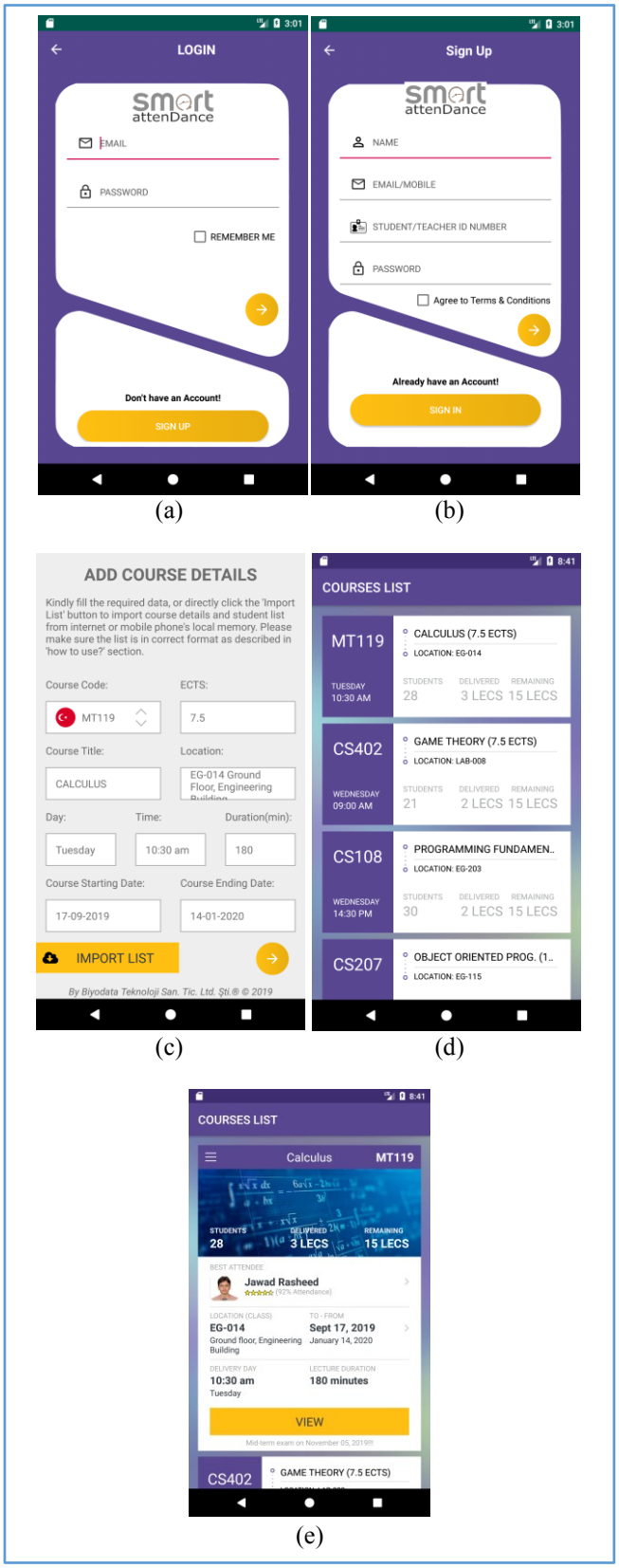

Fig. 3. User interface for smart attendance application

The application starts by registering the user and classifying as teacher or student as depicted in Figure 2. The teacher uploads/adds the course details along with registered students' data.

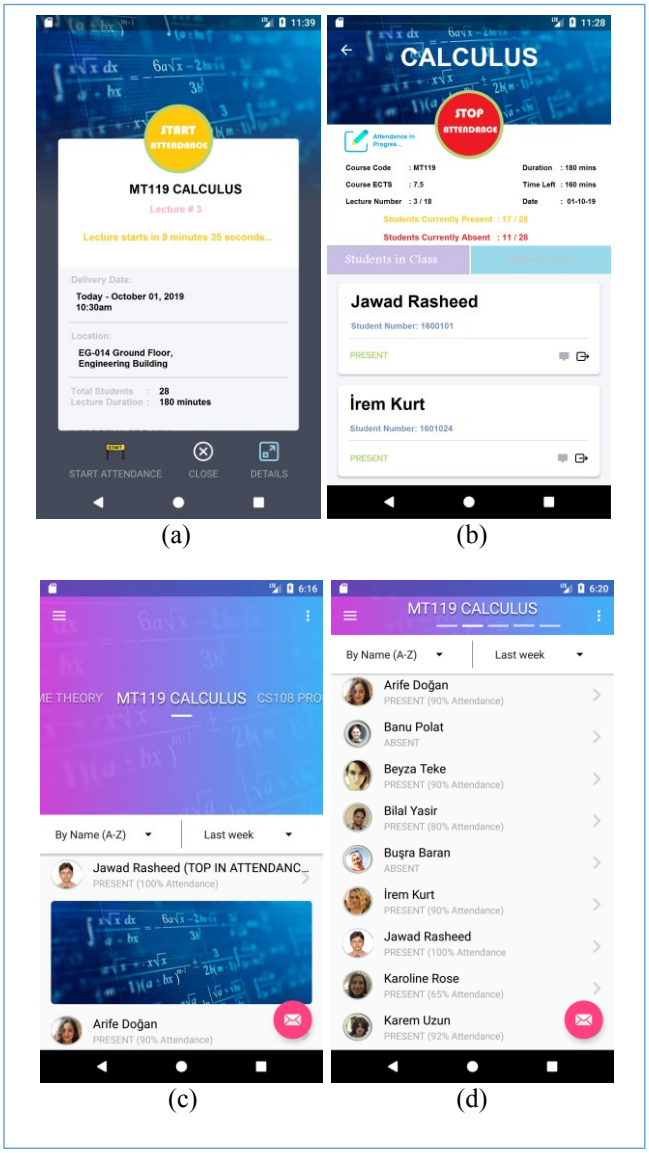

Fig. 4. User interface for marking and viewing the attendance in our developed smart attendance application

When the teacher starts marking attendance at lecture timing, concurrently, the students present in class respond by sending the attendance-marking request via developed smartphone application, by connecting with teacher's smartphone Wi-Fi hotspot.

As per our testing and findings, a smartphone Wi-Fi hotspot can simultaneously maintain 10 connections at one time. To attain the maximum number of connections, the designed application adopts the best principles of coding. Due to maximum connection capacity, student mode application might get connection-failed message while establishing the connection with teacher's smartphone Wi-Fi hotspot. To avoid such issues, the attendee whose attendance is marked, his/her smartphone Wi-Fi connection disconnects automatically. If connection fails, the student's app tries again, after interval of few seconds, to connect with teacher's device for attendance procedure.

Once the attendance is marked of a student, his/her smartphone Wi-Fi connection disconnects with teacher's smartphone, and waits for some period of time (defined by teacher's app) and then connects again with teacher's device to show the students' presence in the class. The Figure 3 and Figure 4 depict few of the layout of human-smartphone-interaction and design interface of Smart Attendance application.

The Figures 3(a) and 3(b) illustrate the login and sign up interfaces of our attendance app, in which user (either teacher or student) needs to enter his/her name, id, email and password for registration. Whereas, Figure 3(c) shows the layout form for teacher mode to add the course details manually or import it from local memory or internet. The form takes the course code, course title, course credit hours, course delivering day, its timing, duration, start and end date, and its location along with the list of students.

The app also gives opportunity to the teacher to add, edit and delete the student details manually. An animated interactive layout screenshot in Figure 3(d) depicts the list of courses of specific teacher teaching in that semester. Once teacher clicks on any course among list in Figure 3(d), an animated layout displays the course details as shown in Figure 3(e).

The app displays a pop-up dialog box interface in teacher mode as a reminder to class, while showing the remaining time and location of class, as illustrated in Figure 4(a). When the teacher presses the "start attendance" button to take the attendance, the application promptly enables the Wi-Fi hotspot of his/her smartphone. Whereas, when students press the button on their application to mark the attendance, the application automatically enables the student smartphone to connect with teacher's device over Wi-Fi hotspot.

Once the attendance of student is marked, his/her device disconnects from teacher's device for a certain period, so that other students devices have a chance to mark their attendances. For each student, attendance procedure automatically repeats to track the presence of attendees without any human interaction. In student mode app, service runs in background and connects with teacher's device to remark his/her attendance over a certain period specified by teacher's device at the time of first communication.

While smart devices are marking the attendance, no human interaction is needed further. The teacher can see the on-going attendance on his/her device that displays the names of students who are still present in class. In teacher's mode, app also shows the number of students absent and statistics of students' presence in the on-going class as shown in Figure 4(b).

The Figures 4(c) and 4(d) depict the attendance record taken of Calculus course with features of sorting and selecting the attendance of specific date. It also displays the student who topped in attendance. The teacher can synchronize the attendance record over the cloud or also email the record sheet by click of one button (called floating button).

The application also caters with the issue of proxy attendance, by checking if two persons' attendance is being marked by same Wi-Fi MAC address in that lecture; it prompts an alert to teacher smartphone to oversee the issue. The developed app also authorizes the teacher to mark the student's attendance manually who does not have smart phone or forgot to bring his/her mobile phone.

We evaluated our app, and found that it outperformed many existing android attendance applications, specially the

applications with Bluetooth or QR-code features. Table 2 lists the comparison results.

TABLE II. RESULTS COMPARISON WITH OTHER ANDROID ATTENDANCE APPLICATIONS

Feature	Android Smartphone Attendance Application			
	Manual apps	***Bluetooth apps***	***Apps with external Wi-Fi***	***Our app***
Infrastructure	No	No	Yes	**No**
Coverage Area (meters)	N/A	<9	0 – 40	**0 – 24.5**
No. of simultaneous connections	N/A	5 – 7	Unlimited	**Max 10**
Human interaction	Much	Normal	Normal	**Less**

V. CONCLUSION

The focus of the study is to develop an android smartphone application to achieve a better way of conducting human attendance. The main aspect of the application is to optimize the performance of attendance procedure without any extra hardware. We accomplished this objective by introducing built-in Wi-Fi hotspot feature to connect students' smart devices with teacher's smart phone. The experiments and results show that developed application outperformed many existing android applications with Bluetooth connectivity feature. The app works perfectly over a coverage area of 24.5 meters radius and handles 10 simultaneous connections to mark the attendance.

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