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Research paper

An Optimized Method for Automated Stadium Attendance Management System

Asnorul Bari'ah Mosman[1], Salama A. Mostafa[1], Aida Mustapha[1], Abu Ubaidah Shamsudin[2], Mohammed Ahmed Jubair[1] and Mustafa Hamid Hassan[1]

[1]Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, Johor, 86400, Malaysia
[2]Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, 86400, Johor, Malaysia
di150052@siswa.uthm.edu.my, {salama, aidam, ubaidah}@uthm.edu.my, mohamed.a.jubair@gmail.com;
**Corresponding author E-mail: mustafa.hamid.alani@gmail.com:*

Abstract

In recent times, football and football players' popularity is increasingly rising which make the football stadium increasingly full of supporters from both the home and opposition teams. However, the management of the stadium attendance still applies conventional methods, which results that the audiences might be dissatisfied with the attendance method. This paper proposes an optimized method for the management of the stadium attendance. The implementation of the method applies a prototype methodology to develop a systematic and efficient Automated Stadium Attendance Management (ASAM) system. In addition, communications technology of smartphones is used to scan barcodes on tickets and dismantle the data to the system. This work is meant to help stadium workers to efficiently manage the attendance of audiences. The test results show that the system successfully retrieves, and processes optimized data and information of the spectators and efficiently manages the stadium attendance.

Keywords: *Automated stadium attendance management, Smartphone, Barcode*.

1. Introduction

In order to enter a stadium, the audiences only have to exhibit tickets purchased at the ticket purchases provided. As the world has advanced with increasingly sophisticated technology, the audiences can still buy tickets at ticket counters at the stadium. This makes buying tickets take a long time (online ticket purchases are also available). Additionally, audiences need to line up on each fence [1-3]. Usually, there are only a few ticket keepers that keep counters in an over-crowded audience and a few ticket checking counters [4]. This work takes the Stadium Tan Sri Dato' Haji Hassan Yunos or better known as Larkin Stadium as a case study. The stadium is very popular among fans in Malaysia especially the people of Johor. It is named after the former Johor Chief Minister, Tan Sri Dato' Haji Hassan Yunos. It was built in 1964, but it was only a small place with only 15,000 people to accommodate. In 1991, its capacity was doubled after a small change. Now, the capacity of the stadium is 28,000 spectators with 22,000 seats [5], [6]. Many football matches are done at this stadium during the football season. Hence, it takes a long time to get into the stadium [7]. With the increasing viewership and admission, the management system to the stadium will be more inefficient. Therefore, the ticketing system needs an application that facilitates the audience entry to the stadium [8], [9]. To solve the issue, a ticket verification application is needed that allows ticket counters to open a little bit and facilitate the work of the people involved. In addition, the data taken allows the management to easily count the audience into the stadium. With this application, it can distinguish original and fake tickets.

This paper proposes an Automated Stadium Attendance Management (ASAM) system. It includes a barcode to check the validity of tickets and the tickets are scanned by mobile phones. When a ticket is scanned at the counter, it indicates that the ticket is valid or not. If the ticket is valid then the system will update the database with the ticket information including the seat number, block number, match date and attendance time. At the same time, it calculates the amount of audience entry into the stadium and shows their seats. If the ticket is not valid, the scanner application warns the gate guard that the ticket is invalid. The method also allows users to update the attendance data of the system from the smartphones.

2. Related Work

This session discusses a review of existing stadium attendance methods and systems. This study is conducted to collect information related to the method to be designed and the system to be developed. Comparative methods will be made on the matching system to get a clear distinction between the advantages of the system to be developed.

Nortech [10] proposes an attendance system that is used to meet strict safety requirements. It includes a Security Solutions Limited (SSL) tasked to prepare a stage monitoring system and management system to monitor the turnstiles that have been installed. Each turnstile is aligned to provide the signal output whenever the audience enters the stadium. Nortech's Stadium Venue Counting System keeps track of

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the number of viewers entering each turnstile and calculates the occupancy level at each of the four entrances. This information is displayed on the computer at the control room of the stadium. Information can be displayed as the number of viewers, the number of seats available or the percentage of occupants. The system is primarily used by the police to ensure that the stadium is filled with secure and secure capacity. The data provided by this system is also used to confirm attendance at day matches so that it can be set up for the local area.

Welki and Zlatoper [11] propose a system to estimate game-day attendance at professional football games in the U.S. using the Tobit analysis. The data that is used is the data taken during the 392 regular season games played during the National Football League (NFL) seasons between 1986-1987. What can be concluded here is that the analysis only examined the effect of specific changes for individual game attendance. This analysis does not develop any system for attendance management system at the stadium.

Saheed et al. [12] propose a system for managing students' attendance. The system is accessible for the lecturers while the reports can be generated automatically in real-time, providing valuable information about the students. This system is implemented using barcode technology by coding each student's ID card, hence each barcode has unique student data such as matric number, department, faculty and all important student information. Students only need to swipe identity card through the barcode reader.

Subramaniam et al. [13] also propose an attendance system that uses Barcode scanner to take attendance of students entering labs. Each student's ID card has a barcode at the back side of it. This barcode contains unique data of the student such as roll number, branch and year and so on. The display screen shows the attendance of a particular student after scanning his/her barcode. All users including teachers and administrators can only access the system using their respective login ID's and passwords.

Mendonca et al. [14] propose a system that registers the attendance of teachers and students. This system is trying to reduce the traditional or manual process of marking attendance in which a teacher has to call out every student in the class and mark their attendance upon their physical presence. This system also aims to reduce the overall process of attendance acquisition process and reduce proxy completely.

It also includes offline features stored as a contingency plan if the online feature does not work normally due to some technical problems. The offline version offers the same basic similar to the generic process. This system not using the barcode system but Radio Frequency Identity Cards (RFID) instead. The system is portable and can be easily installed and used on any mobile phone running in Android. Table 1 shows the summary of the related work.

Table 1: The summary of the related work

Author	Method	Problem	Summary
Nortech [10]	Turnstile	Stadium attendance	Propose an attendance system that is used to meet strict safety requirements
Welki and Zlatoper [11]	-	Game attendance	Propose a system to estimate audiences who came game-day attendance at professional football games in the U.S. using Tobit analysis.
Saheed et al. [12]	Barcode	Class attendance	Propose a system for managing students' attendance
Subramaniam et al. [13]	Barcode, scanner	Class attendance	Propose an attendance system that uses Barcode scanner to take attendance of students entering labs
Mendonca et al. [14]	RFID	Class attendance	Propose a system that registers attendance of teachers and students

3. Materials and Methods

Through the literature review, there is a need for studying the current systems to better understanding the attendance management problems. This section explains the football stadium attendance systems, structure of football stadium, automated attendance methods, type of barcode and also type of barcode scanners. Comparative methods are made on the similar system to get a clear distinction and possible improvement.

3.1. Football Stadium Attendance Systems

To enter a stadium, audiences have to show the tickets purchased at the ticket purchase counter provided. As the world has advanced with increasingly sophisticated technology, audiences can still buy tickets at ticket counters at the stadium. In addition, online ticket purchases are also available. This makes it easy for audiences not to take a long time to buy tickets.

A ticket confirmation counter opens on every fare into the stadium. Counterguard verifies each ticket and tore up the ticket cuttings that the management needs to keep, and the rest of the viewers will keep it. The ticket clipping is kept making an analysis of the number of audiences present at the stadium.

3.2. Structure of Football Stadiums

A stadium is a place to host outdoor sports, concerts, or other events. It usually consists of a field or stage either partly or completely surrounded by a tiered structure that is able to cater thousands of audiences or spectators. It is also designed to allow audiences to stand or sit and view the event [15]. Most of the stadiums with a capacity of at least 10,000 are used for association football, or soccer, the most popular sport in the world [16]. According to [17], the new stadium of Panathinaikos F.C., a historic Greek football club in Votanikos, Athens, Greece is able to host approximately 40,000 audiences. The structure is very majestic, whereby the grandstands are designed to be completely covered for conveniences.

In Malaysia, there are many stadiums used for football matches such as Dato Tan Sri Haji Hassan Yunos Stadium or better known as Stadium Larkin, Bukit Jalil Stadium, Shah Alam Stadium and many more. In every state, have 2 or more stadiums used for soccer matches or even each team training. The number of audiences who can enter the stadium in Malaysia between 15,000 and 90,000 people [18]. Most of the stadiums in Malaysia have four or five entrances. Fig. 1 shows an example of entrances for the audience at Larkin Stadium. This picture is quoted from social media Johor Southern Tigers.

Fig. 1: A top view of the JOHOR stadium (Source: Facebook JOHOR Southern Tigers)

The stadium is also equipped with corporate rooms, VIP lounges, secretarial rooms, treatment rooms, security, and other related services to the needs of spectators and competing teams [7]. There are many attractions available at this stadium besides the existing facilities that can provide you with the experience of enjoying the events happening at the stadium.

3.3 Automated Attendance Methods

Many of these systems make use of sophisticated biometric equipment while some others use Barcodes and Radio Frequency Identity Cards [8]. The barcode is deciphered by a barcode reader revealing the identity of the object and permitting analysis and control based upon this data [9].
Application movements started with audience tickets. They have to hand over their tickets to the gate guard at the entrance of the stadium. The gate guard will scan the barcode on the ticket to make a revision. If the barcode is genuine, the scanner will display a notification interface that the ticket is valid or not. If the barcode on the ticket is not in the data stored by the management, then the scanner will display a notification interface that the ticket is fake. Scanners used by the gate guard are smartphones that have installed scanner applications. Fig. 2 shows an example of automated attendance management architecture.

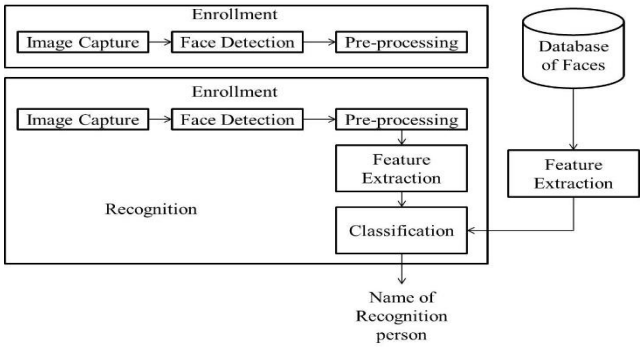


Fig. 2: Architecture of automated attendance management system

3.4 Barcode

A barcode is a type of data representation that uses machine-readable, optical means to describes something about the object that carries the barcode. The codes are designed in a sequence of vertical bars and spaces to represent specific alphabets, numbers and symbols [24]. Originally, barcodes are in the form of linear or one-dimensional (1D) representation where the data is represented by varying the widths and spacing of parallel lines [25]. Two-dimensional (2D) codes were next developed by using shapes such as rectangles, dots and other geometric patterns in two dimensions. They are still referred to barcodes although they do not rely on shapes of bars anymore [26]. Barcodes can be read by using specific device, which is an optical scanner called barcode readers.
Barcodes are common to be used in labelling items such as name badges, inventory and industrial applications. The Code 39 barcode is the easiest of the alpha-numeric barcodes to use and is designed for character self-checking, thus eliminating the need to check character calculations [27], [28]. The complete Code 39 barcode consists of a start character, data digits, an optional check character and a stop character. Fig. 3 shows an example of Code 39P barcode.

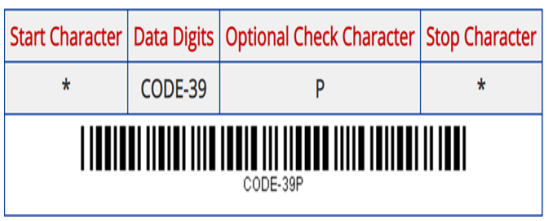


Fig. 3: The Code 39 Barcode example

A barcode scanner or barcode reader is an electronic device that can read and output printed barcode to a computer [29]. Nearly all barcode readers contain decoder circuitry in order to detect the barcodes' image data as provided by the sensor and to send the barcodes' content to the scanner's output port [27]. 2D imaging scanners are the most up-to-date type of barcode reader currently available. The imaging scanner uses a small video camera to capture an image of a barcode [27]. The reader then uses sophisticated digital image processing techniques to decode the barcode.

3.5 Prototyping Methodology

The methodology model chosen for the development of this system is the prototyping methodology. This methodology is applied when detailed information related to the input and output requirements of the system is not available [22]. In this model, all the requirements are assumed to be unknown at the beginning of the project development or in the case that there is no manual process to determine the requirements. This is a challenging scenario especially in developing a large and complex system. This methodology also allows the users to interact and experiment with a working model of the system known as a prototype, which gives the user an actual feel of the system although it has not been refined into the final system. Fig. 4 shows the architecture of the ASAM model.

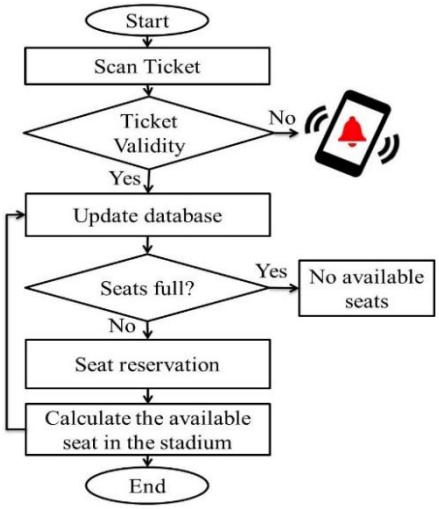


Fig. 4: The prototype model design

The prototype process consists of the process of executing a trial system quickly and easily to be evaluated by the end user [30]. Like most common knowledge, the prototype is the initial version of a system application and will be the starting source of a system. Table 2 shows a summary of the flow of activities involved in developing a stadium attendance system based on a barcode system. The summary of this activity comprises activities undertaken from the initial phase to the end of the Prototype model phases. The planning of this activity is necessary to ensure the system is developed according to planning and systematic.

Table 2: The research phases and activities

Phase	Activity
Analysis	• Activities involved such as title selection for the system to be developed. • Make a proposal. • Identify the problems that are being encountered, the objectives and scope of the system. • The method selected and will be implemented. • The system development has gained a name for the system to be developed. • The objective scope has been listed. • An interview session was conducted between stadiums for information on stadium tickets management. • A co-management meeting has been carried out throughout the system development process.
Design	• Identifying the needs of the system to be implemented in the development of a prototype system that is designing data models, database systems and interfaces. • Make some examples of system interfaces based on the system requirements that have been collected.
Prototype	• Develop a system interface and database according to the design process that has been created. • Develops the processes and functions contained in the system using the programming code. • The complete system generated involves the interaction of the system interface with the database.
Phase	Activity
Customer Evolution	• Make early unit testing activities against modules and functions that are in the system.
Review and Update	• Detects errors that occur during system testing activities.
Development	• Develop a complete system interface and database.
Testing	• Provide briefing sessions to stadiums and guardians on the application of attendance system at a stadium-based barcode. • The stadium management tests the system. • Improves the system in terms of functionality and system interface design.
Final System	• The system is given to the management of the stadium to be tried and used. • Provide support to the stadium management regarding the use of the system.

4. Implementation and Results

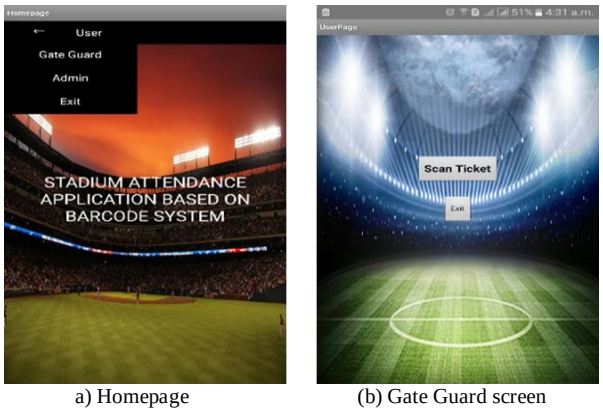
The implementation details for this application involves the scanning and updating data with barcode code and these represented in the form of source codes and image resources in the application. To develop this application, there are several tools used. Among them are MIT App Inventor 2, Google Apps Script, JavaScript and Google Sheets.

- MIT App Inventor 2: App Inventor for Android or MIT App Inventor is a web application maintained by Massachusetts Institute of Technology (MIT). It uses a graphical interface, which allows users to drag-and-drop visual objects to create an application that can run on Android devices.
- JavaScript: JavaScript is an object-oriented computer programming language commonly used to create interactive effects within web browsers. JavaScript can be connected to the objects of its environment to provide programmatic control over them.
- Google Apps Script: Google Apps Script is a platform for building web applications. It uses JavaScript language to develop an application or system. Google Apps Script also the tool that powers the add-ons for Google Docs, Sheets and Slides.
- Google Sheets: Google Spreadsheets is a web-based application that allows users to create, update and modify spreadsheets and share data directly online. Google Sheets uses Ajax program that is compatible with Microsoft Excel and can be saved in Comma Separated Values (CSV) or HTML.

Stadium Attendance Mobile Application based on Barcode System have three (3) modules which are Homepage module, Gate Guard module and Admin Module. Homepage module is the activity for the welcome page. For Gate Guard module, this module will scan the ticket barcode and verify the barcode whether this ticket valid or not and this module used for Gate Guard. While the Admin Module is used by Admin or Stadium Management staffs.

The homepage module is the activity for the welcome page. This page is also known as the home page. It displays the title of the project and at the same time initialize and the loads the background. The flow of this application begins with this module, when the user taps on the User menu bar, it is will display the menu for the user whether Gate Guard or Admin. When the user clicks in Gate Guard it is will display the Gate Guard Activity. Figure 5 shows the homepage screen. Fig. 5(a) shows the default screen with '≡' button and once clicked it displays a content in the user menu bar just shown in Fig. 5(b). Users are given the option to choose the user. When the user clicked in Gate Guard button, it displays a window that used for gate guard function. For the stadium management users, the user must click on the Admin button.

This module will scan the ticket barcode and verify the barcode whether this ticket valid or not. This module not required the user to insert username or password. In this module, the user clicks on 'Scan Ticket' button to scan the barcode ticket. Then, automatically the screen will display the scanning screen. Then, it will verify the barcode whether the barcode has in data or not. Verification the barcode created with a combination of blocks segment in MIT App Inventor, Google Sheets and Google Apps Script.



a) Homepage (b) Gate Guard screen

Fig. 5: The main layout of the mobile application

The admin module describes the most significant procedure for any application that requires user authentication. It is a login interface for admin. For admin login, the username and password is a static authentication. Figure 6 shows the blocks segments for created static authentication for admin. When the user as an admin, the user must log in to do admin's works. In this module, admin can update, delete and insert new data in this application. Admin can also visualize how many audiences in the stadium based on seats divided into several sections. There are six sections that have been divided to facilitate the counting of the audience inside the stadium. Fig. 6 shows the table of the database in this application. Admin can insert new data update the data which mean edit the data and delete the data. Fig. 6 shows the interface to insert new data. When the admin clicks the "New" button, the new interface will display.

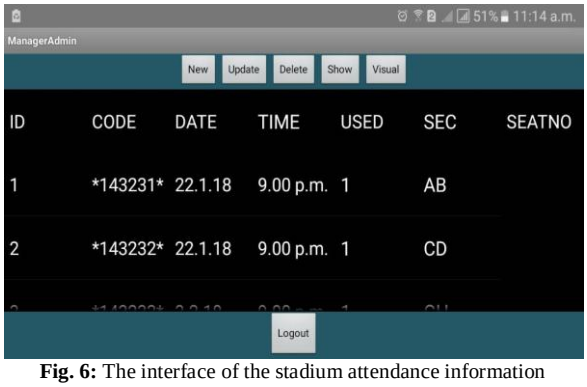


Fig. 6: The interface of the stadium attendance information

The testing phase for stadium attendance application based on barcode system was carried out for each iteration. However, for the sake of brevity, only the final and enhanced iterations test is discussed. Functional testing is more important because it always verifies that an application is fixed for release. In functional testing is to do the testing of the functions of application is implemented. Furthermore, it is performed to verify the application performs and functions correctly according to interface design.
This function displays the title of the project and at the same time initialize and the loads the background. With the test plan from table 2 is to check whether the actual output is equivalent to the expected output. During runs the application, the actual output matches the expected output, then the buttons in the menu bar have passed the testing phase. Table 2 illustrates the test plan for the system. Fig. 7 shows the automated method consumes less time when compared with the manual method.

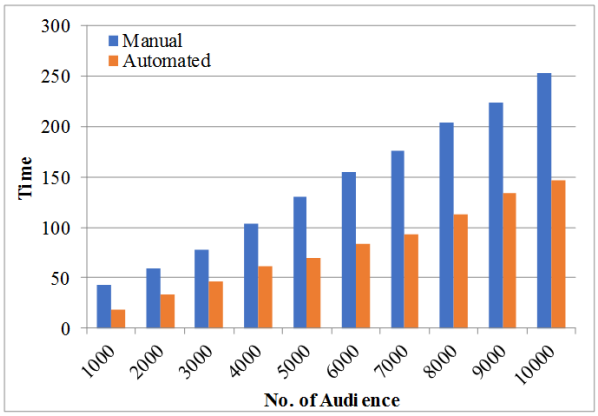


Fig. 7: The comparison time between manual and automated methods

5. Conclusions

In this work, an Automated Stadium Attendance Management (ASAM) system based on Barcode is implemented to facilitate the management and confirming the attendance of the audience into the stadium. When the barcode inside the ticket is scanned, it determines whether the ticket is valid or not. This system is built for reducing the problem of managing the number of audiences entering the stadium. The system also can make easy for stadium management to handle the ticketing system at the stadium which means the management can update all the data using this system. It has the advantage of an optimized management with a neat GUI and easy to use functions. In addition, the system is developed using a mobile platform that makes it easy for users to use anywhere. The testing also revealed certain limitations faced by the application. The primary limitation of the system is that the data must be manually updated in the system database which takes time. There are several enhancements that can be applied to the proposed system to improve its performance and functionalities. Software agent technology provides flexibility and autonomous capability to systems, especially when humans are involved in the systems' run cycle [30-34]. This work can be improved by deploying a software agent to automatically update the data and upload information on the tickets.

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