**Attendance Tracking**

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**Abstract** - We believe that a student’s attendance in their university courses is important for the successful completion of their courses and that student attendance is a marker one can use to identify students in need. The problem this paper addresses is how to track student attendance in university courses in a fast and efficient manner, given class sizes can be as small as 10 students and as large as 300. Our approach uses easily found, inexpensive hardware and makes use of students’ smartphones to help with the attendance tracking process. Our applications for the server and client portions of our system use open source software to minimize development and maintenance costs and do not require end users or system administrators to perform any installation.

**Keywords:** Attendance, Tracking, Smartphone, Web

1 **Introduction**

The Science Student Success Centre (SSSC) at Carleton University is made up of students, staff, and faculty who know what students need to succeed in courses in the Faculty of Science. We collaborate with other on-campus departments to offer workshops, events, and activities that help to develop students' academic and professional skills. The SSSC also takes an active role in helping students struggling in their first-year computer science, math, and science courses. Its mission is as follows:

- Increase the engagement and retention of students in the Faculty of Science
- Foster the growth and achievements of high performing students
- Identify and support students who may be experiencing difficulty with their studies
- Inform students of professional and academic development opportunities
- Aid in the recruitment of outstanding students to the Faculty of Science

One of the methods the SSSC uses to identify first-year students in need is to look at their mid-term marks in their first-term science courses in mid to late October. Those students with marks less than 60% are sent an email and asked to come in and visit with the SSSC team to talk about the issues they are facing with their courses and possible techniques and actions they can take to overcome the issues.

The SSSC believes that a student’s attendance in their university courses is important for the successful completion of the courses. We also believe that student attendance is an important marker that can be used to identify students in need. It is not that attendance is mandatory, but that students falling below a given level of attendance should be asked to meet with the SSSC team to talk about the reasons behind their low attendance and support given to help correct any issues the students are having.

The problem this paper addresses is how to track student attendance in university courses in a fast and efficient manner, given class sizes can be as small as 10 students and as large as 300. Taking attendance using paper and pen is one approach, but it is slow and prone to errors. In addition, this method must go through a data entry phase in order to generate reports, which also suffers from the same problems. Therefore, using pen and paper is not an option.

1.1 **Goal**

Our main goal is to provide a fast and efficient attendance tracking system. In addition, the system must work in any and all classrooms at Carleton University, including its electronic classrooms – those with computers and projectors – and those classrooms containing no computers. Finally, our goal is to provide a system that requires minimum hardware, and as a result is built and maintained at minimum cost.

1.2 **Objectives**

To meet the goals mentioned in the previous section, we have the following objectives:

- Use easily found, inexpensive hardware
- Make use of students’ smartphones to help with the attendance tracking process
- Use open source software to minimize development and maintenance costs
- Installation, either for end users or system administrators, should be fast and simple
- Attendance reports should provide end users with the greatest flexibility for manipulating the collected attendance data
- Support both Mac and PC platforms, and Android and iPhone smartphones
1.3 Outline

In section 2 we describe literature on existing attendance tracking systems. Section 3 describes our overall approach. Section 4 describes the current view of our system, including screen shots of the Web frontend of our system. Section 5 provides our conclusion and identifies our future work.

2 Background

Attendance tracking has been viewed as a method of improving student attendance and retention rates. Professor Mehmet Dicle and John Levendis at Loyola University in New Orleans created a computer program designed to electronically check students into class, eliminating the need for a lengthy roll call and saving valuable class time [1,2].

“The technology, called the DL-Electronic Attendance System, uses a quarter sized computer chip to track attendance by having individual students pass the chip in front of a scanner as they enter class. The scanner, hooked up to the professor’s computer, records the students’ attendance, eliminating the need for roll call.”

Dicle and Levendis’ system is relatively inexpensive. The cost of the scanner is about $20 and is available online or in electronics stores. The chips that are scanned are also inexpensive, costing less than 30 cents each. The downside to this approach is that each student must be given a chip and the chip must be registered with the system.

Northern Arizona University (NAU) also implemented a similar attendance tracking system, based on RFID technology [3]. However, it was costly, with a price tag over $85,000, and created tension with the student body, raising the fear of invasion of privacy

“Northern Arizona University recently received $85,000 to fund a new tracking initiative that revolves around a series of scanners stationed outside lecture halls.” [4]

DeVry University [6] uses a system similar to TSU.

“A card reader is an automated system that collects class attendance by students swiping their DeVry ID cards for every scheduled lecture and lab session. The card readers are conveniently located in each classroom and lab.”

The University of Mississippi (UOM) uses a system similar in need to the SSSC at Carleton University.

“The Class Attendance Guidelines Policy discusses the importance of attendance relative to learning. Instructors are asked to report cases of freshman students missing three or more class periods as part of the Freshman Attendance-Based Intervention (FABI) program. The Academic Support Center follows up on these cases to connect students with resources. Yet, taking attendance for large classes can create an administrative burden for the instructor and also take away from critical class time.”

Their system uses the Symbol MK500, a small computer with a barcode reader and a network connection making it similar to what retail stores use for checking prices. As noted [7], the process for checking attendance is as follows:

- Students scan their student IDs by placing them under the scanner so that the ID barcode is readable
- The scanner reads the student ID information and sends it to SAP using the SAP Netweaver Gateway system.
- SAP processes the records to update class attendance based on the location, time, class, and student in near real-time
- The results are made available to the instructor using the new “Manage Attendance” option within the Class Rolls and Grades interface in myOleMiss

What was interesting about this system is the use of cell phones was considered, but ruled out.

“We considered having students check in with cell phones, but some instructors do not want cell phone usage to be part of the solution due to their potential to distract.”
In addition to attendance tracking system that are owned and operated by individual universities and colleges, open Web-based systems like myattendancetracker.com are also available to educators [8]. After creating an account, classes and students entries, users can start recording student attendance over the Web and generate Excel reports. The disadvantage of the system is the task of entering information and the inability to quickly log student attendance using card readers or RFID tags based on student ID cards.

2.1 Summary

As described, there are different options available for attendance tracking system, each having a different hardware interfaces to where the student information resides. Hardware interfaces included RFID scanners, barcode scanners, card strip readers, and chip scanners. The choice of hardware depends on what students have available on their ID cards or if there is no ID card available. In some cases, the interface is the Web, and all data entry must be done manually. The cost of each system can vary greatly depending on the interface choice, and consideration must be given to the number of interfaces devices required by an institution. What is missing from the discussion is the time required to check in large classes using each of the approaches. For example, using 10 seconds as a check in time per student using a single reader, a class of 200 students requires 33.34 minutes to check in every student. In our case, this check in time is unacceptable for any class.

3 Approach

In the following sections we outline our approach. First we set the context for our approach, describing the environment that our attendance tracking system must operate in. The next section describes our database scheme. Our approach uses a combination of Web and smartphone logging and our database schema reflects this approach. The final section describes our implementation, interfaces and goes into a description of the system’s features.

3.1 Context

At Carleton University, student ID cards have a magnetic strip on the back containing minimal information (no name or student id) but just enough to be able to access the student’s record in the university database. The omission of name and id information is due to governmental Freedom of Information and Protection of Privacy Act regulations.

The university has Internet access in all classrooms. This access includes wireless connections for all students and faculty, and wired connections for instructors in electronic classrooms. Electronic classrooms include a locked computer and monitor, one or two LCD projectors, screen(s), chalkboards, and may include wired speakers. The classroom’s electronic control system enable instructors to connect USB devices to the locked computer, or switch the LCD projector to connect to any laptop they decide to bring and operate in class.

3.2 Database Schema

Our database scheme contains four tables: Organization, User, Event, and Register. The Organization table is responsible for providing information on organizations, such as Carleton University, that want to track attendance. The Organization table contains the following columns:

- **ORGANIZATION_PRIMARY_KEY**: the primary key of the organization
- **NAME**: the text name of the organization

The User table is responsible for recording information about users of the attendance tracking system, such as instructors and administrators. The User tables contains the following columns:

- **USER_PRIMARY_KEY**: the primary key of the user.
- **EMAIL**: the email address of the user.
- **FIRST_NAME**: the first name of the user
- **LAST_NAME**: the last name of the user
- **PASSWORD**: the user’s system password
- **ORGANIZATION_FOREIGN_KEY**: a foreign key reference back to the user’s organization
- **TYPE**: the type of users, which is either instructor or administrator.

The Event table is responsible for recording the different events, such as a class or an exam, which an organization wants to track attendance. The Event table contains the following columns:

- **EVENT_PRIMARY_KEY**: the primary key of the Event
- **USER_FOREIGN_KEY**: a foreign key reference back to the user who will be recording attendance of the event
- **NAME**: the name of the event
- **NUMBER**: the number of the event
- **YEAR**: the year of the event
- **DEVICE_ENTRY_TYPES**: an or’d bit string indicating which hardware devices (Web, iPhone, Android) are permitted to log user attendance
- **OTHER_INFORMATION**: an open text field contain other information related to the event
- **TERM**: the term the event occurs in
- **SECTION**: the section of the event
- **ORGANIZATION_FOREIGN_KEY**: a foreign key reference back to the event’s organization
- **LATITUDE**: the latitude of the event location
The Register table is responsible for logging student attendance at an Event. The Register table contains the following columns:

- **REGISTER_PRIMARY_KEY**: the primary key of the Register
- **USER_FOREIGN**: a foreign key reference back to the user that recorded the attendance of a student
- **EVENT_FOREIGN_KEY**: a foreign key reference back to the event being logged
- **DEVICE**: the device used to log the attendance
- **FIRST_NAME**: the first name of the person attending the event
- **LAST_NAME**: the last name of the person attending the event
- **PHONE_INFO**: the phone information of the student attending the event
- **STUDENT_NUMBER**: the student ID of the student attending the event
- **CARD_STRIP**: the contents of the person’s id card
- **EVENT**: a string representation of the event
- **ORGANIZATION_FOREIGN_KEY**: a foreign key reference back to the user’s organization
- **ENTRY_TIMESTAMP**: the time the attendance was logged.
- **LATITUDE**: the latitude of the were the log was taken
- **LONGITUDE**: the longitude of the were the log was taken
- **ALTITUDE**: the altitude of the were the log was taken
- **ACCURACY**: the accuracy of the were the log was taken, compared to the latitude, longitude and altitude of the event

### 3.3 Implementation, Interfaces and Features

#### 3.3.1 Server

The server side of our application is a standard Web application setup. We use an Apache HTTP Server that communicates with a Tomcat application server when requests of the form srr.carleton.ca:8080/attendance/xxxx are received. xxxx is used to indicate what functionality of the attendance application is being requested. Our attendance server application is written in Java using Struts2 and Hibernate, the latter providing communication to our MySQL database server.

The MySQL database is replicated on another slave MySQL database server ensuring that all data is backed up immediately. In addition, nightly snapshots of the database are taken. Database administration, such as user, event, and organization creation, modification, and deletion are done on the server using the MySQL workbench.

#### 3.3.2 Interfaces

We have three interfaces to log attendance. The first is our Web interface that users access using the URL mentioned previously, and for this reason Internet access and a browser are required to use our system. This recording interface is provided to a user after they log in to the system, and for this reason the interface is only available to registered instructors for their associated events. Once logged in, a user selects a course, from here on synonymous with an event, they are responsible for and registers students by swiping students’ ID cards.

In order to swipe ID cards, users must have a magnetic card reader and access to a USB port on the computer they are accessing our Web interface. Using a Mac or PC, after plugging in the card reader, users should be able to swipe ID cards providing data to the corresponding required field in the Web interface. Our card reader of choice is the MagTek SureSwipe Reader USB HID Keyboard Interface, Model#: 21040145, shown in Figure 1. Single unit price is near $50.00 CDN, with cheaper prices available for multiple unit purchases.

The SureSwipe Reader is available with a USB interface in either HID or a Keyboard Emulation mode and it can be reconfigured in the field. The SureSwipe reader captures 3 tracks of data from all ISO and AAMVA encoded magnetic stripe cards. A green/red LED indicator on the reader provides the operator with status of the reader operations.


Figure 1: MagTek SureSwipe Reader, Model#: 21040145
Once the server receives the card swipe and event information, it accesses the university database in order to retrieve specific student information needed to complete the register record. If Web logging is permitted for the event, the register is completed and recorded in the database showing it was done with the Web as the device. In this case, altitude, longitude and latitude information is considered perfect giving an accuracy of 1.

The other interfaces we have are through iPhone and Android smartphone applications. These applications require students to enter their first name, last name, phone number and student number into the application, along with the course identification string. Once entered, it is a simple matter of students hitting the submit button at the bottom of the application. In addition to this information, the student’s current location information (latitude, longitude, and altitude) on the phone is transmitted to the server. If iPhone or Android logging is permitted for the event, the register is completed and recorded in the database showing it was done with the corresponding smartphone device. The accuracy of the register is also computed and stored in the record by comparing the altitude, longitude, and altitude of the event with the corresponding values sent from the phone.

The combination of the three supports attendance tracking in all sizes of courses.

- Registered users: Users of the system are identified as users or administrators. Users are only permitted to view results from events that they are responsible for, while administrators can view everything.
- Reporting: Real-time Excel spreadsheets are downloadable by users and administrators showing attendance results for events.
- Real-time: All logs and reports are done and generated in real-time.
- Inexpensive Hardware: Magnetic card readers are relatively inexpensive and less than $50.00 per unit if purchased in bulk.
- Other than server installation, users don’t install any software to support the system.

4 Current System View

Our attendance tracking system is live and running at srr.carleton.ca:8080/attendance. Organizations, events and user can be added by contacting the author directly. Once added, users can log in using the startup URL and providing the information requested, as shown in Figure 3. A user’s id is their email address, and their password is provided to them once they request a user id. The password is encrypted in our database so no one can ever view it directly as clear text.

When a user logs in, they request to “Login To Record” or “Login To Reports”. When they “Login To Record” and their id and password are correct, they are presented the screen shown in Figure 4. On this screen they can select any course they are associated with and can swipe a student’s id card into the Swipe field. If desired, they can enter this information manually. Once they enter the information, by selecting the Record button, the corresponding log is made in the server and the Swipe field is cleared. As shown in Figure 5, the user is given an indication if the log was successful and what information was recorded.

When the user chooses to “Login To Reports” and their id and password are correct, they are presented the screen shown in Figure 6. In this screen they are presented a drop down list of all courses they are associated with. After selecting one of the courses and selecting the Download button, an Excel spreadsheet containing the following columns and associated event data are downloaded for them to save or review:

- First Name: student first name
- Last Name: student last name
- Student Number Phone: student phone number (smartphone only)
- Number: student id
- Event: event/class string
- Organization: event’s organization string
- Card Strip: card swipe text (Web only)
- Time: log time
- Latitude: log latitude (smartphone only)
- Longitude: log longitude (smartphone only)
- Altitude: log altitude (smartphone only)
- Accuracy: log location accuracy
- Device: log device

Some column information is Web or smartphone specific.

Figure 3: Attendance Tracker Login

Figure 4: Attendance Tracker Record

Figure 5: Successful Log

To make navigation easy, the user can move from recording logs and generating reports at the click of a button on any screen. The user’s session is timed and will logout the user after thirty minutes of inactivity.

Figure 6: Attendance Tracker Reports

5 Conclusion

Our goals for the attendance tracking system were to provide a fast and efficient system that was simple to use in any classroom at Carleton University while not requiring any specialized hardware or installation. To meet these goals we developed a system that had three different interfaces. The first one was a Web interface combined with a USB magnetic strip reader. Just plug in the card reader to any Mac or PC and they will automatically install the required software making the reader simple and easy to use. The Web interface also enables instructors to take attendance for events, combined with the card reader, in a fast and efficient manner. For large
classes, the system includes applications for iPhones and Android phones that enables students to use their phones as logging devices. To ensure students are actually in class when logging their attendance, the smartphone’s location services are used to provide location information that can be matched against the locations of the corresponding events. The software for the server includes Apache HTTP Server, Tomcat, MySQL, Struts2, and Hibernate, all open source and making the cost of software for development $0.00. iPhone development and Android development use Xcode and Eclipse respectively, both freely available to developers. The smartphone applications are available to students at no cost, making the overall cost to them $0.00. Finally, reports are created in Excel format, giving end users flexibility in how they manipulate the data from their classes. Our objectives have been met, in the process of achieving our goals.

The driving force behind the development of our attendance tracking system is student retention and the ability to detect students, especially those in first year, that would benefit from coming to the SSSC and discussing issues they are having with their classes, especially the ones they are not attending regularly. As discussed, this is not only desired by Carleton University’s SSSC, but by other university departments that are interested in student experience.

We believe participation, both by students and faculty, depends on how easy the system is to use and on how minimally intrusive it is to the overall class structure. We believe our system achieves these features with its combined interfaces and the simplicity in which both students and faculty access it.

5.1 Future Work

In our system, we are recording what both students and faculty do in order to determine the errors they make using it. By identifying these errors, it provides us with the opportunity to fine-tune the system to make for a better end-user experience. This fine-tuning will be a constant effort on our part in order to improved the overall success of the system.

Currently, server administration, such as the creation of new users, is done through the MySQL Workbench. Standard activities such as this will be moved to a Web interface, so that these reoccurring activities can be done faster and easier.

6 References


