OR code based attendance system using machine learning

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ABSTRACT

Every classroom/lab/workshop has an attendance tracking system in them. Currently the ways in which one can takesuchattendance/presencemarkingisviamanualcallingofIDs (roll numbers in case of universities), fingerprint scanners or face detection mechanisms. But all these either require an infrastructure (scanners) or are too tedious. This paper puts forward a new technique of marking the attendance of students. It uses QR code mechanism, which is very common in payments and shipment tracking today, to mark attendance or presence.

GeneralTerms

Faculty: The entity willing to register the attendance of students.

Student: The entity to be marked attended/present at some place typically classroom, lab, workshops, and community sessions

Keywords

AttendancedecentralizedQR-codeon-demand-server

1. INTRODUCTION

Attendance marking and management is a very important and tedious task for universities. In most of the classrooms it is taken by manually calling out names or roll numbers which is prone to errors as there could be proxies, i.e., fake answering of this call by someone else. This is a security risk as there isa chance of masquerading attack on system. So instead onecan utilize technology to take advantage of some unique identifiers within humans like fingerprints to mark attendance or presence. As mentioned in [1], largely there are two typesof attendance marking frameworks:

    a. ManualAttendanceSystem(MAS)

    b. AutomaticAttendanceSystem (AAS)

MAS is the traditional pen paper and calling based method.As mentioned it is prone to proxy errors. Also it is time consuming and does not scale well when the head count is large as is the case of universities with typical size of classrooms being 70 to 100 students.

So to reduce this workload one can use AAS. As the name suggests these are automatic systems and hence easy to manage. Typically these include a proprietary system with scanner which scans fingerprints, iris or other biometrics anda centralized server which manages these systems. These servers are a concern as they are a single point of failure. Although with the rise of cloud and micro service based architecture it is not that common for a server to fail. But it is still infrastructure that needs investment. Also major

universitieshaveaprivatenetworkbuiltandrequires gatewaystocommunicatewiththesesproprietaryserver.

Major research is going on in improving the scanner technology to make them as simple and powerful as possible but this paper dives into replacing the centralized aspect and infrastructure required to setup such systems with some more common, day-to-day technologies like cameras within smartphones.

2. LITERATUREREVIEW

Therearevariouscommonattendancemarkingsystemswhich are discussed here.

Biometricbased

From [8], [9] and [10], it is clear that in these system the scanners read the basic elemental biometric data their systems rely on for e.g., segments from fingerprints, iris scans or others. These systems use the fact that humans have a built in uniqueness in their fingerprints and iris and take advantage of that to ensure that onlythe correct student is marked attended. In system security terms it is a mechanism which ensures entity authentication on the basis of something possessed by the user. These systems have a single device with embedded scanners in them and are generally portable. These devices capture the biometric and send the data to servers for further maintenance and storage. The issue is the cost which is on an average Rs. 25/person/month. For an average classroom of100 students this cost goes to Rs. 2500/classroom/month and there could be 10s to 50s to 100s of such classrooms in a decent university making the total cost around Rs. 25k to almost Rs. 250K which is very expensive for just attendance sake. Also it can cause distraction during the lecture as students get distracted by these systems.

RFIDBased

As mentioned in [7], the RFID based systems require that every user has an RFID tag embedded within their ID cards and students have to swipe them near the register for marking the attendance. These RFID based ID cards are issued by the universities and hence the university again bears the cost of infrastructure. Issue arises as this method is again prone to proxies as a student only needs another student's ID card to fool the system which becomes much easier than MASs

MachineLearning,aka,facerecognition

There is a huge surge in machine learning technology which gave rise to face recognition technology where companies are using face as a primary medium to authenticate an entity.From [2] and [6] it is clear that these devices analyze camera feed in frames and try to recognize the face and then match it with a user. There is a tremendous rise in using this type of technology for attendance marking system but the only issueis that the feed of classroom can have faces of let's say 40% from onefeedofcameramakingit40studentsonanaverage.

So the task is too expensive as now the face recognition algorithm has to first recognize 40 of these faces in contradiction to 1 and map these 40 faces to a student in database. These steps of recognition and mapping although sound simple are very difficult as accuracy of recognizing faces in such heavy feed can be affected drastically on the basis of models and sometimes it might even miss outstudents if it cannot identify their faces or map themaccurately which implies that scaling is a big issue for such systems and similarly proxy also becomes easier as now one just has to show these cameras a photo of the student who isto be proxy.

3. PROPOSEDSYSTEM

Itiscommonforstudentsandfacultiestohavemobiledevices and these mobile devices are powerful. The system uses this aspect as an advantage and offer an application that runs onthe devices of students and faculties for Attendance system. The system proposed uses the more common technology QR code which has seen rise since the rise of mobile based payment wallets, and is many times used for tracking shipments as well.

Thesystemalsoreliesonthefactthatdevices(atleastin vicinity) have a next to 0 probabilityof having the same Media Access Control (MAC) Address.

In thissystemthereare2main entities:facultyand astudent.

Facultystartsaclassroomthatstudentscanmarkthemselves as attended to. This is done using QR codes and on-demand HTTP servers on faculty's device. The studentcan use their mobile devices to scan the QR code and mark them present for that lecture

Architecture

The proposed solution is an application with 2 modes: viz faculty and student and runs on Wi-Fi network primarily. Fig1 shows an overview of the proposed system.
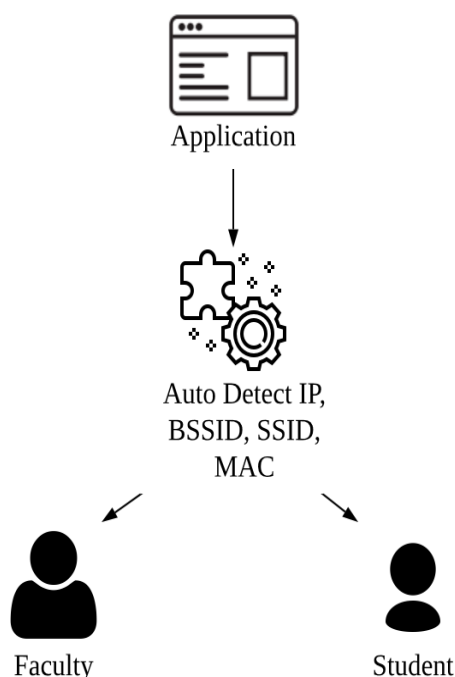

Fig1: SystemArchitecture

Auto-detectionofIP,BSSID,SSID, MAC

This component is responsible for fetching the IP(v4) address of the device it is running on, BSSID of the Wi-Fi Access Point (AP), SSID the access point's name and the device's MAC (media access control) Address for unicast mode.

Faculty

In faculty mode the first step, as shown in Fig 2, is to collect details about faculty and the lecture being conducted. This information is used ahead in the attendance sheet that will be saved on faculty's device. The faculty mode further has two complicated components in itself viz: QR code and On-Demand On-Device Server. The students who are marked attended will be stored in an Array (hereafter named studentsArray) and when the server is closed by faculty this studentsArray will be used to create the attendance sheet. The server also maintains a map which saves the MAC addresses of the students who are marked attended successfully forproxydetection.
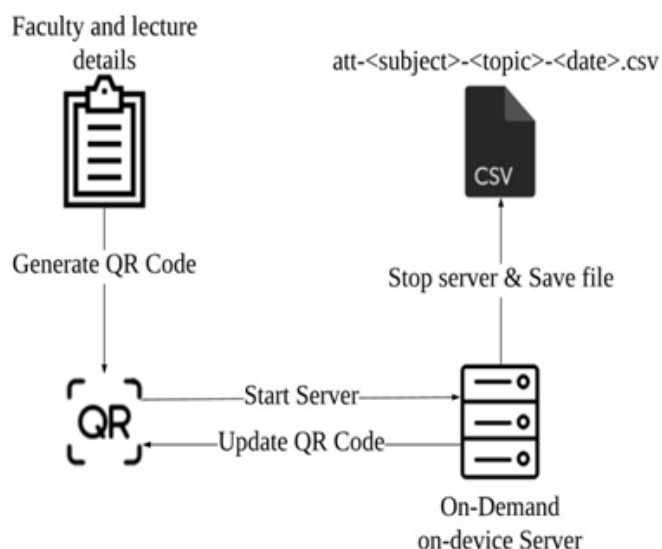

Fig2:FacultyMode

QRCode

The algorithm used to generate QR code could be standard available with packages or libraries but the data we use tohide in it is important and a new encoding scheme is used forit (any encoding scheme not necessarily this can be used and corresponding decoding has to use on the student side ofwhich some are mentioned in [4]) which is as follows

The length of the string who's QR code is to be generated has to be 128 characters long

- Thestring(hereaftercalledtext)willbedividedinto several parts. Viz first salt, index (current length of studentArray), encoded IP, and encoded BSSID, SSID and second salt.

- All of these parts are then concatenated using "#" and hence a constraint is that salts cannot contain "#".

- The encoding of IP and BSSID is done on the basis that they both contain a special character '.' and ":" respectively. We replace these with alphabets in orderly fashion, i.e., first '.' by 'A', second by 'B', third by 'C' and so on.

- Sofore.g.consider

studentsArray: [],

IP:192.168.0.101,

BSSID: 02:00:00:00:00:00,

SSID:"Testnetwork".Thenthetextcomesouttobe:-

?$[$:+i0|+:^d*|[dih:#0#192A168B0C101D#02H00I00J0
0K00L00M#Testnetwork#&~w7384*]{[%/f{:xz85rd^a

Note:charactersE&FareleftoutdeliberatelyasBSSIDuses   A-F
and hence it can lead to ambiguity to use them for encoding
purposes

on-Demandon-DeviceServer:
This component is the heart of the application and the main

POST /students
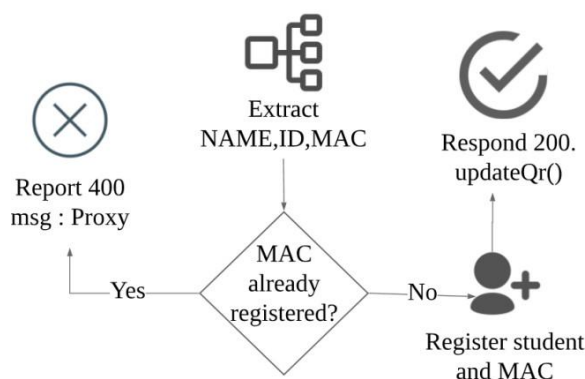
part responsible for decentralization. This component uses the
faculty device as a resource and runs a small "http" server onit
while the faculty is willing to take attendance. The server is
not meant for high performance as according to the
architecture the faculty device (as explained ahead) should
only receive one request for marking attendance at a time and
today's modern devices are capable enough to do so. The
component goes as shown in Fig.3.

Fig3:On-DemandOn-deviceserver overview

Each request on server has to have {NAME,ID,MAC} the
followingattributesin thebody. TheMACaddressis checked for
existence in MAC map, and if found it indicates that the
server has already received an entry from the following MAC
address and this could be an attempt to mark proxy for some
student and hence report it. If the MAC does not exist in the
MACmapthenitisregisteredinthemap,thestudent'sdetails   like
NAME, ID (roll number) are combined as an object and
appended to the studentsArray. After this as the index is new
the QR code is to be updated using the new index. The index
encoded in the QR code should always indicate the current
length of the array. This helps in another form of proxy
detection as students could just capture the QR code imageand
share among themselves but since the index is updated every
time a student marks himself present the recorded QR code is
no longer valid and hence cannot help mark proxy.But
thisalso imposesaconstraintthatonlyonestudentshould try to
mark himself attended at a time otherwise a valid attendance
might be regarded as proxy by the system.

After the work is done faculty can request to close the
attendance and the application will save an attendance sheet
into the faculty's device which can be used further for
management. The name of the file saved is in the format: att-
<subject>-<topic>-<date>.csv

where subject is the subject being taken, topic of the lecture
and date on which the lecture was taken.

Student
Thestudentmodeisrathermuchsimplerandjusthastwo phases
(refer Fig 4).

Scanning
Scan theQRcode, read thetext, split at "#"and extract index,
encoded IP, encoded BSSID and SSID. The BSSID and SSID
are used to ensure that the student and facultyare on thesame
network and if not the student has to ensure the same. The IP
address will be decoded and then it will be used to make a
POST request as this is the IP address of the server (faculty
device) on which the attendance service will be running

Request
In this phase the actual request is made to the decodedIP
address with the body containing {NAME, ID (roll number),
MAC}. The response from the server is then displayed to the
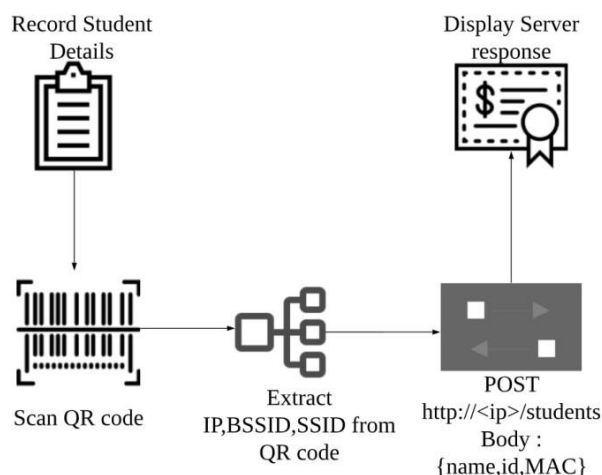student which could be getting marked as attended or proxy
being interpreted.

Fig4:Student mode

4. IMPLEMENTATIONAND CONSTRAINTS
HardwareRequirements:

- 2 GB RAM (minimum), 4 GB or more
  (recommended) (Although application does not
  requireallthatmemoryit   safeforthedevicetohave
  some extra memory for OS and background tasks).

- Storage: 100 MB for application and 50 MB for
  attendance sheets. Total 150 MB.

SoftwareRequirements:

- iOS:10and above

- Android:6(Marshmallow)andabove

The application in [11] is developed using react-native
framework so that it can be used across different platforms.
The framework has several packages and libraries that help
with QR code generation, scanning and deploying on-demand
on-device server as well.

The systemcan easilybe used byanyfacultyis that the above
systemcanbeusedtotrackattendanceofclassroom,labs,

sessionsandsuchpresencemarkingcases.Table1below showsacomparisonoftheproposedsystemagainstthe existingsystems.

Table1:Comparisonwithexisting systems

	Cost(toadministration)		Accuracy	Scaling	Timeofoperation	Security(against proxy)
	Devices	Operational				
Biometric	High	Low	Very high	Normal	Very high	Very strong
RFID	Very high	Moderate	Very high	Easy	High	Poor
Facerecognition	Moderate	High	Moderateto low	Difficult	Low	Poor
ProposedSystem	Low	High	Very High	Easy	Very High	Very strong

Butthesystemhasthefollowingconstraints:

- *Same Network*: Both the faculty and students haveto be on the same network for this application to work without any internet (outside the private network resources).

- *Serial Attendance*: Only one student at a time can mark himself present because of the security of the system to prevent proxies.

- *Acquiring MAC Address*: An issue that arises in implementing the above system is that somevendors block any application from acquiring information about device's MAC address but this is resolved by using the device ID assigned by the vendor to that device and is expected to be unique

5. CONCLUSIONAND FUTUREWORK

Conclusion

The above system decreases the cost to the university for tracking attendance as the system uses devices that the faculties and students already own and convert them into resources for attendance system and with rise in smartphone marketitcanensuredthatthissystemisfeasiblewithalmost3 billionsmartphonesintheworldandthecountincreasing.Itis also a simple system where in a faculty has to just place a device in the room and every student entering it can scan it mark themselves present without causing much distraction.

FutureWork

Integrationtouniversitysystems

Many universities have some system for the management ofits tasks like result display, lab experiments and attendance as well. Currentlythissystemdoesnothaveanywayto integrate it directly to the university system making the management part more easy and automated

Securityofthe servers

Currently there is no method for ensuring the security of the requests that are made and anyone can make requests to the server with fake credentials and break its integrity. This security feature can be implemented by using encryption and hiding the keys inside the QR code which although available for all can only be understood by the application by means of encoding.

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