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Radio Frequency Identification(RFID) And Image Attentication System (Hardware Structure): Effective Way Of Taking Class Room Attendance

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Abstract:
Educationalinstitutions'administratorsinourcountry andthewhole worldareconcernedaboutregularity ofstudentattendance.RadioFrequency Identification(RFID)based class attendancesystem is asystem thatcanautomaticallycapture student'sattendanceby students passing through an RFID reader with the tag on them or swiping the tag on RFID reader with a web camera that captures their tags' electronic product code (EPC) and images respectively, compare and match them with what is already existing in the database (MySQL) for proper validation and authentication. The tools we used in achieving this system are C variant, Arduino based programming language (the programming languages for the microcontroller AT89C51 on Arduino development board), and the Arduino 1.6.5 IDE, Java programming language was used for serial communication, the image training, detection and recognition and for the application interfaces, and in connection other physical components. At the completion of this work we were able to achieve the following: Asystem thatautomaticallycaptures student'sattendanceby flashingtheirstudentcardattheRFIDreader, that is able to provide security and privacy in such a way that the tags with their unique product codes and identification were not compromised because each student is uniquelyidentify by their images attached totheiruniquetag electronic product code (EPC). The system accepts images through webcam and tags EPC from students through serial communication COM ports with the help of the line drivers (MAX 232) attached to the hardware and store them in a database (MySQL). The system sends alarm to indicate that the right or wrong person passed through the RFID reader, this can draw the attention of the lecturer in charge in the case of a student with another person's tag. The system have an interactive interface designed with Java programming language that can enable lecturers register the students, view, edit and print out the student's attendance weekly, at the end of the month and at the end of the semester.

Key Words: (*Radio frequency identification (RFID), electronic product code (EPC), Radio frequency identification (RFID) tags, Radio frequency identification (RFID) reader)*

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I. Introduction

Educationalinstitutions'administratorsinourcountry, Nigeriaandthewhole worldareconcernedaboutregularity ofstudentattendance.Student overall academicperformanceis affectedbyit.Theconventional method of takingattendancebycallingnamesorsigningonpaperis very timeconsuming,andhenceinefficient.Themostcommonmeansoftrackingstudent attendance in the classroom in Nigeria is by enforcing the students to manually sign the attendancesheet,whichisnormally passedaroundtheclassroom whilethelectureris conductingthelecture.Forinstance,lecturerswith alargeclassmayfindthehassleof havingtheattendancesheetbeingpassedaround theclassandthemanualsigningof attendancebystudentsareburdensomeandmostlikelydistractthemfromteaching andgettingfullattentionfromthestudents. Besides,astheattendancesheetis passedaroundtheclass,somestudentsmayaccidentally orpurposely sign another student'sname.Thefirstcaseleadstoastudentmissingouttheirname,while thelatter leadstoafalseattendancerecord. Another example of the conventional/ manual attendance system which I personally use is the taking of students' attendance by calling out their registration numbers and checking whether the right person answered before starting my lectures, in cases where the number of students is more than two hundred in number like the 100 level general class (this comprises of students from all the departments in the University with at times total number of three thousand (3000) students) it is impossible for me to use this

method that might take the whole day. This method is more than time consuming and very clumsy. Anotherissueofhavingtheattendancerecordin a hardcopyformis thatalecturermaylose the attendance sheet. Interms ofattendanceanalysis,thelectureralsohastoperformmanual computationtoobtainthe students' attendance percentage,whichnormallyconsumealotoftime. This prompted us into looking for automatic identification (AUTO-ID) approaches that will help us handle the issues of conventional/manual attendance system. During our research we found out that there are different AUTO-ID technology namely, infrared technology, Barcodes technology and the Radio Frequency Identification (RFID) technology (Lim et al, 2009). We chose to use the RFIDtechnology which overcomesthelimitationsofother automaticidentification approachesthatuselightto communicate, (suchasbarcodesandinfraredtechnology) becauseatagmay behiddenorinvisibletothe eyeandcan beusedinaharshordirty environment.Readerscanbeset toremotely andautomatically readwithoutlabor-intensive manualscanning oftheobjectasinmostbarcodesystems.RadioDetectionandRangingisacommunicationmediumto subliminally detect objectsthataremilesaway,invisibletothe nakedeye.

Research Objectives:

RadioFrequency Identification(RFID)basedattendancesystemisoneofthesolutions toaddress the above mentionedproblems.

i. To develop asystem thatcanautomaticallycapture student'sattendanceby flashingtheirstudentcardattheRFIDreader or passing under the reader without physicalsiteofcontact, this was achieved by writing codes in arduino C variant language, building the codes via the universal programmer into the microcontroller AT89C51/52 (in arduino platform) in the constructed system.
ii. RadioFrequency Identification(RFID)basedattendancesystem will be able to provide security and privacy in such a way that the tags with their unique product codes and identification will not be compromised because each student will be uniquelyidentify by their images attached totheiruniquetag electronic product code (EPC).
iii. The system will be able to accept images and tag EPC from student and store it in a database (MySQL) through serial communication COM ports with the help of the line drivers (MAX 233) attached to the hardware.
iv. The system will be able to process the incoming images and tag EPC from students, recognize and match them with the preregistered ones in the database and assign attendance or reject attendance.
v. The system will be able to send alarm to indicate that the right or wrong person passed through the RFID reader, this can draw the attention of the lecturer in charge in the case of a student with another person's tag.
vi. The system will have an interactive interface designed with net bean (Java programming language) that can enable lecturers register the students, view and edit their records, view, edit and print out the student's attendance weekly, at the end of the month and at the end of the semester.

EvolutionofRFID:

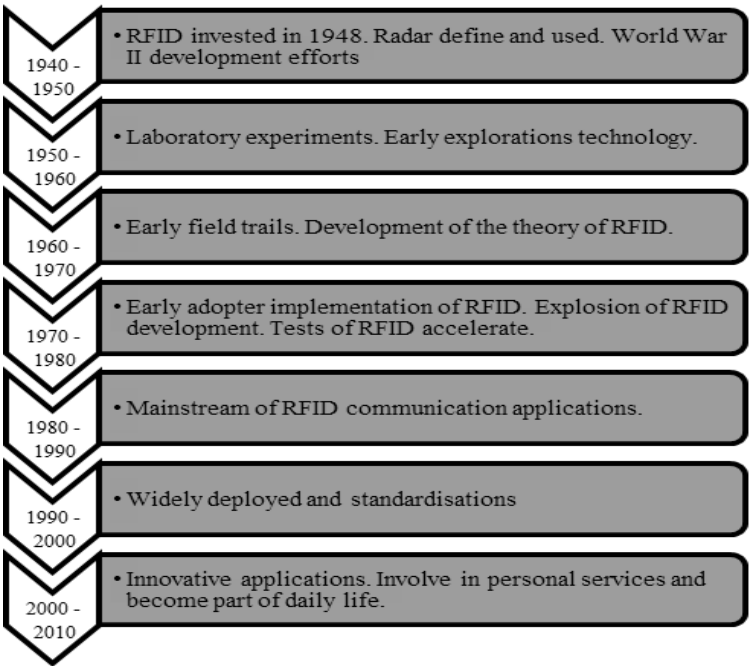

Figure 1: AdepictionoftheevolutionofRFID technologyadaptedfrom(Domdouzis et al. 2007),

ThesuccessofRFIDtechnologyprimarily centersonthe adventofradiotechnology(Domdouzis et al, 2007).The developmentsinradio technologywereaprerequisitetoharnesstheessenceofRFID technology.Thereissignificantgrowthoverthepast coupleof decadesinthistechnology (seefigure2). From the figure 2, Radio Frequency (RF) was invented in 1948 during World War II for military tracking of war planes, vehicle and equipment. From 1950 to 1960, further successful laboratory experiments were done on Radio Frequency (RF). From 1960 to 1970, the theory of Radio frequency Identification (RFID) was developed. From 1970 to 1980 the design and implementation of Radio frequency Identification (RFID) exploded. From 1980 to 1990, Radio frequency Identification (RFID) was applied in telecommunication. From 1990 to 2000, applications and deployment of Radio frequency Identification (RFID) increased. From 2000 to date, innovative applications have been made, RFIDtechnologyis rifeinmodernindustriesthatdemanddataintegrityand high efficiencyofthesystem.This technology is presently usedfortracking vehicles and goods, courierservicesand luggagehandling.Otherapplications include animal tracking,securetoll payments,inventory managementsystems,accesscontrol mechanisms,etc.

RadioFrequencyIdentification(RFID):

RFID,whichstandsforRadioFrequencyIdentification,is an automaticidentificationtechnologyused forretrieving fromorstoringdataonto RFIDTagswithoutany physical contact (AbdulandJyothi, 2013). It isatechnology thatisusedtocollectinformation automatically byradiofrequencydatacommunication between mobile objects and an RFID reader, to identify,categorize andtrackthe mobile objects.According to Lim et al, 2009, anRFIDsystemprimarilycomprisesofRFID Tags, RFIDReader, Middleware and a Backend database. RFIDTagsareuniquely anduniversallyidentifiedbyan identificationsequence,governedbytherubricsofEPC (Electronic product code) global TagDataStandard.A tagcaneitherbepassively activatedby anRFIDreaderoritcanactively transmitRFsignalstothe reader.TheRFID reader,throughitsantenna,readsthe informationstoredonthesetagswhenit's initsvicinity.

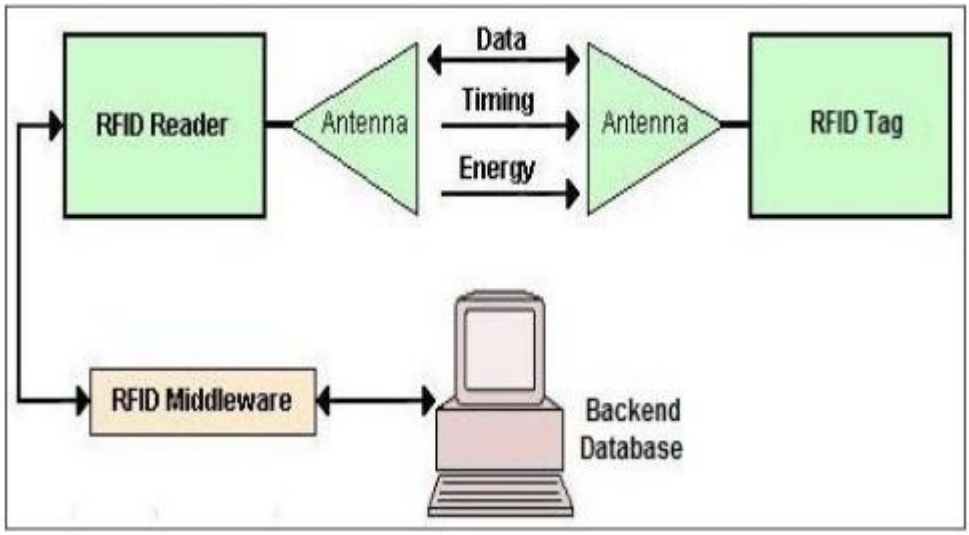

Figure 2: RadioFrequencyIdentification**(RFID) system**(Lim et al(2009)

The reader,whoseeffectiverangeis basedonitsoperational frequency,isdesigned tooperateatacertainfrequency. According to Amin et al, (2014), the operationalfrequencyofthereaderrangesfrom125KHz–2.4GHz.The Middlewareencompassesallthose componentsthatare responsibleforthetransmissionof germane informationfromthe readertothebackend managementsystems. The Middlewarecaninclude hardwarecomponents likecablesandconnectivity portsand embedded system software like Assembly language and embedded C that monitor and control the communication between the hardware and the computer system. The Backenddatabasestoresindividualtagidentifierstouniquelyidentifytheroles ofeachtag.Thedatabasestores recordentriespertainingto individualtagsanditsrolein thesystem application. The RFID systemisinterdependentonitscorecomponents to achievemaximumefficiency andoptimumperformanceof the application.Duetoitshighdegreeofflexibility,thesystem can beeasilyadopted for an arrayofapplications ranging fromsmallscaleinventorycabinetstomultifariousandhighly agilesupply chainmanagementsystems.Although,the cost of incorporating this technology has restricted its outreach,thetechnology promisestohaveuntappedpotential.

The system mode of operation:
Thesystem providessolutiontoproblem through coordinatedhardwareandsoftware designhandshakingdatacommunications betweenRFIDtagandRFIDreader as shown in figure 3.ThissystemisbasedonpassiveRFIDtag.The RFIDreaderwill be mounted at the entrance door of any class room which will alsoconnectwiththe classroomcomputer or the lecturers' laptop or system. Software runningonthe system will havetagid/electronic product code, student name, student registration number, date of birth, course name, course code, date,time,and classroomlocationetc.Thisinformationpassesthroughhardwarewhichprovidesthe filteringoperation.TheATMEL 128kb microcontrolleron arduino board takesinputsfromtheRFIDreader and the webcam,processesthem and sends them to PC through MAX232for storingthe attendanceand verification of the images with the EPC.
Each student will hold a unique RFID tag and whenever student enters the RF receiver zone the attendance will be registered automatically with proper images matching the prerecorded images attached to particular EPC. The data is then compared with the pre-assigned data in the database and based on that the attendance is register to the particular student. The transmitter will hold a unique address which will be transmitted by the means of radio frequency to a particular region. The 2.3GHZ transponder will continuously respond to the incoming data and will gather the data from the transmitter.

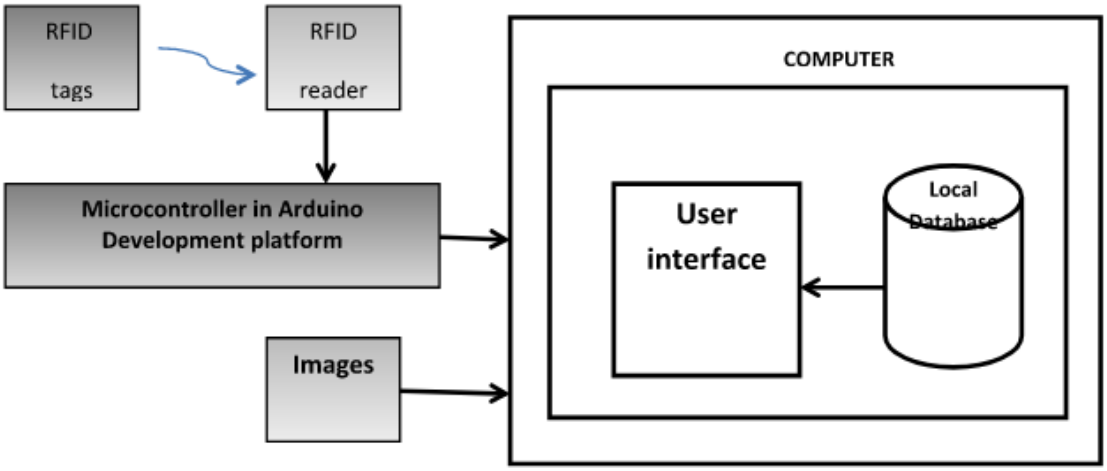

Figure 3: The System block diagram

The researchwas conductedonasampleof4students with 40 RFID tags uniquely assigned to each studentenrolledinaparticular PhD course. On point of registration, the students images are also captured, the unique ID/EPC of the tags are assigned only for a tag for a particular student. As described above no two students can use one tag or student's attendance must be accepted only when he/she uses the tag assigned to him/her.

Thesystemalgorithm:

i. Step1.RFID card was initially sensed by the reader.
ii. Step2.RFID reader starts to match the string which was available on the card with the database entries as RFi .RFi . T= I, RFi .RFj . T= 0 RiRF+tagEPC of individual.
iii. Step 3. Web camera capture image send to permanent database for matching the patterns which were in the database entries as RFi .RFi . T= I, RFi .RFj . T= 0 RiRF+image of individual.
iv. Step 4.Usinghardwareperformthefilteringoperationtoremoveunwantedfield and extract and attach tag EPCs and images to the student bioidentity.
v. Step 5.Searchstudenttags EPC inpermanent database withincoming RFID student'stags.
vi. Step 5.1 search for the images in the permanent database with the new captured image, image matching will be analyzed with face recognizer if it recognized FPi .FPi . T= 1, FPi .FPj T=0. The image pattern is pre-processed and is converted into a binary pattern as: $B(i)=1$ if $I(i) \geq T = 0$ $I(i)$
vii. if found go to step 5.2 else go to step 4.
viii. Step5.2.Searchclassroomid,iffoundgotostep5.3.elsegotostep 4.
ix. Step5.3.Searchcourseid,iffoundgotostep5.4.elsegotostep 4.
x. Step5.4.Searchstudentid,iffoundgotostep 6.elsegotostep 4.
xi. Step6.Comparedetectedstudent's image and tagEPCwithclasstimetableandif matchfoundthangotostep 7elsegotostep3.

xii. Step7.Check persontypeand markthepresence.
xiii. Step.8 Repeatstep3tostep7 forallpresent RFIDtags and images.

Structure of the New System:

Figure 4 shows the structure of the system. The system has two levels, the hardware level and software level. For this paper, we are laying emphasis on the hardware level. At the hardware level, the tag electronic product code (EPC) or the tag identification number of student will be pre-registered through the RFID reader to the system database. The same procedure for the student images which will be assigned to the EPC in the database. Also at this level, there will be a programmed microcontroller attached to an ardiuno board where the EPC/image processing, recognition and merging will be carried out. The processed EPC/image will be sent to the system database for matching and authentication.

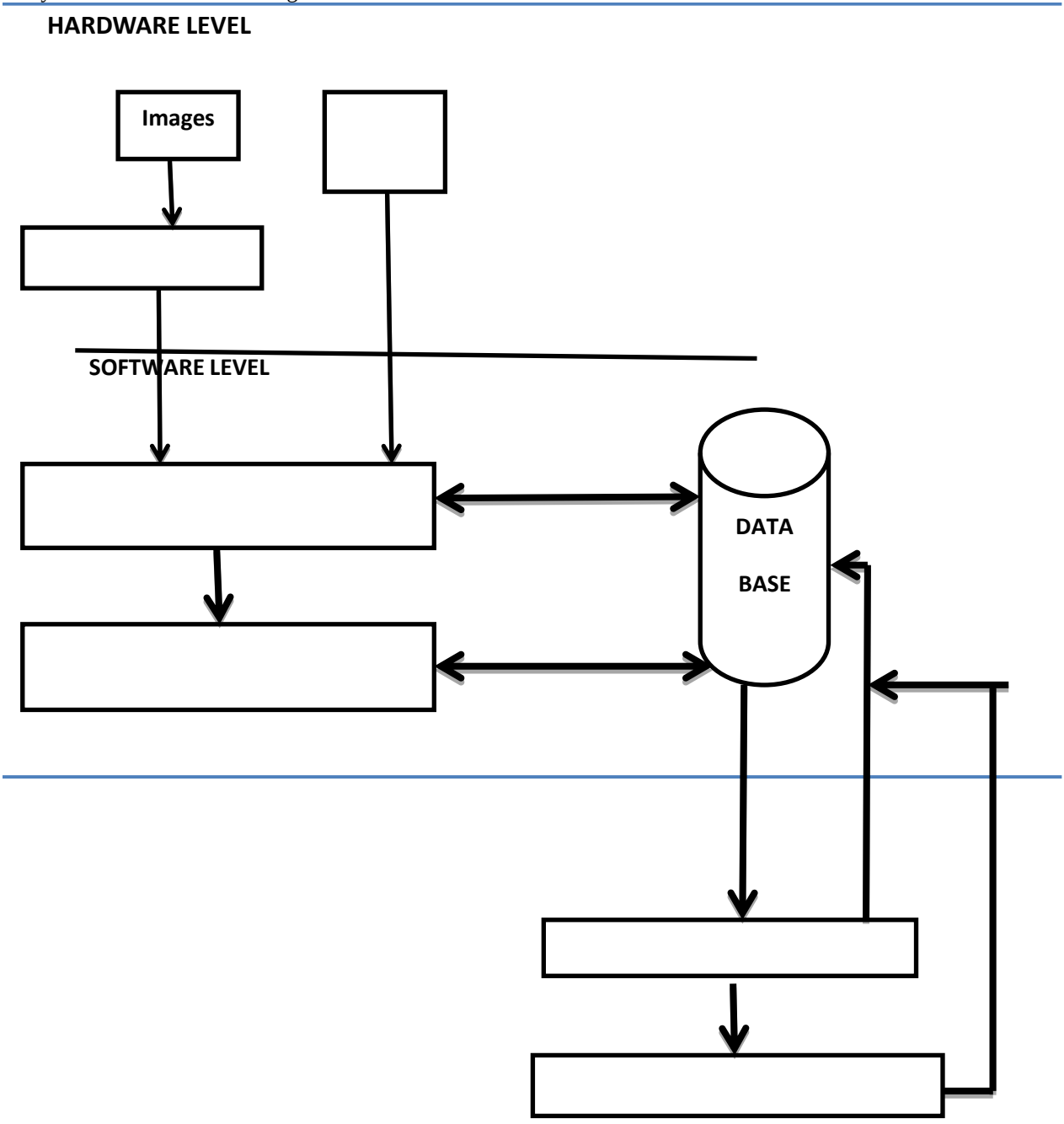

Figure 4: System Structure of the New System.

The software has the serial communication drivers working through the operating system's free COM port already included in the programming language (net bean) codes. When the received signals (tag EPC and images) match with the ones in the database it will authenticate and attendance will be taken.

Hardware design:

In order to develop the embedded software efficiently and ensure that the developed software is of high quality, there is a need to execute the appropriate tasks in the appropriate sequence in the course of development. This trend has led the development of embedded software to expand in scale in order to meet the ever-growing functional needs. Practically and from our experience, the first step we will follow is the construction of the hardware block diagram and the structural diagram as shown in the figure 3 and in figure 4 respectively. After these diagrams, we went into the circuit diagram, looking closely to what we have in the block diagram. Figure 5, 6 and 7 are the circuit diagrams and simulations we did using Proteus VSM 8 professional.

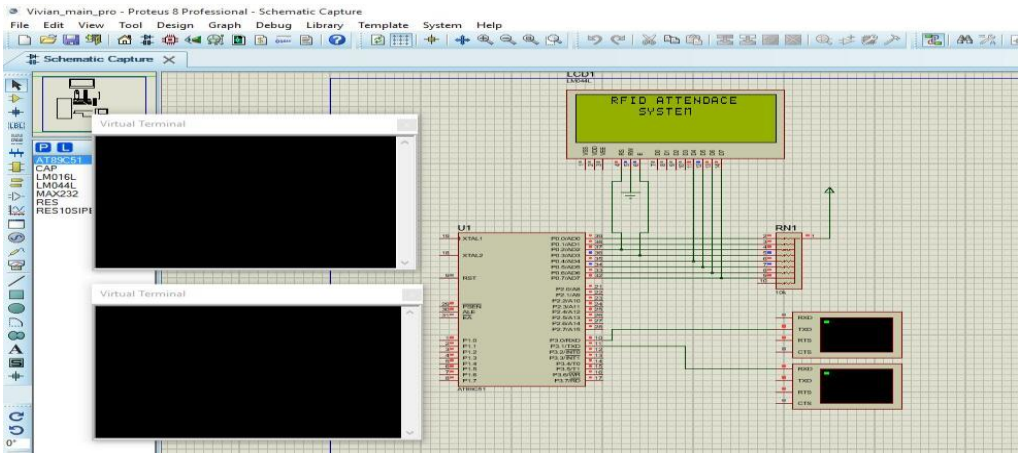

Figure 5: system circuit in Proteus VSM 8 professional

The system circuit was also used in Proteus VSM 8 professional for testing and simulation. The same components in the circuit diagram were also used in the Proteus work bench.

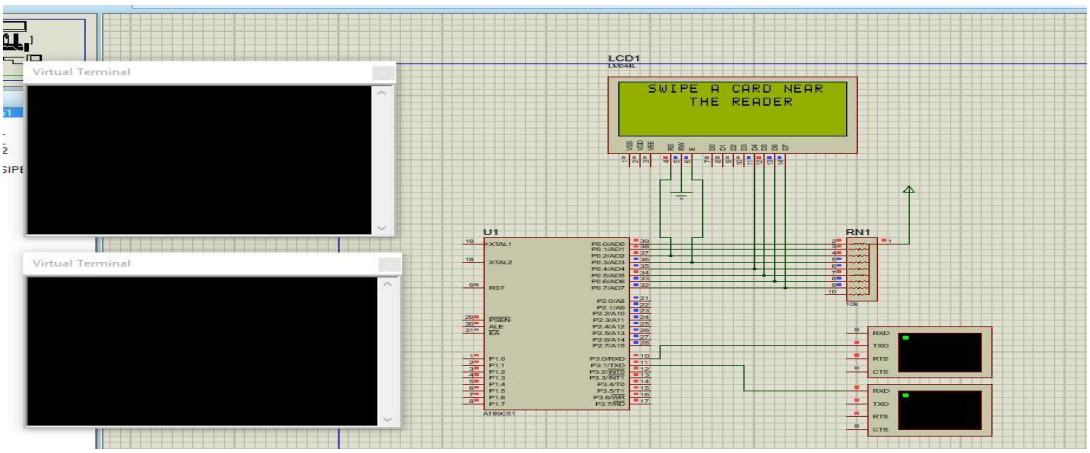

Figure 6: simulation when RFID tag passes through it

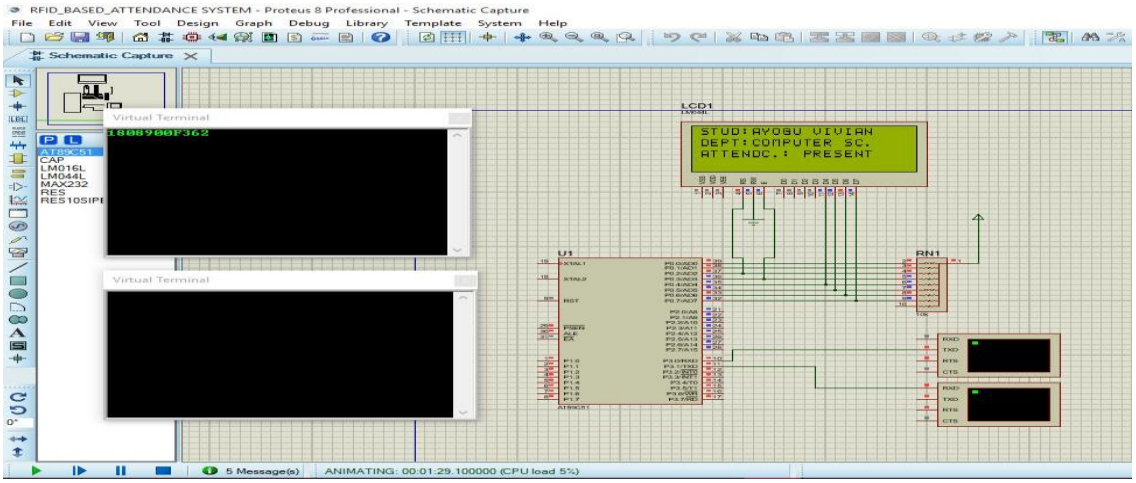

Figure 7: system when student attendance is captured

Table 1: components and quantity

S/N	Component name	quantity
i.	LCD (Liquid Crystal Display) (16*2)	1
iv.	Ardiuno development board	1
v.	Web camera/ adafruit camera	1
vi.	RFID Reader	1
vii.	RFID passive tag	2
viii.	40 and 16 pin IC socket	4
ix.	Regulator 7805	2
x.	Capacitor 10µf	10
xi.	Connectors	15
xii.	Max 232	2
xiii.	Ribbon cable	8
xiv.	bread board	2
xv	Crystal Oscillator - 11.0592 MHz	4
xvi.	Connecting wire	Many
xvii	Soldering lead	1 roll
xviii	Reset button	2
xix	Resistor 10K/1K/470/100 ohm	45
	Variable Resistor 10k	5
	Transformer	1

From the simulation we did, we are now sure that all the components will work during physical connection. These components from table 1 were used to achieve the design in in figure 5. The hardware design on implementation was attached to the computer system via USB for proper communication with the software.

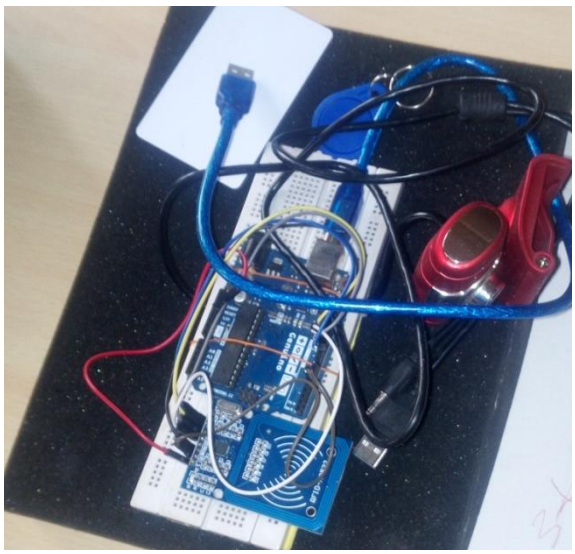

Figure 8: hardware design (live)

When a person with RFID tag or transponder enters in the frequency range of RFID reader, the RF field induces voltage in the coils of tag. The range can be set by using the appropriate reader of appropriate frequency. This induced field supplies the voltage to the passive tags and act as a battery in that case. If active tags are used then the case will be different as they have battery of their own. Due to interaction of Tag with Reader characters, electronics product codes (EPC) from tag are sent to controller, from the controller via serial communication to personal computer through free COM port to net bean program. Already the microcontroller has been loaded with .hex file as the control program. In our case, we have forty tags we will register thirty and use ten on trial for new registration. Once the system is connected to the personal computer via USB, it will automatically on as shown in figure 9;

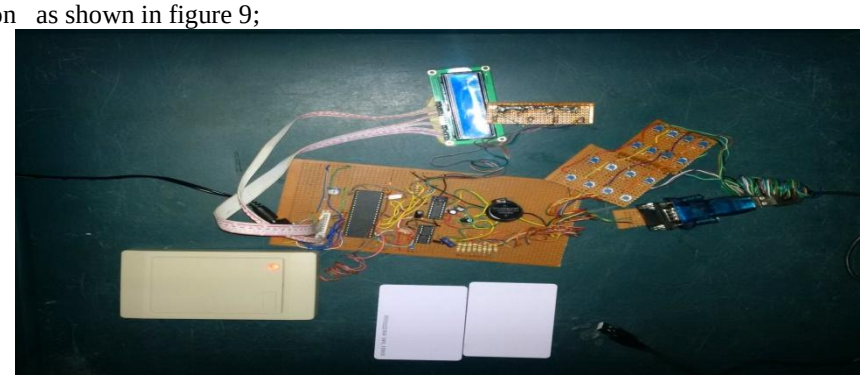

Figure 9: initial stage of the system

Second stage is the initiation of the reader and the camera getting them ready for picking tag signal and capturing of incoming student into the classroom as shown in figure 10;

Figure 10: initiation of the reader and the camera

Third stage involves the activity during which data and the images from the reader and the camera are transferred to the personal computer; the personal computer matches the input with data stored in the data base. If the data and the images match with the ones in the data base then controller sends a positive signal to the reader which flashes green on the LED and the time & date of entrance is saved. If the inputs do not match any data in the database, the controller sends a negative signal which flashes red on the LED. This activity is shown figure 11.

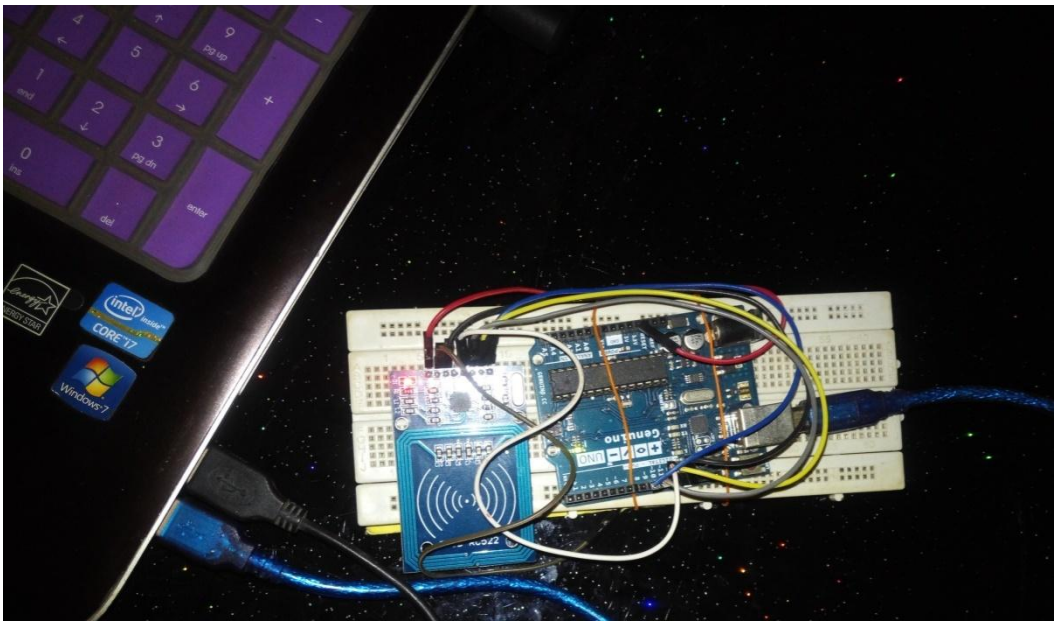

Figure 11: attendance taken by the hardware part

II. Result

The system performance was very good, very flexible and easy to use interface. Performance evaluation was designed to test the system and compare it with other existing system like the manual method, RFID with finger print. This is represented in the table 2 showing that the time take to take an attendance using RFID with image is only 0.2 second compared with the others that took 5 seconds and 10 seconds respectively and so on. A graph was generated as shown below to explain this more using Microsoft excel.

Table 2: evaluation of attendance systems

Method	**Total Number of Students**			
	1	**10**	**60**	**100**
Manual Entry	10 seconds	100 seconds	600 seconds	1000 Seconds
RFID with finger print	5 seconds	50 seconds	300 seconds	500 Seconds
RFID with image	0.2 seconds	2 seconds	12 seconds	20 seconds

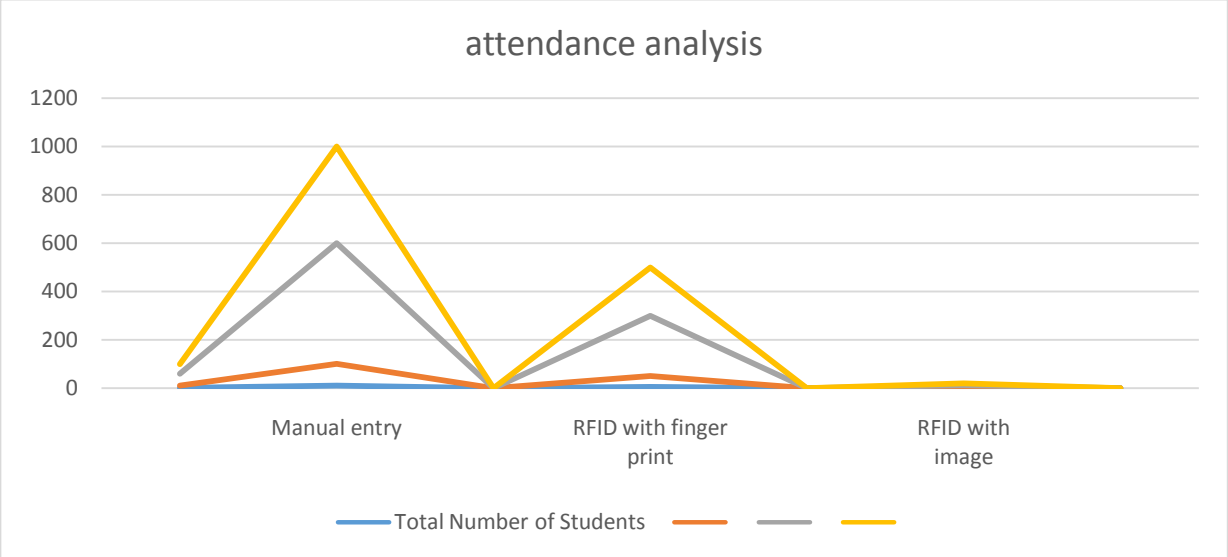

Figure 12: attendance evaluation graph using Microsoft excel

III. Conclusion

The primary aim of this work was to develop and implement aRadio FrequencyIdentificationtechnology (RFID) based class attendance system which willsignificantlyimprovethecurrentmanualprocess ofstudents' attendancerecordingandtrackingsystem,especiallyinauniversityenvironment.The system was able to promoteafully-automatedapproachincapturingthestudents'attendance using their tag Electronic product code (EPC) and their images. At the completion of this work we were able to achieve the following:

i. Asystem thatautomaticallycaptures student'sattendanceby flashingtheirstudentcardattheRFIDreader, this was achieved by writing codes in arduino C variant, building the codes via the universal programmer on the arduino development board into the microcontroller AT89C51/52 (on arduino platform).
ii. A RadioFrequency Identification(RFID)basedattendancesystem that was able to provide security and privacy in such a way that the tags with their unique product codes and identification were not compromised because each student was uniquelyidentify by their images attached totheiruniquetag electronic product code (EPC).
iii. The system was able to accept images and tag EPC from student and store them in a database (Microsoft access) through serial communication COM ports with the help of the line drivers (MAX 233) attached to the hardware.
iv. The system was able to train the incoming images from students detect, recognized and matched them with the preregistered ones in the database and assign attendance or reject attendance.
v. The system was able to send alarm to indicate that the right or wrong person passed through the RFID reader, this can draw the attention of the lecturer in charge in the case of a student with another person's tag.
vi. The system have an interactive interface designed with net bean (visual JAVA) that can enable lecturers register the students, view and edit their records, view, edit and print out the student's attendance weekly, at the end of the month and at the end of the semester.

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