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# An Implementation of an Automated Class Attendance System Based on Facial Detection and Recognition

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## Abstract

Class attendance is a mandatory requirement amongst the TVET institutions in Kenya. Each institution has its own way of marking trainee's attendance and keeping a record of the same. Majority of the institutions mark the trainee's attendance manually while a few have adopted automated techniques such as voice recognition, eye detection, Radio frequency identification (RFID) or biometric. The daily maintenance of class attendance records is not only time consuming but also a difficult task. Therefore maintaining attendance register daily is a difficult and time-consuming task. Trainees have a tendency to manipulate the manual register by signing for their absent colleagues. Face detection and recognition has increased in the domain of image processing in the last few years and researchers have been able to implement it in various fields of our daily life such as for security purposes. Facebook for instance has implemented facial recognition algorithms into their website and applications, meaning that they cannot only *find* faces in an image; but they can also *identify* whose face it is as well. Facial recognition is an application of computer vision in the real world. This project aims at using a class video footage to extract picture snapshots, then detect and recognize faces from the snapshots. The detected faces will then be matched against registered records of faces in the database and mark students as being *present* or *absent*. This system enables trainers in learning institutions to mark learner's class attendance easily and overcome the challenges of marking attendance manually. This paper has demonstrated a smart and efficient method for taking class attendance. The primary identification for human beings is the face. Therefore, face recognition offers an accurate way of overcoming ambiguities such as false attendance, time consumption and high cost. In addition, face recognition is a biometric method that has the merits of both low intrusiveness and accuracy.

**Key words:** Face recognition, class attendance, Open CV, face detection

**Introduction**

In the field of computer vision, human recognition is an emerging research area. Human recognition is applicable in the class attendance system, where such attendance gets updated in the class attendance database. The use of automated human recognition systems helps to avoid the manual process where trainers take attendance on a daily basis and to avoid proxies or unauthorized persons attending the class. Human recognition can employ a number of biometrics such as face, fingerprint, and iris. Fingerprints and Iris are short- distance biometrics that require relatively short distance contact. Iris and fingerprints are not suitable for class attendance systems because of the requirement of close proximity to the devices. In classroom setup, we need a system that is able to recognise a trainee from a distance, and this is possible through facial recognition. The manual way of marking class attendance wastes a considerable amount of time for both trainees and trainers. The wait time for trainees increases if the number of trainers is relatively large. The manual way of taking class attendance does not weed off proxies in the classroom. In general, manual processes have a cost human error, which also affects the marking of attendance registers. In the field of human vision, the face is the primary recognizable proof for human presence. Therefore, when we automate class attendance processes, chances are that the class productivity will increase. All organizations and institutions of learning need an attendance system for maintaining evidence of class attendance or presence in the place of work. These organizations have their own mechanisms for doing this work. Whereas, some organizations do this work manually others have automated their attendance process. The manual techniques involve the use of a pen and paper which results in the wastage of resources and a painstakingly time consuming process. The manual technique is a risky endeavour that encourages proxies and is prone to human errors. The automated class attendance system involves the following techniques:

- Biometric includes voice recognition, iris, and fingerprint scans. The use of biometric authentications is 100% accurate. However, false acceptance and false rejection are errors that can result in increased fraud.
- Radio frequency identification (RFID) is another technique to automate class attendance. With this technology, a trainee carries her or his own RFID card. Therefore, this method is relatively costly. It also encourages fraud since unauthorised person might use the RFID card to gain entry to class.
- Face detection and recognition is an efficient way of identifying people. Facial detection and recognition is useful in circumstances where we have a large number of

people such as in organizations, colleges, and even in schools. This technology is also non-intrusive. This technique is suitable for taking attendance of large number of people, reduces the chances of taking fake attendance and is fast. Facial detection and recognition is a secure and an easy way of taking class attendance. The attendance records are stored in an electronic database as the system continuously detects faces of the trainees through the camera as they get into the classroom. The system detects the faces and compares it with the registered set of facial datasets in the database.

**Literature review**

According to Arun Katara et al. (2017) the use of iris, fingerprint, and RFID card system recognition has numerous disadvantages such as trainees helping their colloquies to sign attendance. However, iris and fingerprint systems are effective, but not effective since it takes time to verify trainees. Human face has fewer features in comparison to the iris. The use of iris recognition albeit with more features might breach the privacy of trainees or even other users. The use of voice recognition is probable, but it is less accurate in comparison to other available techniques.

Users often fail to distinguish face recognition and face detection. In face detection, the computer seeks to determine the face region or the face segment of the image, while in face recognition the computer seeks to identify the owner of the detected face. Therefore, face detection has to happen before face recognition. Wei-Lun Chao (2007) and S. Aanjanadevi et al. (2017) identified factors that make both face detection and face recognition a difficult task for machines and these include translation, scaling, rotation, occlusion, expression, pose, illumination, and background.

In general, colleges and schools have many trainees in each class. It is the obligation of every trainer to mark trainee's presence or absence in every class. Trainee's attendance is taken manually using a preformatted sheet of paper. However, this process is time consuming. In addition, it is extremely difficult to verify each student in a huge classroom setup. According to Fischler and Elschlager (year of publication) it consumes a lot of time to call out names of each individual trainee when marking attendance register. To overcome this challenge, the use of fingerprint based class attendance became a viable option. At first the trainee's fingerprints get registered against their admission numbers. During the class attendance times, trainees press their fingers on the fingerprint scanner, and the system compares the fingerprint against the once registered. If a match is found the student is marked as present.

The use of fingerprints systems results in reduced work force and time. However, the use of fingerprints is inefficient with large classrooms.

**Statement of the problem**

Trainers or teachers face the problem of checking attendance of trainees. However, the majority of learning institutions have installed CCTV cameras in the classrooms and especially in the laboratories mainly for security purposes. Making use of video footage generated by CCTV cameras to take attendance of trainees can be an added advantage. The number of courses offered by TVET institutions is increasing along with an increase in the number of students enrolling for the same courses. Obiniyi and Ezugwu (2010) observed that student enrolment in tertiary institutions is increasing at a very alarming rate. This calls for a change to the manual way of taking class attendances. The change is significant because the manual way of taking attendance is facing a major limitation of unproductive utilization of time and resources and it will go a long way in promoting TVET for a green economy. A successful implementation of an automated class attendance system will greatly reduce overreliance on papers and the associated stationary thus saving our forests and promoting the greening of our society. The use of automated class attendance system based on face detection and recognition will increase the effectiveness of attendance monitoring and management.

**Objectives**

1. To design an automated class attendance system based on facial detection and recognition
2. To develop a prototype for an automated class attendance system based on facial detection and recognition.

**Methodology and design**

The objective of this project is to design and develop facial detection and recognition system for trainee's class attendance. The methodology begins with the capture of facial image using Logitech web camera, the captured facial image is then pre-processed and facial landmarks are extracted from the facial image. The facial images are then classified for the purpose of the recognition process. According to Daniel et al.(2012), Haar Cascade classifiers are useful in identification of facial landmarks. According to Gonzalez and Woods (2008), scaling of images is an important task in image processing, since the size of the image needs

to be carefully manipulated to avoid loss of spatial information. Therefore, to perform face recognition we need to equalise the size of the image.

**System design**

During the system design stage related functions were grouped together to form sub systems, which in turn formed the entire system. Decomposing the system into various components, informed the logical design of the automated class attendance system.

**General overview**

Figure 1 below shows the block diagram of the system operation. From the diagram, it is evident that the key sub-systems deals with image operations such as extraction, face detection, face recognition and face matching. All these operations make use of an Open Source Computer Vision library called OpenCV. OpenCV library is free for both commercial and academic use. OpenCV is a free, open source, image processing library. The library has Java, Python, and C++ bindings and is portable for use in Android, MacOS, Linux, and Windows operating systems. The library focuses more on real time applications. OpenCV has over 2000 algorithms that are useful in detecting and recognizing faces as well as objects.

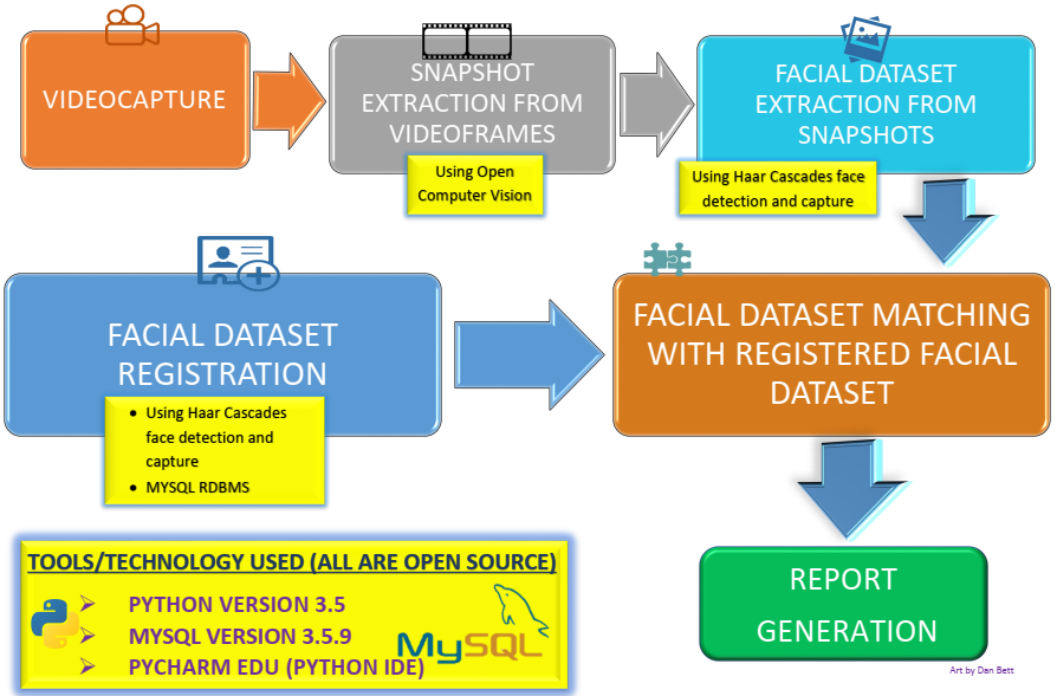



Figure1: Block diagram

The OpenCV library has a face recognition class library called Face_Recognizer. The class manipulates and recognizes faces from the command line or from the Python programming environment. OpenCV is built on top of dlib library, which is a state of the art face

recognition library implemented using deep learning. Dlib is a cross-platform open source software library implemented on several platforms. It has an accuracy of approximately 99.4%. The dlib library comes with a face_recognition command line tool that allows users to do face recognition on a directory of images.

The face is one of the easiest ways to differentiate an individual identity to each other. Face detection and recognition employs personal characteristics of a person to identify the person's identity. Other forms of identification like use of fingerprint scanner and iris would require that the person to be identified come into close proximity to the gadgets.

This system includes a registration module for capturing the facial datasets of the trainees and then stores them in the database, a module to extract snapshots from the video, a module to recognize and extract faces from the snapshots, and finally a module to match the extracted faces against the ones stored in the database. The system uses OpenCV's module of Python face recognition to filter images with faces detected and faces matched using a trained model. To develop a face recognition system we will rely on the built-in Haar cascade classifier that comes with OpenCV. Haar cascade classifiers are machine learning object detection library for the identification of objects in a video or an image.

Figure 1 shows a block diagram of the project methodology. The diagram illustrates the steps for the registration of facial datasets into the MySQL relational database management system, video capture of an ongoing class, extractions of snapshots from video frames, facial dataset extraction from snapshots. Finally, we have facial dataset matching with registered facial datasets and a report to indicate the presence or absence of a trainee from class.

- **Video capture:** This is the process where a CCTV camera captures video of an ongoing class. The class video is useful in detecting and recognising trainee’s faces who attend their classes.
- **Snapshot extraction from video frames:** This process involves extraction of snapshots from the video frames. A video is a consternation of pictures, and this step seeks to extract the pictures that make up a video as shown in figure 2.
- **Facial dataset extraction from snapshots:** Here the OpenCV library is instrumental in detecting and recognising trainee’s faces as shown in figure 2.
- **Facial dataset registration:** This process involves the use of a web camera to register trainee’s bio data together with their facial dataset. The OpenCV library is also used in this step. The trainee’s bio data is stored in the MySQL RDBMS. To improve the accuracy of facial detection and recognition 30 images for each trainee are taken and then stored in the hard disk of the computer as evidenced in figure 3 below.

- **Facial dataset matching with registered facial dataset.** The facial datasets that are recognized from the video are matched against the ones stored in MySQL RDBMS database. If a match is found the student is marked as present, otherwise the student is marked absent.
- **Report generation:** Finally, a class attendance register is generated for use as per the needs and format of the institution.


**Figure 2:** Facial dataset for registered trainee

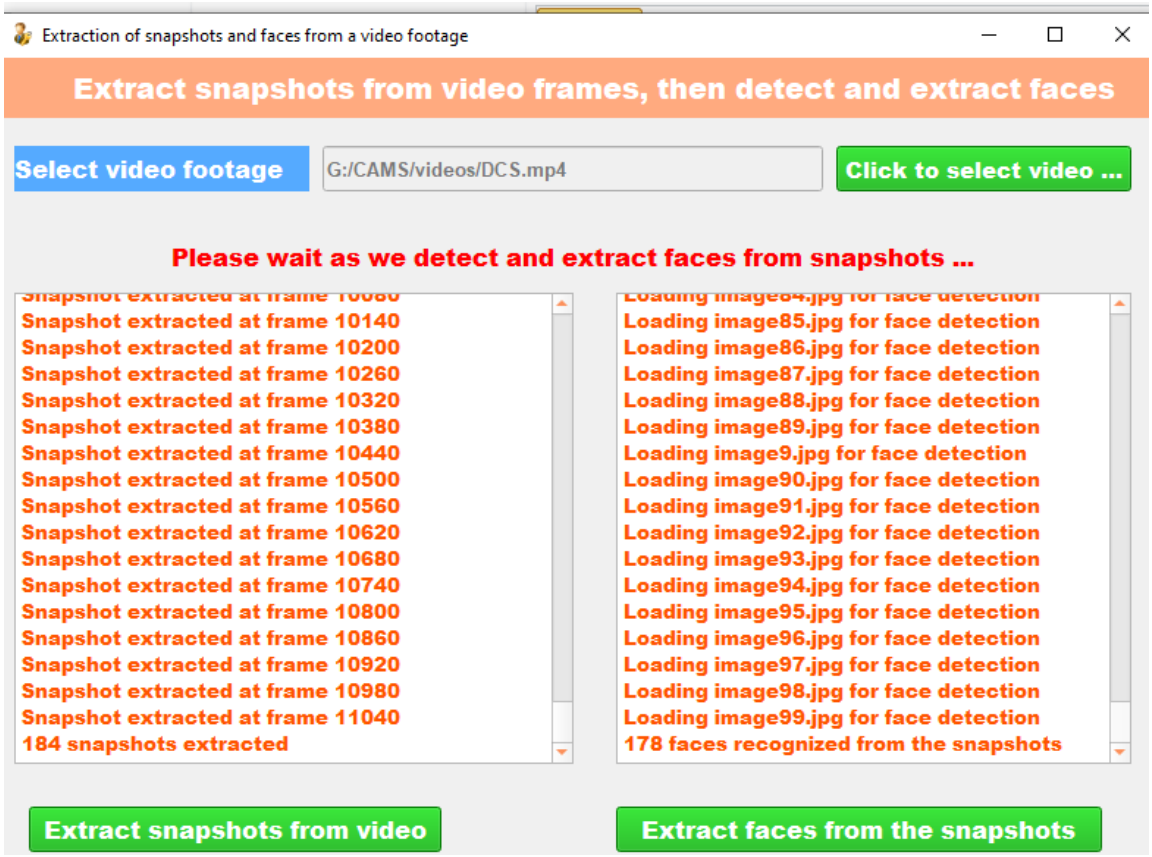


Figure 3: Figure showing 184 extracted snapshots and 178 recognized faces from the snapshots

**Tools/technologies used**

This project majorly used open source tools and technologies namely:

- **Python:** Python programming language was used to develop the automated class attendance system. Python was the programming language of choice because it's open source and it has many modules that are used by a huge scientific community. According to Wes McKinney (2018) Python has become one of the most popular interpreted programming languages, along with Perl, Ruby, and others. Besides Python there are other libraries they are useful such as Numpy and Pandas for manipulation of data.
- **Pycharm Edu:** Pycharm Edu integrated development environment (IDE) was used to write Python source codes. For the design of graphical user interface (GUI) PyQt5 designer was used.
- **MySQL:** MySQL relational database management system was used for the design of the prototype facial data sets data.

**Results and findings**

The automated class attendance system has a graphical user interface designed using Qt5 designer. Access to the system is through a login screen, in which the user types a registered email address and a password as shown in figure 4.

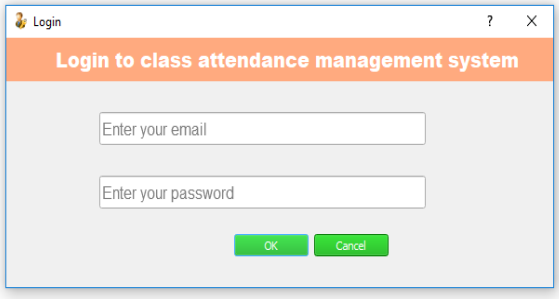



Figure 4: Login screen

After successful login the main screen loads, from the main screen system functionality can be accessed.

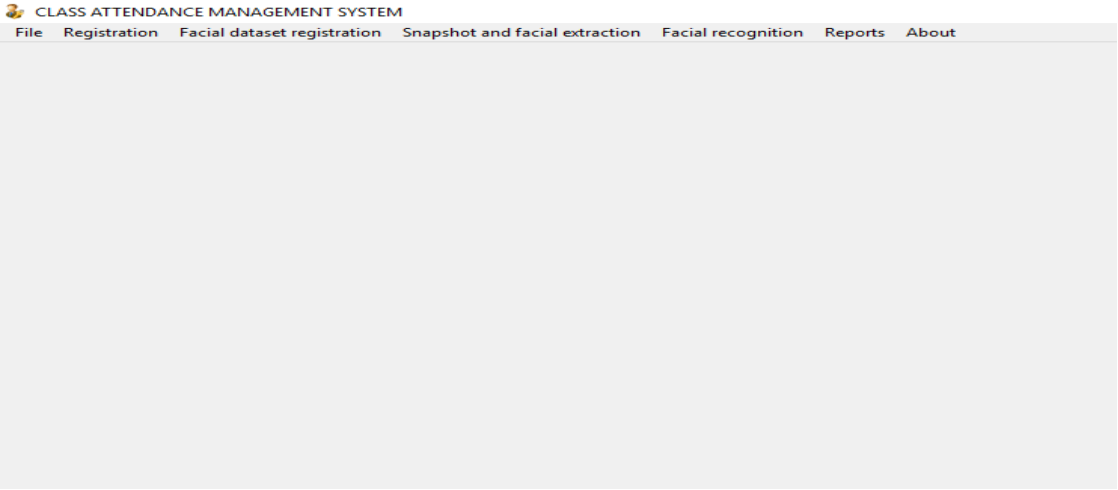



Figure 5: Main screen

From the main screen, quite a number of registrations are done and these include Departments, courses as per departments, classes and their corresponding subjects. Trainees are also registered where registrations number, names and class details are captured and stored in the database. Trainees' facial datasets are registered, where a web camera is used to capture them and stored in the computers storage space as shown in figure 3.

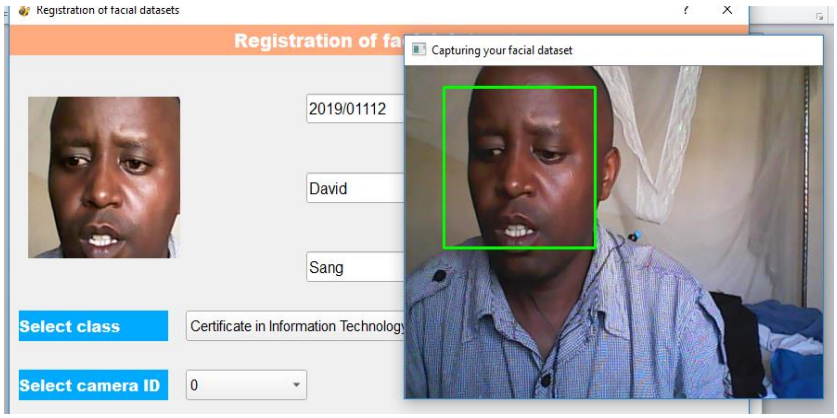


Figure 6: Facial dataset registration

The system performance was tested with two groups of trainees, one group with 10 trainees belonging to Diploma in Computer Studies and the second with 19 trainees belonging to Diploma in Information Communication Technology Module III. The two groups combined had 29 trainees in total as shown in figure 7.

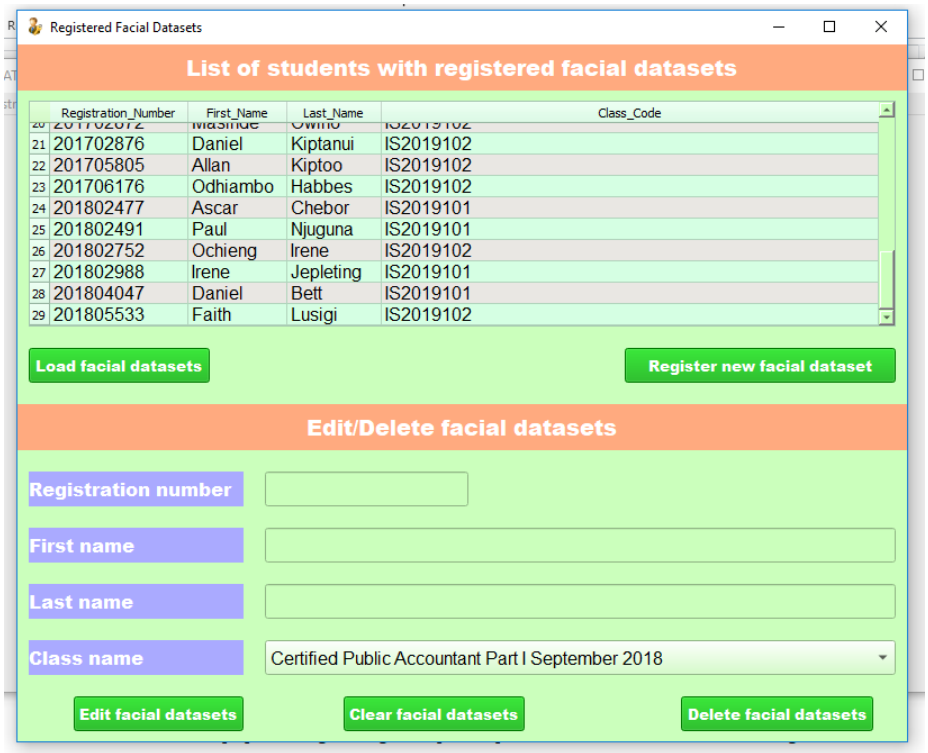


Figure 7: Total number of registered trainees

After the registration of trainees was complete, a demo class was organized where class videos were taken. For Diploma in Information Communication Technology Module III class, a video lasting for 6:06 minutes was recorded and for Diploma in Computer Studies class, a video lasting for 6:08 minutes was recorded.

After recording of the videos snapshots from the videos were extracted and saved in the computer's hard disk, from the extracted snapshots the system was used to detect trainees' faces and extract and save them. The table below shows a summary of the number of extracted snapshots and faces for each video.

| **Video** | **Extracted snapshots** | **Detected and extracted faces** |
|---|---|---|
| DICT Module III | 183 | 1319 |
| DCS | 184 | 991 |

The trainees' extracted facial datasets were then compared and matched with the registered ones so as to determine if a trainee was present or absent in the class. The results of this stage were saved in the database. From the results the system was able to positively identify all trainees in the video as present. Therefore, it can be noted that the system is 100% accurate.

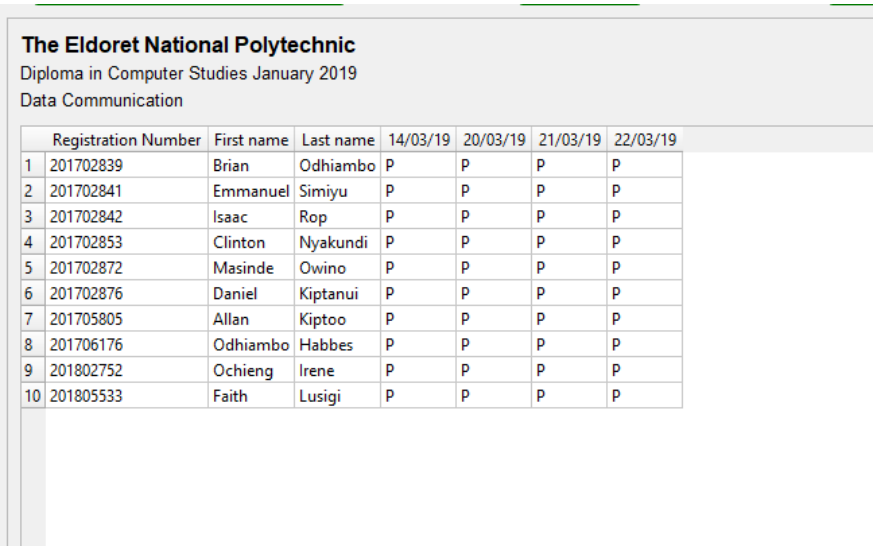
**The Eldoret National Polytechnic**

Diploma in Information Communication Technology Module III January 2019

Data Communication and Networking

| | Registration Number | First name | Last name | 25/02/19 | 01/03/19 | 04/03/19 | 08/03/19 | 18/03/19 | 22/03/19 | 25/03/19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 201602630 | Gilbert | Kiarie | P | P | P | P | P | P | P |
| 2 | 201602641 | Peter | Kiplangat | P | P | P | P | P | P | P |
| 3 | 201602672 | Christopher | Cheruiyot | P | P | P | P | P | P | P |
| 4 | 201602820 | James | Kipng'etich | P | P | P | P | P | P | P |
| 5 | 201602979 | George | Otieno | P | P | P | P | P | P | P |
| 6 | 201602998 | Anderson | Wekesa | P | P | P | P | P | P | P |
| 7 | 201603383 | Willington | Engendi | P | P | P | P | P | P | P |
| 8 | 201603525 | Tiberius | Momanyi | P | P | P | P | P | P | P |
| 9 | 201603635 | Chrispus | Kipleting | P | P | P | P | P | P | P |
| 10 | 201603980 | Benjamin | Kiplangat | P | P | P | P | P | P | A |
| 11 | 201603982 | David | Kimeli | P | P | P | P | P | P | P |
| 12 | 201604213 | Coronelias | Bett | P | P | P | P | P | P | P |
| 13 | 201604320 | Bright | Ochango | P | P | P | P | P | P | P |
| 14 | 201604466 | Hillary | Bett | P | P | P | P | P | P | P |
| 15 | 201604659 | Donald | Tarus | P | P | P | P | P | P | P |
| 16 | 201802477 | Ascar | Chebor | P | P | P | P | P | P | P |
| 17 | 201802491 | Paul | Njuguna | P | P | P | P | P | P | P |
| 18 | 201802988 | Irene | Jepleting | P | P | P | P | P | P | P |
| 19 | 201804047 | Daniel | Bett | A | A | A | A | A | A | A |

Figure 5: Sample DICT Module III class register attendance extracted from the same video.



**The Eldoret National Polytechnic**
Diploma in Computer Studies January 2019
Data Communication

| | Registration Number | First name | Last name | 14/03/19 | 20/03/19 | 21/03/19 | 22/03/19 |
|---|---|---|---|---|---|---|---|
| 1 | 201702839 | Brian | Odhiambo | P | P | P | P |
| 2 | 201702841 | Emmanuel | Simiyu | P | P | P | P |
| 3 | 201702842 | Isaac | Rop | P | P | P | P |
| 4 | 201702853 | Clinton | Nyakundi | P | P | P | P |
| 5 | 201702872 | Masinde | Owino | P | P | P | P |
| 6 | 201702876 | Daniel | Kiptanui | P | P | P | P |
| 7 | 201705805 | Allan | Kiptoo | P | P | P | P |
| 8 | 201706176 | Odhiambo | Habbes | P | P | P | P |
| 9 | 201802752 | Ochieng | Irene | P | P | P | P |
| 10 | 201805533 | Faith | Lusigi | P | P | P | P |

Figure 6: Sample DCS class attendance register extracted from the same video.

**Recommendation**

The use of an automated class attendance system is highly recommended because it saves time, helps promote greening, is cheap to implement and can be integrated with existing CCTV systems and operates efficiently and effectively.

**Conclusion**

It is, therefore, concluded that an automated class attendance system can be popularized for use in taking class attendance.

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