

# AI-Based Attendance Tracking and Monitoring System for UIDT Staff in Thies

Yousouphe Guisse<sup>1</sup>, Ababacar Sadikh Faye<sup>2</sup>, Jupiter Ndiaye<sup>2</sup>, Aliou Ka<sup>1</sup>, Youssou Traore<sup>2</sup>, Mame Andallah Diop<sup>2</sup>, Oumar Diallo<sup>2</sup>, Ousmane Sow<sup>2</sup>

<sup>1</sup>ED2DS, Iba Der Thiam University, Thies, Senegal

<sup>2</sup>University Institute of Technology, Iba Der Thiam University, Thies, Senegal

Email: sow.ousmane@univ-thies.sn

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## Abstract

Academic institutions in Senegal, focused on social relations, knowledge transfer, and research, must now modernize in the face of health risks, theological developments, economic and social development, and security risks. Events such as COVID-19, the series of protests that took place throughout Senegal from March 2021 to February 2024, digitalization, and the use of generative AI, which have disrupted academic institutions, are forcing them to rethink how they operate. However, in an institution such as Iba Der Thiam University in Thies, the increase in student numbers is putting pressure on infrastructure, administrative management, and educational monitoring. Security and transparency remain a challenge, as the existing mechanisms are still prone to fraud. A multitasking system for teaching and administration is a solution for the university in terms of attendance and monitoring. It is very useful for automating the tracking of working hours and supervising activities. The system put in place is autonomous, multitasking for teaching and administrative purposes, modular, open source, and can be used in all institutions. A clocking system based on a very simple DLIB facial recognition model, the Python programming language, and electronic resources. It automatically records and authenticates staff as they enter or leave the establishment, thereby monitoring their punctuality. In addition, it monitors exams and ensures compliance with rules, such as the prohibition of using a phone during class, thanks to the integration of real-time surveillance with the help of cameras, an AI accelerator (Tinker Edge T), and an object detection and recognition model. It can be deployed both in the cloud and locally. A graphical interface allows you to view attendance and track activities to verify compliance with school rules. This automation solution contributes to improving the management of administrative staff, working hours, discipline, safety, and transparency.

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## Keywords

Productivity, Personnel, Clocking, Arduino, Visualization Interface, Cloud, Open Source and AI

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## 1. Introduction

With the new VISION SENEGAL 2050, structured around four main strategic areas: Competitive economy, Quality human capital and social equity, Sustainable planning and development, and finally good governance and African engagement [1], achieving these economic objectives and quality human capital requires rationalization of resources, increased productivity within institutions, and promotion of quality training. While the number of students in Senegalese universities is very high, resource management remains inadequate. Senegal is one of the countries in the ECOWAS region that presents significant risks of academic corruption [2]. Furthermore, the clocking-in systems used often require interaction or physical proximity between users. This can lead to health risks, hinder productivity, and make data vulnerable to loss, forgetfulness, or theft, thereby reducing the reliability of attendance tracking.

Researchers have proposed solutions based on traditional clocking systems. Radio frequency identification (RFID) tags are equipped with an identification chip that uses an electromagnetic field to exchange data [3]-[5]. Employees are assigned personal codes in the form of PINs, which they enter into a terminal to record their arrival and departure times [6]. Other methods rely on filling out forms, where each employee personally records their arrival and departure times for identification purposes. There are also biometric clocking systems that analyze each individual's physical characteristics: fingerprinting uses the pattern of lines on the skin of the fingers for identification. Each individual has different patterns, which is what motivates their use [7] [8]. Iris morphology is also an extremely reliable technique that contains an infinite number of characteristic points (fractal set), although fraud is still possible using lenses [9]. Facial recognition is also a technique that involves identifying a person from an image of their face [10]-[12]. With regard to exam surveillance, researchers have adopted people counting solutions based on various environmental parameters such as CO<sub>2</sub>, carbon monoxide (CO), and total volatile organic compounds (TVOC), but these have only been tested in spaces that can accommodate fewer than 10 people at a time [13]. Video camera-based approaches to counting people [14] [15] have achieved good accuracy, but they rely on complex image processing algorithms that require significant computing resources. However, their method only produces accurate results when there is minimal movement in the classroom. There is also traditional surveillance, where the person must be active, moving around the room, and reporting any suspicious activity [16]. An exam cheating detection system using YOLOv11: a comprehensive real-time object detection framework to improve academic in-

tegrity. It identifies six distinct behaviors: the examiner, leaning over to copy, looking around, sitting normally, talking and cheating, and walking [17].

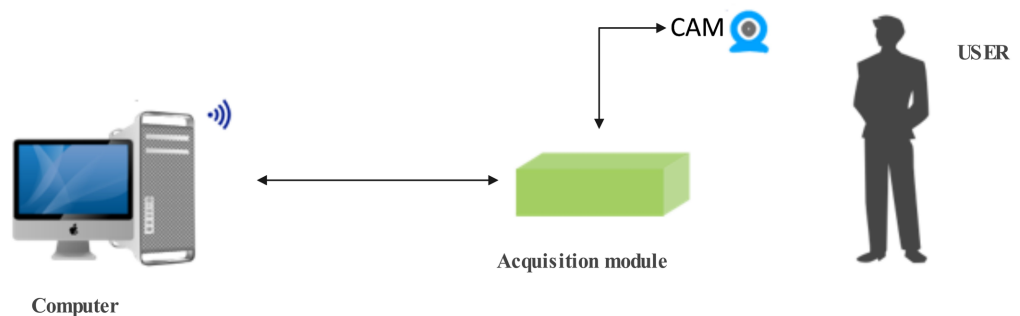
To improve these systems, this project focuses on the design of an automated and intelligent scoring device, with surveillance as a future extension.

According to the report on the Biometric System Market by Fortune Business Insights [18], the biometric systems market is valued at USD 36.3 billion in 2024 and is expected to grow to USD 113.32 billion in 2032, with a CAGR of 15.2%. Facial recognition, which is valued at USD 7.73 billion in 2024, is expected to reach USD 24.28 billion in 2032, with a CAGR of 15.5%. The time and attendance systems used in Senegal are most often fingerprint reader systems with paper forms, which can be costly, pose health risks, and are prone to fraud. With technological advances such as electronics, information technology, and AI, these systems increasingly need to be upgraded. Biometric systems have become one of the most relevant technologies used to ensure the security of time and attendance systems. They will make administrations and institutions more secure by improving identification methods and resource management.

The aim of the study is to develop a biometric system that registers and authenticates administrative staff in order to improve the quality of time and attendance services using AI and IoT. In addition, the exam monitoring system detects unauthorized objects and counts the number of people in the room, then sends a message with an image of the detected object. This solution will enable decision-makers to independently view the staff present in the administration or establishment in real time and, at the same time, obtain reports via an interface. The system operates in four main phases: acquisition, motion detection, facial image capture, person identification, and registration.

## 2. Materials and Methods

The device consists of a number of interconnected components: a central processing unit, an Arduino board, a camera, and a photoelectric sensor. The central processing unit is responsible for processing the data received via the camera, which is linked to an Arduino board connected to a photoelectric sensor. A real-time data visualization interface enables quick and effective decision-making. The architecture of this prototype is shown in **Figure 1**.



**Figure 1.** Overview of the scoring system.

## 2.1. Main Computer

The computer (**Figure 2**) is essential to the functioning of the system, accelerating data processing. It is equipped with Wi-Fi and Ethernet connectivity. The system is built with a sensor that collects information from the external environment in order to detect movement and capture images. The captured image is stored in the mini-computer and, depending on the device, will either be sent to the cloud to be processed with an artificial intelligence model for facial recognition in order to identify the person or processed locally with artificial intelligence models. **Table 1** shows the characteristics of the mini-PC.



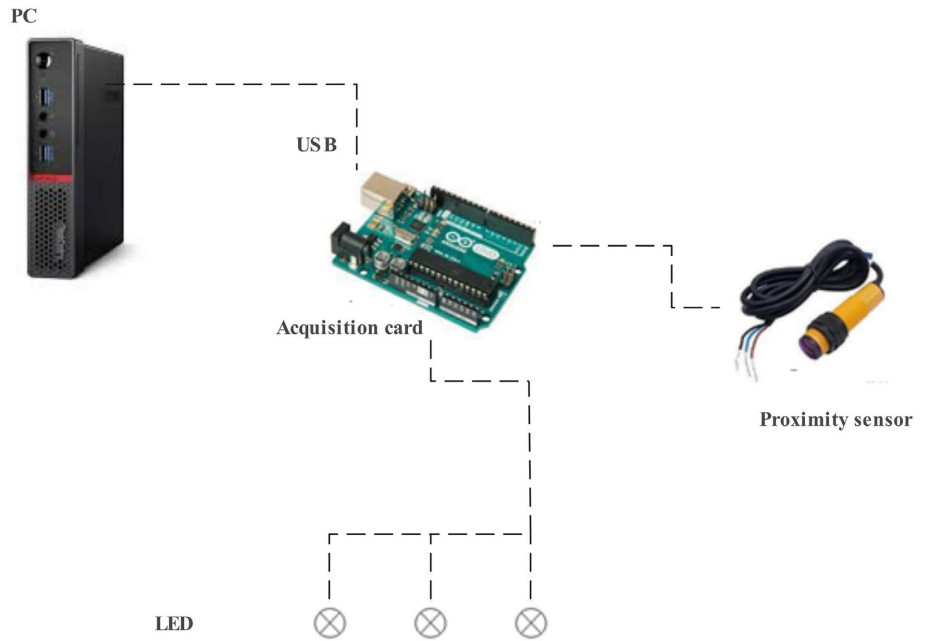
**Figure 2.** Lenovo ThinkCentre M700 Intel mini-PC.

**Table 1.** Specifications of the Lenovo ThinkCentre M700 Intel Mini PC.

Operating System	Windows 10 Pro 64-bit
Processor	Intel(R) Pentium(R) CPU G4400T at 2.90 GHz (2 CPUs)
RAM	8 GB
Storage	118.0 GB hard drive
Graphics	Intel® HD Graphics 510
Connectivity	WIFI 802.11 ac Bluetooth v4.0 Ethernet 10/100/1000 Mbit/s
Front Interfaces	2 USB 3.0 ports 1 × 3.5 mm microphone jack input 1 × 3.5 mm headphone jack output
Rear Interfaces	4 USB 3.0 ports 2 Display Ports 1 LAN RJ45 port 1 × 3.5 mm headphone jack

## 2.2. Acquisition Card

In this project, we use an Arduino Uno board that is interconnected with components (**Figure 3**). It can be programmed for various tasks; in our case, to control three LEDs and a sensor. **Table 2** summarizes all the connections established between the Arduino board, the proximity sensor, the PC and the LEDs.



**Figure 3.** Input and output connections to the Arduino board.

**Table 2.** Addressing of the electronic board.

Address	Nomenclature	Function
Pin 2	D1	Proximity sensor
Pin 8	V1	Operating indicator light
Pin 9	V2	Processing indicator light
Pin 10	V3	Out of service indicator light

### 2.3. Visualization Interface

The display interface (**Figure 4**) is a tool that displays data or information in a way that is understandable to the user. It is developed using the Python tkinter library and can be accessed either locally or remotely on the same network, depending on the prototype. The information displayed includes the surname, first name, date, arrival and departure times, and status, which manages the agent’s attendance, absence, and lateness times.

The first visualization interface stores data in an AWS cloud database, using a Python script developed with Tinker. This data is then displayed on the interface. The second interface stores data in a local WampServer database, which can be used to visualize data either through SQL queries or via a Tinker Python script, either locally or remotely on the same network. As for working hours, we have set a limit of 8 a.m. to 8:30 a.m.; beyond this range, the agent is considered late, and from 12 p.m. onwards, they are considered absent. Each interface has a menu with several options, such as attendance management, working hours, and daily, weekly, monthly, and overall reports (**Figure 5**), not to mention holiday management, all in real time for better organization.

Système de Présence UIDT

Date de début (AAAA-MM-JJ): 2025/5/01 Date de fin (AAAA-MM-JJ): 2025/05/30 Nom:

PrenomNom	Date	Heure entrée	Heure sortie	Statut
Demba Diol	01/05/2025	10:06:00	17:45:28	En retard
Sanou Abdoulaye FAYE	27/05/2025	8:07:09		Présent
Ousmane SOW	27/05/2025	8:17:19	17:45:28	Présent
Timothee KELLER	27/05/2025	8:23:19	17:35:20	Présent
Emmanuel Monteiro	27/05/2025	8:36:16	17:15:03	Présent
Youssouphe GUISSÉ	27/05/2025	8:36:16	17:15:03	Présent
Djiby COULIBALY	27/05/2025	9:02:21	18:15:03	Présent
Demba Diol	27/05/2025	9:10:35	18:05:12	Présent
Mouhamed DIOUF	27/05/2025	11:03:00	18:23:00	En retard
Aliou ka	27/05/2025	13:14:36		Absent
Emmanuel Monteiro	28/05/2025	8:20:19	18:00:12	Présent
Timothee KELLER	28/05/2025	8:25:29	17:58:20	Présent
Demba Diol	28/05/2025	8:36:16	18:15:03	Présent
Djiby COULIBALY	28/05/2025	9:09:10	18:15:13	Présent
Youssouphe GUISSÉ	28/05/2025	9:20:19	17:50:28	Présent
Aliou ka	28/05/2025	11:08:03	17:50:28	En retard
Youssouphe GUISSÉ	29/05/2025	8:56:10	18:05:06	Présent
Demba Diol	29/05/2025	10:03:00	18:23:00	En retard
Djiby COULIBALY	29/05/2025	11:02:21	18:01:09	En retard

Récupérer les présences Gestion Presences Horaires Travail Personnes Rapports Calendrier Conge

Figure 4. Visualization interface.

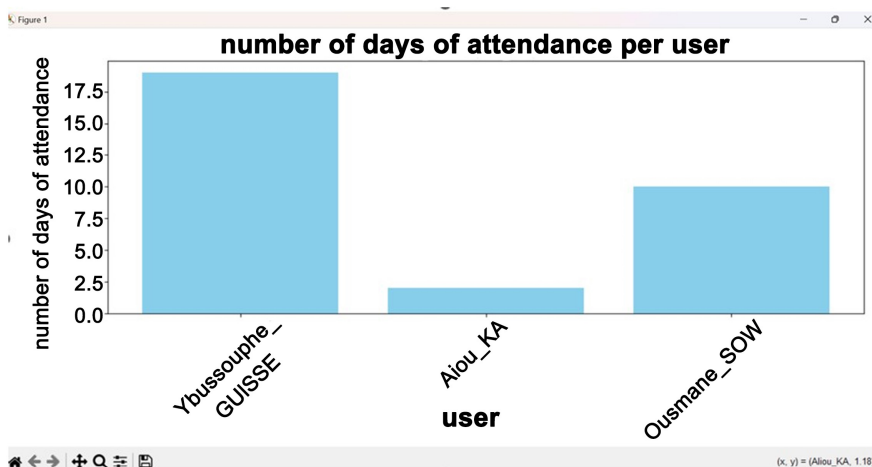


Figure 5. Weekly report.

## 2.4. Cameras

The first device has one camera, while the second has two extendable cameras. They are used to take photos if movement is detected in order to identify the person.

## 2.5. Sensors and LEDs

### 2.5.1. Photoelectric Sensor

This measures the distance between different objects, with a detection range of 5 to 30 cm. It is set to detect whether there is a person in the device.

### 2.5.2. Infrared Motion Detector

The heat emitted by an individual produces infrared rays. It is thanks to this infrared radiation that the sensor can detect the presence of intruders.

### 2.5.3. LED

There are three LEDs: red, green and yellow. Red indicates that the device is out of service, yellow that it is processing information and green that it is waiting for information.

## 2.6. Exam Monitoring Prototype

In order to enhance the educational environment, an intelligent real-time monitoring system linked to cameras has been set up. The device uses two USB cameras, a Tinker Edge T, and algorithms. The Tinker Edge is equipped with Google Edge TPU, a machine learning (ML) accelerator that speeds up processing efficiency, reduces energy requirements, and facilitates the creation of connected devices and intelligent applications. Thanks to this integrated ML accelerator, the Tinker Edge T is capable of performing 4 tera-operations per second (TOPS) using only 0.5 watts per computing unit. It is also optimized for TensorFlow Lite models, which facilitates the compilation and execution of common ML models [19]. The object detection model used is the TensorFlow Lite API developed by Google AI Edge.

The device detects and identifies objects such as phones and computers, which are not allowed during exams, and sends an alert message with a screenshot as proof. It is also capable of counting the number of people in a room. At this stage, the system is being tested, and several improvements are planned for future versions.

## 3. Results and Discussion

### 3.1. Scoring Module

The scoring device is a box divided into two compartments (Figure 6). The first

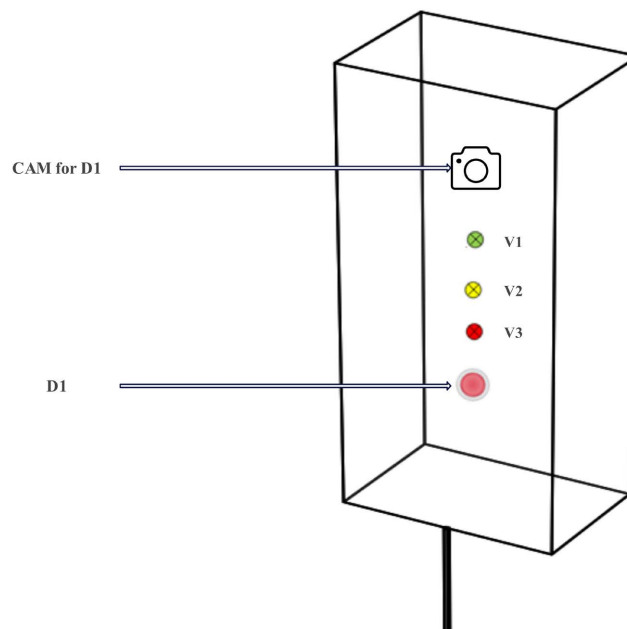
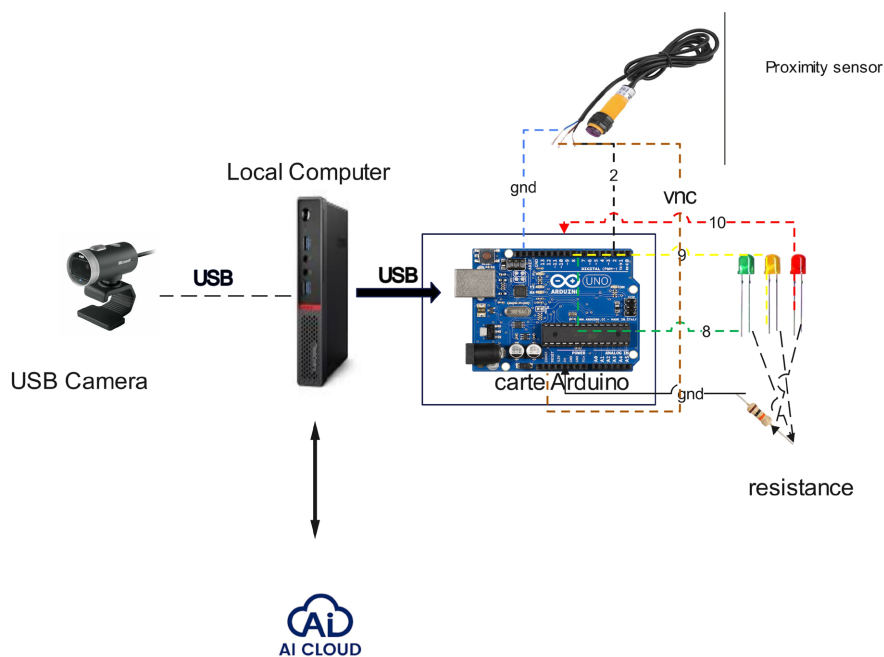


Figure 6. Overview of the scoring system.

part of the device is dedicated to taking photos. It has an illuminated opening that receives the photo captured by the camera. The second part, for control and command, is equipped with an Arduino board that manages Boolean inputs and outputs, indicating the activation of the system (photo capture, processing, and shut-down).

### 3.2. First Prototype

The first scoring system (**Figure 7**) was developed using Python scripts to manage the connection between the Arduino board, the photoelectric sensor, the three LEDs (green, yellow, and red), and the camera, and to send the data to the cloud server.



**Figure 7.** Architecture of the scoring system.

When a person is detected by the photoelectric sensor, the green LED turns yellow to indicate that the image capture program is active, then turns green again after capture. The image is saved with the date, hour, minutes, and seconds. The image name is saved in a file called `enregistrement.txt`, then the connection is checked. When the connection is established, the image is transmitted to the cloud for identity verification; if this fails, the image name is saved in the file `erreur.txt`.

For this system, the person must stand in front of the prototype and face the camera at a distance of 25 cm to ensure proper identification. The position of the device is important, as lighting is a key factor in obtaining a better photo. The captured image is then sent to the cloud for processing using AWS Rekognition, a deep learning-based image recognition service.

The cloud is used for data processing by AWS artificial intelligence. It enables savings to be made by pooling services across a large number of customers. Ac-

According to a study by the American think tank Brookings Institution, governments could achieve savings of 20% to 25% on their IT budgets if they migrated to cloud computing [20]. The use of cloud computing also relieves the company of certain tasks: maintenance, security, and service upgrades are the sole responsibility of the service provider. These are generally performed better and faster than when they are the responsibility of the customer, especially when the customer is not an IT organization [21] [22].

However, cloud computing also has its limitations, as the data collected is sent to other countries for storage and processing, which can lead to a loss of control over the information. Data access and management depend on the provider's policies and tools, with a risk of dependence on the provider. There are also security issues, such as data confidentiality, online threats, and privacy violations, if the provider does not comply with strict standards. Finally, connection problems can make it difficult to send data to the cloud for processing. Control over personal data, therefore, remains a major challenge for privacy protection. **Figure 8** shows the device as it was built, and **Figure 9** shows an example of processing performed by the system.



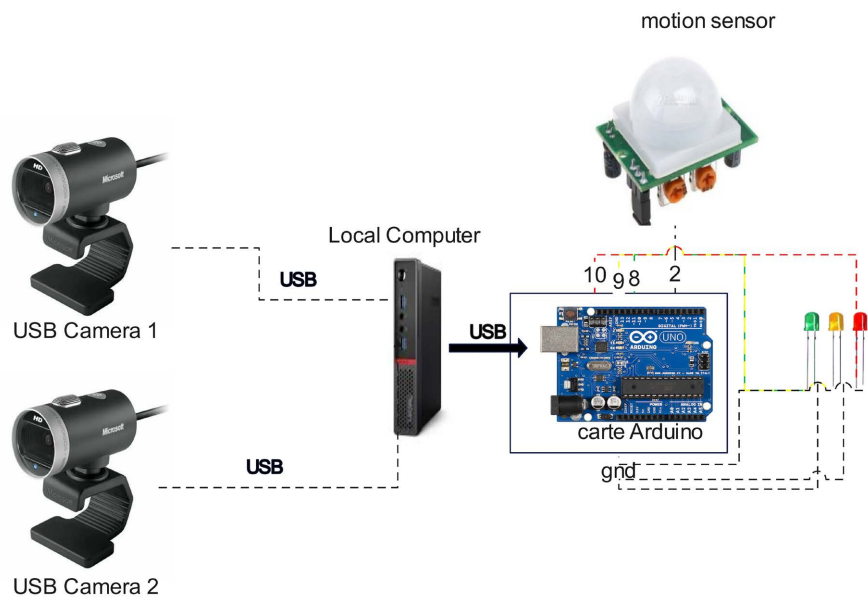
**Figure 8.** First prototype.

```
Le code a mis 12.1940438747400 secondes a s exécuter.  
2025-01-15T17:12:36.277967  
Photo du visage capturée.  
La photo a été téléchargée sur registre-uidt/acquisition/2025-01-15T171236.jpg  
Nombre de visages correspondants trouvés : 1  
Visage correspondant avec une similarité de 100.00%  
Youssoupe_GUISSÉ  
Élément ajouté avec succès.  
Pas d'erreur  
Fin enregistrement  
Le fichier n'est pas vide.
```

**Figure 9.** Processing performed by the system.

### 3.3. Second Prototype

After the first prototype based on a cloud-connected scoring system for identity verification, the second prototype (Figure 10) takes a local approach with two cameras positioned differently to improve the probability of individual recognition. The two images are verified to ensure they have been captured correctly, resized to the same height, combined side by side, and then saved with the date, hour, minutes, and seconds. The name of the image is saved in a file called `enregistrement.txt`. The officer concerned does not need to be present in front of the device to trigger the prototype, as the cameras are automatically activated as soon as they enter the motion detector's field of action.



**Figure 10.** Scoring system architecture.

To process the collected data, a pre-trained minimum norm vector recognition model (dlib 128D descriptor) is used, which is open source locally. This model is built using dlib's advanced facial recognition technology with deep learning. It achieves 99.38% accuracy on the Labeled Faces in the Wild benchmark [23]. Dlib is a modern C++ toolkit containing machine learning algorithms and tools for creating complex C++ software to solve real-world problems [24]. It stands out for its easy-to-use Python interfaces, which make it particularly accessible for integration into various projects. The model performs facial recognition by projecting each face into a 128-dimensional feature space. It then compares the representations obtained by calculating the Euclidean distance between them: if this distance is sufficiently small, the system concludes that the faces match.

All processing is performed locally from a single reference image. The position of the two cameras used to take the facial image is crucial, because if neither camera captures the face correctly, identification will be impossible. This is because the system relies entirely on capturing the face: if it is not photographed correctly

or if the person is not within the cameras' field of view, identification cannot be performed.

### 3.4. Third Prototype

After the second prototype, which uses two cameras and local processing to enhance recognition reliability, the third device (Figure 11) simplifies the architecture by using only one camera while retaining the same processing model. The image is saved with the date, hour, minutes, and seconds. The image name is saved in a recording.txt file. The agent concerned must be present in front of the device to trigger the prototype and ensure identification. For data processing, the model applied in the second device was used. The information is recorded in a database that is entirely local with WampServer.

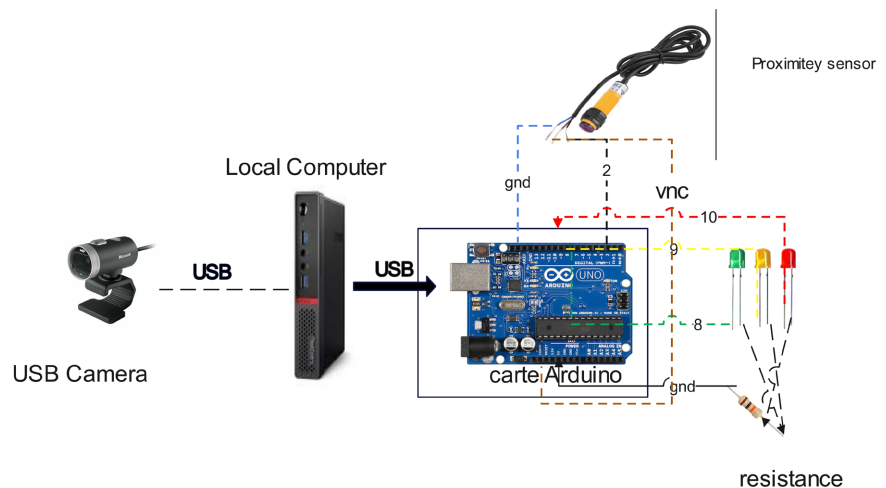


Figure 11. Scoring system architecture.

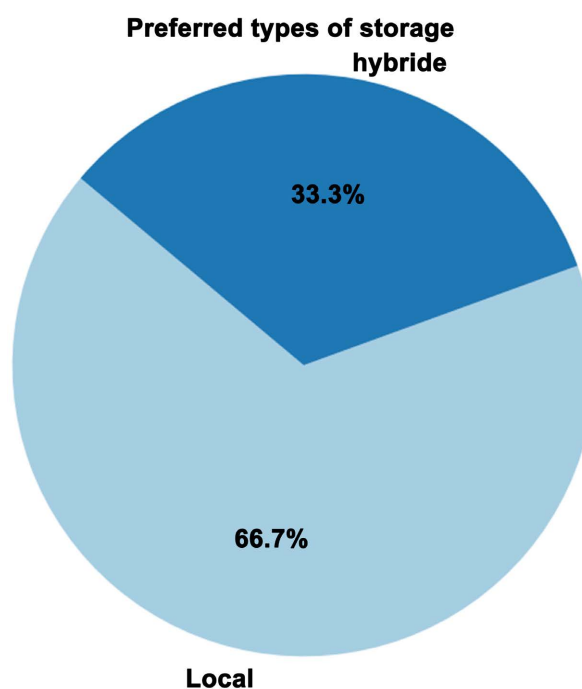
## 4. UIDT Data

The data collected aims to identify the requirements for a time and attendance system within the various departments of Ibar Der Thiam University in Thies. To this end, six departments were surveyed using a structured questionnaire sent to department heads. The data received was analysed to identify current needs and expectations regarding the types of time-and-attendance systems used, the size of each department, the type of storage, the type of time-and-attendance system desired, the data stored, the purpose of the system, etc.

### 4.1. Types of Attendance Tracking Used and Desired

Most do not use any system or use a manual system. Among the six components, only 16.7% have a formal system that uses logbooks to record the surname, first name, arrival, and departure times for each employee. This indicates a low level of automation or digitization of the time and attendance system. All entities want a modern, biometric, and automatic solution that integrates an entry/exit or multi-clocking system. This reflects a significant need for reliability, strict moni-

toring, and security. **Figure 12** illustrates the result obtained.



**Figure 12.** Types of clocking systems used.

#### 4.2. Company Size and Type of User

The system is intended solely for managing administrative staff. Almost all structures have fewer than 50 employees; only the rectorate has more than 50 and fewer than 500 employees.

#### 4.3. Desired Data Storage

The data collected is personal information based on the photos, names, and identities of employees. Most UIDT organizations wish to maintain internal control over their data, but some are considering a hybrid approach, possibly for security or connectivity reasons. Two-thirds of entities (66.7%) prefer local data storage, while one-third (33.3%) opt for a hybrid solution combining local and cloud storage. **Figure 13** shows these results.

#### 4.4. Comparison of Processing Time between Cloud and Local Storage

We also compared cloud and local processing times on the university's Wi-Fi network for 30 processes to obtain the average processing time for each environment. We noticed greater consistency in processing times with the local environment, which had a peak but did not exceed 50 seconds. Overall, local processing time ranged from 26 to 50 seconds. Cloud processing, on the other hand, varied much more, ranging from 7 to 70 seconds. This result can be explained by heavy traffic on the university's Wi-Fi network during the test. The results are illustrated in

Figure 14.

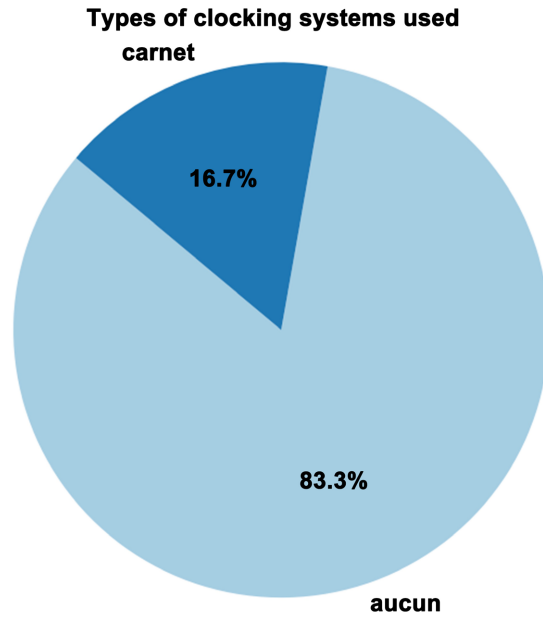


Figure 13. Preferred types of storage.

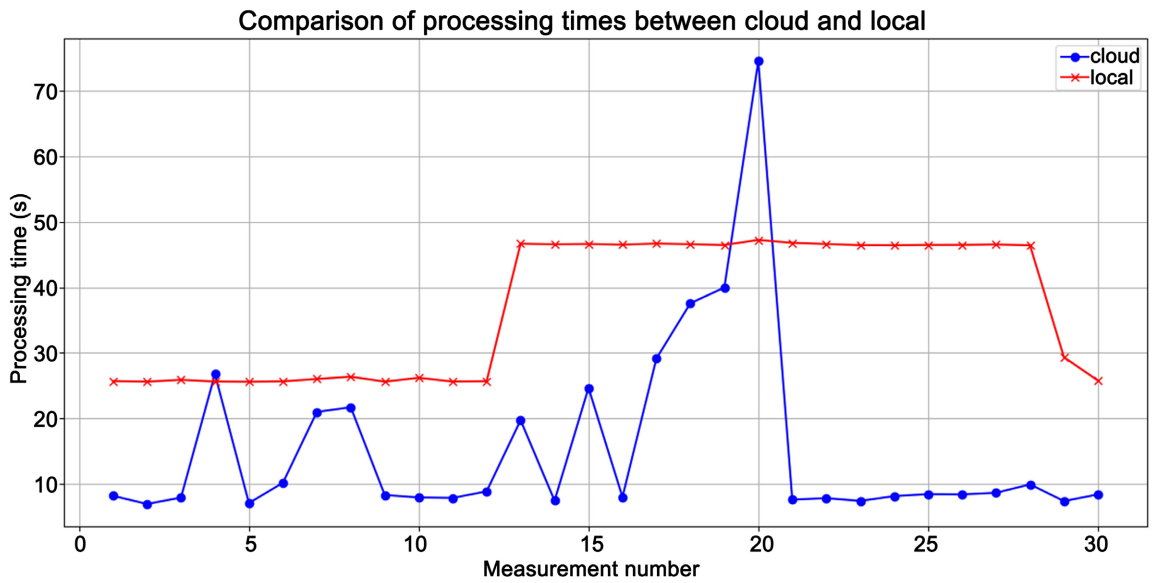


Figure 14. Local and cloud processing.

### 5. Conclusion

The design of a multitasking system is an important element in public and private institutions, particularly in a context where agents constitute the main workforce of the company. With this in mind, technical solutions are being implemented to ensure the effective management of structures by integrating revolutionary clocking and surveillance systems. This paper proposes a clocking system solution to make the institution more flexible and digital, and to open the way for the inte-

gration of AI and object detection for exam surveillance. The system uses open-source facial recognition and object detection models. It can be deployed entirely locally. The introduction of this technological solution into UIDT structures could help improve staff management, credibility, and the effectiveness of attendance monitoring. It is also important to highlight a key limitation of the system: its sensitivity to image quality. Blurry, poorly lit, or poorly angled images can reduce the reliability of facial recognition and lead to identification errors. Additional efforts will therefore be required to improve the accuracy of recordings and ensure the security of personal data collected by the system. With the latest innovations in facial, morphological, and iris recognition systems, attendance management is now carried out in real time, enabling quick and efficient decision-making without the possibility of dispute.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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