SMART ARTIFICIAL INTELLIGENCE-BASED ONLINE PROCTORING SYSTEM

A Project report submitted in partial fulfillment

for the award of the degree of

MASTER OF COMPUTER APPLICATIONS

(2023-2025)

Submitted by

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Under the esteemed guidance of

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CERTIFICATE

This is to certify that the project report entitled "**SMART ARTIFICIAL INTELLIGENCE-BASED ONLINE PROCTORING SYSTEM**" is the bonafide work done by me **P. SUVARNA SAI, REGD.NO- 23G21F0061** in partial fulfillment of the requirements for the award of the degree of **Master of Computer Applications,** from Jawaharlal Nehru Technological University Ananthapuramu, during the year 2023-2025.

Project Guide

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DECLARATION

I, Ms. P. SUVARNA SAI, Regd.**No-23G21F0061,** hereby declare that the project work entitled "**SMART ARTIFICIAL INTELLIGENCE-BASED ONLINE PROCTORING SYSTEM**" done by us under the esteemed guidance of Associate Professor **Prof . V. CHANDRASEKHAR** and is submitted in partial fulfillment of the requirements for the award of the Master's degree in **Computer Applications.**

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ACKNOWLEDGEMENT

We express our deepest gratitude to **Dr. Vanki Penchalaiah**, Chairman of Audisankara College of Engineering & Technology, for providing us with an excellent academic environment and unwavering support throughout our project.

We extend our heartfelt thanks to **Smt. Vanki Anusha**, Vice Chairperson, for her encouragement and continuous motivation, which have been instrumental in our academic journey.

We sincerely appreciate the guidance and support of **Dr. Raja Murugadoss Jeyraju**, Director(Engg., & Principal), whose leadership and vision have inspired us to strive for excellence.

We extend our heartfelt thanks to **Mr. V. Chandrasekhar,** project guide, for his/her invaluable insights, encouragement, and unwavering support, all of which played a significant role in the successful completion of our project.

Our sincere gratitude goes to **Mr. V. Chandrasekhar,** Head of the Department, for valuable insights, motivation, and support, which greatly contributed to the successful completion of our project.

We are thankful to **Dr. A. Immanuel**, Institute Project Coordinator, for his expert guidance and coordination, which played a key role in shaping our project.

We also extend our appreciation to **Mr. Ch. Dayakar,** Department Project Coordinator, for providing valuable feedback and ensuring the smooth progress of our project.

We express our gratitude to our **department faculty** for their constant encouragement, technical guidance, and mentorship throughout this journey.

Our special thanks to the **non-teaching faculty** for their assistance and support in various aspects of our project work.

We would like to extend our heartfelt appreciation to our **parents and friends**, whose encouragement, patience, and moral support have been our driving force in completing this capstone project successfully.

Finally, we acknowledge the collaborative efforts of our **team members**, whose dedication and hard work made this project possible.

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ABSTRACT

The sudden transition to online learning amid the COVID-19 pandemic fueled an imminent need for safe and reliable systems to hold virtual exams. Although virtual classrooms have seen virtual learning platforms easily fit in, protecting the integrity of the online test continues to be a major issue. Most of the available proctoring tools are mainly aimed at verifying identities using facial recognition or simple authentication processes. They tend to be weak, though, when it comes to detecting deceitful activity or keeping test-takers on their toes and unassisted during the test.

This project introduces an intelligent online proctoring system that extends beyond conventional techniques by adding real-time behavioral observation to strong authentication. The system utilizes a common webcam to constantly examine video frames, authenticating the user and identifying deceptive behavior. It utilizes a blend of state-of-the-art computer vision technology like face spoof detection to identify real faces from images, face verification for checking identities, and head pose estimation. Moreover, the system also incorporates eye tracking in order to identify if the person is gazing away from the screen and mouth movement analysis for identifying potential speaking behavior. It also scans for the existence of prohibited objects or more than one individual in the scene, generating alerts when such discrepancies are observed. All of these features are constructed with lightweight, efficient models to support real-time behavior even on low-resource hardware.

By integrating all these aspects into a single, smart pipeline, our solution provides an end-to-end monitoring experience that boosts the integrity of online exams. It lessens dependency on human proctors and prevents malpractice as much as possible, and so it becomes an asset for education institutions and remote assessment conducting organizations. This project not only fills the existing gaps in online exam security but also lays the groundwork for future innovations in ethical and scalable remote proctoring technologies.

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1. INTRODUCTION

1.1 ABOUT PROJECT

Smart Artificial Intelligence-Based Online Proctoring System is an end-to-end solution developed to meet the increasing demand for secure and scalable examination monitoring for online learning platforms. With greater numbers of educational institutions and certifying bodies going online, securing the integrity of tests has emerged as a pivotal challenge. In-person supervision, the traditional option, is no longer possible in remote environments, and several of the existing online proctoring solutions are inadequate, either being highly dependent on manual intervention or having limited automated functionalities. The project was designed to close the gap by creating a real-time system that leverages several cutting-edge technologies to authenticate examinees and identify suspicious activities during tests. At the heart of this project lies a vision to simulate the role of a vigilant human invigilator using artificial intelligence and computer vision. The system operates with a basic webcam to scrutinize the examinee during the entire course of the exam. It starts by verifying the candidate's identity by face recognition in order to check whether the one sitting for the test is really the intended authorized candidate. This is then followed by face spoof detection, which distinguishes between a live individual and an imitation representation like a printed image or pre-recorded video. These two processes operate simultaneously to avoid impersonation and maintain the integrity of the examination process.

After the exam starts, the system keeps monitoring the video stream to detect abnormal or suspicious activity. People detection and counting module ensures that only one person is present in the frame. If nobody or multiple people are detected for a prolonged number of frames, the system raises a red flag. This capability is vital in avoiding outside help, a usual problem in unattended places. Aside from tracking the individuals, the system also includes object detection to recognize any illicit items like mobile phones, books, or auxiliary devices. Whenever such items are frequently found or kept in sight for a prolonged duration of time, they are recognized as possible aids for cheating.

A side from static verification, the system also dynamically monitors the examinee's behavior. One of the essential parts is head pose estimation, which determines the direction and angle of the examinee's head to ascertain whether or not he is facing the screen. It is especially effective in detecting if a student keeps his head averted for long durations, likely to glance at notes or converse with someone. Adding to this is an eye tracking module, which

tracks the movement and direction of the eyes using facial landmarks. If the gaze of the examinee keeps drifting away from the screen, the system classifies this as suspicious behavior.

To further strengthen behavioral analysis, the system also has a mouth movement detection capability. By monitoring certain areas of the face, it can determine if the examinee is speaking. If the mouth remains open for more than a few frames, it could suggest that the examinee is engaged in unauthorized conversation, and the system would raise an alert. All these behavioral monitoring modules run in real time and are backed by a lightweight architecture, enabling the system to remain efficient even in low-end computational devices. The modular architecture of this system guarantees that every element operates independently but aggregates to form a cohesive and intelligent monitoring process. The combination of these functionalities presents a layered safeguard against malpractice such that every behavior is examined, recorded, and assessed without the intervention of human beings. This not only lightens the load for educators and proctors but also offers an expandable and uniform process for online examination oversight.

Finally, the Intelligent Online Proctoring System is a visionary solution that marries precision, efficiency, and pragmatism. It fills essential gaps in online learning by providing a solid framework for maintaining exam integrity, all while being as non-intrusive as possible to the examinee. Through the use of real-time video analysis, machine learning, and computer vision, the system applies human-like vigilance to the virtual exam room, making it a trustworthy instrument for contemporary learning environments.

1.2 INTRODUCTION ABOUT ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is a transformative field of computer science that focuses on building systems capable of performing tasks that typically require human intelligence. These tasks include learning from data, understanding visual information, recognizing speech, making decisions, and adapting to new situations. Over the years, AI has evolved from simple rule-based systems to complex machine learning and deep learning models that can process massive amounts of data and derive meaningful patterns. The rise of AI has had a significant impact on various industries such as healthcare, finance, transportation, and more recently, education.

In the context of online examination systems, AI plays a pivotal role in enabling automated, real-time monitoring and decision-making. The Intelligent Online Proctoring System developed in this project leverages several AI techniques to replicate the behavior of a human invigilator. For instance, face verification and spoof detection use machine learning algorithms trained to distinguish between genuine and fake identities. These models analyze facial features and make intelligent comparisons to validate user authenticity with high accuracy. Computer vision, a key subfield of AI, is deeply integrated into the system to analyze video frames in real-time. Modules such as head pose estimation, eye tracking, and mouth movement analysis relies on visual input to detect behavioral patterns. Instead of requiring constant human supervision, the AI algorithms monitor these cues and raise alerts when they detect anomalies, such as looking away from the screen or speaking during the exam. These decisions are not hardcoded but are the result of AI models trained on real-world behavior, enabling the system to adapt to subtle human actions and respond appropriately.

One of the strengths of AI in this project lies in its ability to work autonomously and consistently, reducing the potential for human error or oversight. Moreover, the use of lightweight AI models ensures that the system remains responsive and efficient, even on standard computing devices. This makes the technology accessible and scalable for a wide range of institutions, regardless of their infrastructure. The integration of AI into the proctoring system highlights the shift from passive exam recording to active and intelligent supervision. It reflects how AI can be ethically and effectively applied in education to uphold integrity while minimizing manual effort. As the demand for remote learning continues to grow, AI-driven solutions like this one are expected to play an increasingly important role in shaping the future of digital assessments.

1.3 LITERATURE SURVEY

S. Prathish et al. suggested one of the initial models for proctoring over the web, with an emphasis on head pose estimation and audio-based detection of abnormal behavior. Their method employed a model-based approach to compute head orientation and depended on audio input to indicate possible cheating situations. The overall head tracking accuracy was restricted in general, particularly when the examinee changed pose substantially. Furthermore, the microphone dependence caused privacy concerns, since incessant audio recording throughout an examination might be construed as invasive. The strategy did not

even provide for eye or minute facial motion, and the student's important blind spots went unaddressed.

Yousef Atoum and co-researchers brought in a more sophisticated model based on the application of multimedia analytics for supervision during examinations. Their system had aspects such as text recognition, tracking of active windows, facial authentication, gaze calculation, and voice detection. They combined these components to identify cheating actions using low-level and high-level feature detection. Although highly designed, their system had substantial hardware requirements—examinees needed to use wearable cameras (wearcams), rendering the solution unsuitable for large-scale applications. Besides, it did not have a mechanism for spoof detection, so it was susceptible to impersonation via photos or videos of legitimate users.

Senbo Hu and coauthors tried to improve behavioral surveillance by integrating image-based head pose estimation with analysis of mouth movements. Their solution enabled the detection of examinees who were talking during the examination or habitually turning their heads, suggesting potential interaction with illicit resources. Although this was an improvement on earlier work, their system lacked eye-tracking capabilities. This left room for subtle but revealing movements, like rapid glances at surrounding notes or screens, to be missed. Their work also lacked a strong authentication process to confirm the examinee's identity beyond initial recognition.

Vahid Kazemi and Josephine Sullivan made an important contribution to the field of facial alignment by introducing a rapid and effective approach in terms of regression trees. Their method was adopted as a building block for numerous face landmark detection models applied to behavioral analysis. Nevertheless, such landmark-based approaches suffer from decreased performance when the subject's face is partially occluded or appears at very wide angles. This is especially applicable to online tests where a student can unknowingly move or change position away from the optimal camera view.

Adrian Bulat and Georgios Tzimiropoulos investigated 2D and 3D face alignment models on a large scale, with datasets possessing large facial landmarks. Although their research pushed facial analysis more accurate, the high computational requirement of 3D alignment made its application in real-time systems, particularly in devices with constrained hardware like student laptops, cumbersome.

Xiangyu Zhu and Stan Z. Li created dense 3D face modeling systems that provide accurate pose estimation. Their models performed well in controlled environments, but their high computational cost and dependency on depth maps made them inappropriate for scalable online proctoring platforms. Real-time monitoring systems require lightweight models that can perform reasonably without specialized hardware or high-end GPUs.

Nataniel Ruiz and colleagues advanced with deep learning head pose estimation models such as Hopenet, which provided high accuracy in pitch, yaw, and roll angles with a ResNet backbone. Yet, despite their success, such models were too resource-intensive for real-time use on average consumer hardware. For realistic proctoring applications, a compromise between model speed and accuracy is essential—something Hopenet's deep structure could not attain without optimization.

Yijun Zhou and James Gregson, in their work on WHENet, suggested an effective head pose estimation system based on EfficientNet as the backbone. Although it provided a promising balance of speed and accuracy, it still needed some computational capability not always present in standard online exam environments. Their approach, as with the others in this class, was not combined with more general behavioral analytics such as eye and mouth tracking or person detection, rendering it less suitable as a solo exam proctoring tool.

Informed by the strengths and weaknesses of the foregoing works, the Intelligent Online Proctoring System adopted for this project employs a more combined and lightweight model. It puts face spoof detection, face verification, head pose estimation, eye tracking, and mouth movement analysis into a single pipeline. Different from earlier systems which focused on only one or two aspects, this project achieves real-time multi-dimensional monitoring with high-performance and high-speed optimized models on typical hardware. By drawing lessons from existing research and eliminating its shortcomings, this project provides a real-life, scalable, and intelligent means of ensuring online exam integrity. The modular nature guarantees that each part works independently yet in conjunction to provide correct results. The system also keeps the user from interfering by passively working with a common webcam without the need for extra hardware. Its technically viable and user-friendly design makes it feasible for institutions to easily move into digital assessment systems.

2. SYSTEM ANALYSIS

2.1 EXISTING SYSTEM

Traditional online proctoring solutions tend to depend significantly on human invigilators to monitor exams using live video streams. The invigilators are tasked with observing candidates for the entire length of the exam, making sure every student sticks to academic integrity policies. Such an approach, however, requires constant human observation, rendering it not only resource-intensive but also ineffective when implemented on a large scale to monitor numerous students at once.

One of the biggest issues in this arrangement is the inability to closely monitor faint facial expressions or eye movements, particularly when monitoring a large group. Even with screen sharing and webcam viewing, the human eye can miss brief or subtle instances of cheating. Additionally, the lack of automated notifications means that invigilators have to remain extremely vigilant for extended periods, which heightens the risk of oversight through fatigue or distraction.

Moreover, most of these systems do not have the capability to identify actual-time cheating actions like talking off-camera, using mobile phones out of sight, or getting assistance from other people in the room. In case of suspected suspicious activity, the only recourse is to watch recorded video, which takes time and is not always successful in stopping unfair play during the actual test.

Disadvantages:

- Large-scale or frequent exams become economically unfeasible with the high expense of using human proctors in each exam session.
- Limited real-time detection enables cheating to evade detection during the exam owing to the lack of automated notifications.
- Catching background noise or off-screen activity is impossible, easing the provision of unauthorized aid to examinees.
- Rescheduling or cancellation of exams is difficult and time-consuming owing to reliance on proctor availability and scheduling issues.
- Human distraction may result in overlooked cheating attempts, particularly when observing numerous candidates over a long time.

2.2 PROPOSED SYSTEM

The Intelligent Online Proctoring System designed in this project is an AI-based, completely automated tool meant to substitute the conventional manual invigilation of online examinations. It uses computer vision and machine learning algorithms to recognize, confirm, and track candidates in real-time with inputs from a regular webcam and microphone. In contrast to traditional systems that utilize solely human supervision, this system carries out constant and smart monitoring during the examination process.

The essential functionality starts with face recognition to authenticate identity, confirming that the examinee is the registered candidate. A face spoofing functionality is employed next to confirm the live user's authenticity and ward off impersonation through images or videos. Having been authenticated, the system commences real-time monitoring of head movement, direction of eyes, and mouth action, which enables it to detect actions like glancing away from the screen, talking, or reading from an outside source.

Also included in the system is person detection to check only one person inside the frame and object detection for detecting banned material such as cellular phones, texts, or any other electronic objects. All such checks operate ongoing, frame-by-frame, and notify the system in case anything suspicious occurs and thus ensure good integrity while examining.

ADVANTAGES:

- Completely automated system minimizes the human proctor requirement, reducing manpower needs while assuring supervision quality.
- Affordable compared to conventional proctoring processes, as it minimizes costs related to the employment and organization of live invigilators.
- Live watching guarantees that cheating attempts are detected and dealt with instantly, not after the exam.
- Reliable face and behavior detection ensures higher test process reliability and maintains academic integrity.
- Reduces human error based on dependable AI algorithms, precluding risks of fatigue or negligence from human invigilators.

3. SYSTEM STUDY

FEASIBILITY STUDY

The feasibility study is significant in determining the practicability of the adoption of the Intelligent Online Proctoring System. The phase guarantees that the solution is in accordance with the objectives of improving exam integrity without causing excessive technical, financial, or social costs to stakeholders. It entails the assessment of the system from three perspectives:

- Economical feasibility
- Technical feasibility
- Social feasibility

ECONOMICAL FEASIBILITY

This aspect assesses the cost-effectiveness of the system implementation. The Intelligent Online Proctoring System leverages several open-source tools and pre-trained models (e.g., OpenCV, Dlib, Scikit-learn) for functionalities such as face detection, object detection, and eye tracking. This significantly reduces licensing costs and development overhead.

TECHNICAL FEASIBILITY

The system is technically feasible with minimal hardware requirements. It runs efficiently on standard computing devices with webcams and does not require high-end servers or GPUs. By developing a lightweight head pose estimation model from scratch and optimizing the processing pipeline, the system ensures real-time performance while maintaining accuracy in abnormal behavior detection.

SOCIAL FEASIBILITY

Social feasibility examines user acceptance and ease of use. The system is designed to be user-friendly for both examinees and administrators. By automating tasks like authentication, face spoofing detection and monitoring of suspicious behavior (e.g., speaking, turning away), it reduces human error and bias. Moreover, it ensures transparency and fairness, which builds trust among users.

4. SYSTEM REQUIREMENTS

4.1 SOFTWARE AND HARDWARE REQUIREMENTS

HARDWARE REQUIREMENTS

- System : intel i3 or above.
- Ram : 8 GB or higher.
- Storage : 250 GB HDD/SSD.
- Webcam : 720p HD or higher.

SOFTWARE REQUIREMENTS

- Operating System : Windows
- Coding Language : Python 3.7

4.2 INPUT AND OUTPUT DESIGN

INPUT DESIGN

Input design serves as the crucial link between users and the system, ensuring that data is captured accurately, efficiently, and securely. In the Intelligent Online Proctoring System, input refers not only to traditional data fields but also to real-time video and image streams that are processed to detect abnormalities, verify identity, and ensure the integrity of online examinations. The input design aims to streamline the capture of both manual and automated data while minimizing errors and enhancing usability. Real-time video streams captured through webcams form the primary input. Additional data inputs include facial recognition inputs, eye-tracking metrics, head pose angles, and mouth movement data. Input Design considered the following things:

- What data should be given as input?
- How should data should be arranged or coded?
- How will users (examinees or proctors) interact with the system?
- What validations are applied to the input?

OBJECTIVES:

1. Convert user activity (e.g., webcam presence, facial expressions) into machine-readable formats using intelligent algorithms.
2. Ensure data acquisition is automated, accurate, and resistant to manipulation (e.g., spoofing or substitution).
3. Provide user-friendly mechanisms for initiating and verifying examination sessions.
4. Ensure real-time validation of input to trigger alerts for suspicious or invalid behavior.
5. Offer clear prompts and feedback to users during the input process to ensure proper engagement with the system.

OUTPUT DESIGN

The output design of the Intelligent Online Proctoring System is focused on delivering concise, actionable, and informative feedback to users and administrators. Outputs are primarily generated after analyzing the input stream and include logs, alerts, authentication confirmations, and behavioral reports.

Outputs include real-time visual indicators (e.g., system messages), flags for detected anomalies, and post-exam reports summarizing exam conduct. These outputs help institutions ensure fair examination practices and provide transparency in result processing. Output Design considered the following things:

- Clearly indicate authentication success/failure (e.g., face verified or spoof detected).
- Provide visual or audio alerts for detected cheating behaviors (e.g., multiple person detected, looking away, speaking).
- Present summarized behavior reports to exam administrators.
- Enable saving logs or screenshots for future review or audit.

The output form of an information system should accomplish one or more of the following objectives.

- Provide real-time feedback to alert users and proctors about suspicious activities.
- Trigger system actions such as logging an event or flagging a session for review.
- Confirm successful or unsuccessful user authentication.

- Deliver post-exam reports that include timestamps of all suspicious behaviors detected.
- Ensure that output formats are accessible, organized, and actionable for decision-making.

4.3 SOFTWARE ENVIRONMENT

INTRODUCTION

The Intelligent Online Proctoring System has been developed using Python, a high-level, open-source programming language created by **Guido van Rossum** and first released in 1991. Python is known for its readable syntax, cross-platform compatibility, and a vast ecosystem of libraries—making it a suitable choice for building computer vision and machine learning applications such as ours.

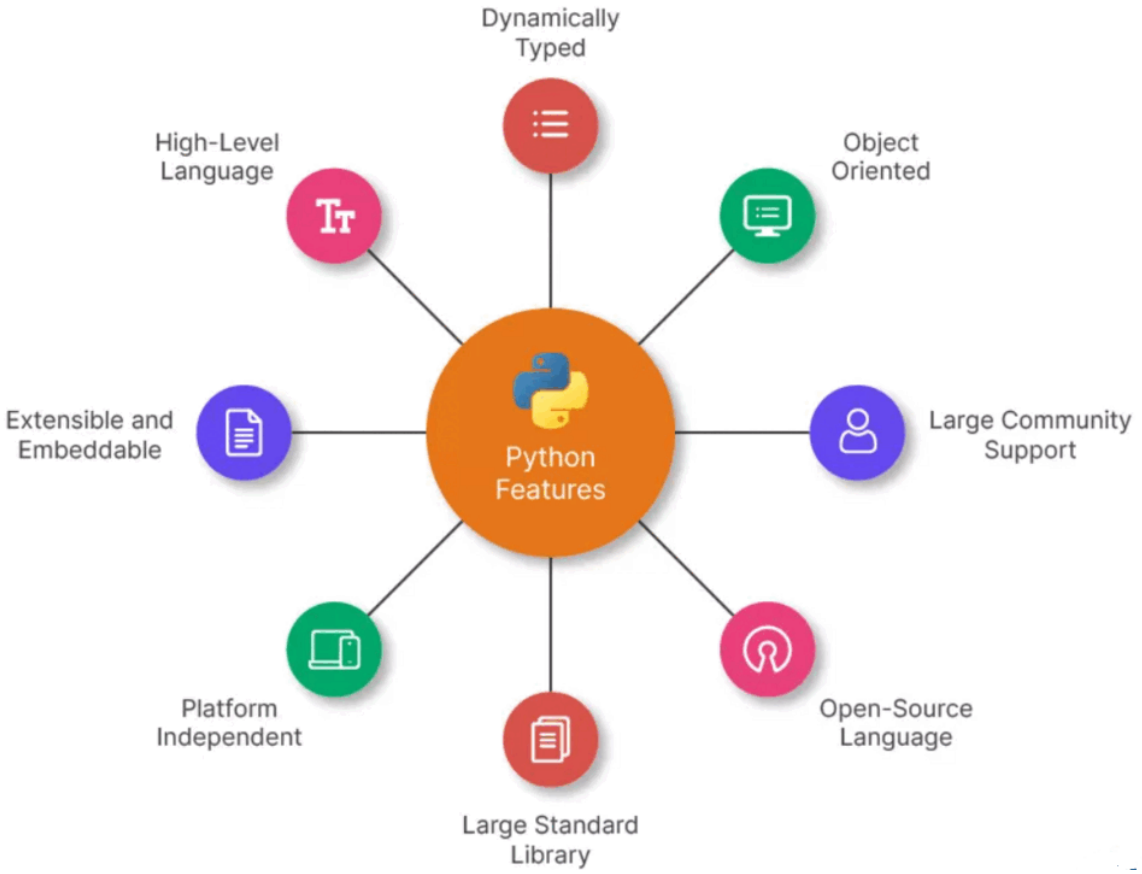
Python's ease of use and powerful libraries allow rapid development and maintenance of complex systems. The language supports both object-oriented and procedural programming paradigms, and is backed by a large global community. The primary implementation, CPython, is maintained by the Python Software Foundation.

Python enables the development of our real-time video processing pipeline with fewer lines of code compared to other languages like Java or C++, making the software environment more agile and manageable.

Python is a high-level, object-oriented programming language used in coding, created by Guido van Rossum in 1991. Python puts readability at a high standard and this makes it great for both programmers and non-programmers to learn. Python is cross-platform, which means you can run it on all major platforms like Microsoft Windows, Linux, and Mac OS X. Python is open source software and, as a result, has a large community of developers who help improve and contribute to the language. Currently, the main implementation of Python, CPython, is managed by the Python Software Foundation, a non-profit organization working to develop and maintain the Python standards.

Python gives you the ability to rapidly develop projects, while being able to maintain them at the same time. Python usually uses less lines of codes than other object-oriented languages, like C++ and Java, and it has a simple and easy syntax. A simple "Hello, world!" can be done with just one line of code (actually this is called a command) and only four lines when recreating it as a GUI!

Features of Python programming language



Readable: Python is widely appreciated for its clear and readable syntax, which closely resembles the English language. This design philosophy helps both beginners and experienced developers understand and write code more easily. The use of indentation to define code blocks improves visual clarity and structure. Unlike many other programming languages, Python avoids complex symbols, making it easier to spot errors and understand logic. Readability enhances collaboration among teams, as code is more self-explanatory. Overall, this trait significantly reduces the time spent on debugging and reviewing code.

Easy to Learn: Python is often recommended as the first programming language due to its simplicity and expressiveness. Its high-level nature allows developers to focus more on solving problems than on syntax details. The language has a minimal learning curve, making it ideal for beginners in computer science and data science. Python's documentation, tutorials, and large community support make the learning process smooth. Its structure helps new learners grasp fundamental programming concepts without being overwhelmed. As a result, it is one of the most widely taught languages in schools and universities.

Cross Platform: Python is a highly portable language that runs seamlessly on different operating systems including Windows, macOS, Linux, and Unix. This cross-platform capability means that code written on one OS can be executed on another with little to no modification. It allows developers to build applications that are accessible to a broader audience. Many popular Python IDEs and tools also support multiple platforms, enhancing productivity. The same Python script can be deployed across systems without needing specialized adaptation. This makes Python a top choice for developers building versatile and scalable solutions.

Open Source: Python is an open-source programming language, meaning its source code is freely available to the public. Developers can study, modify, and distribute Python without paying any licensing fees. This openness has led to a large community that continuously contributes to its development and improvement. The collaborative nature ensures that bugs are identified and resolved quickly, and features are added regularly. Open-source licensing also encourages innovation and experimentation in both personal and commercial projects. Python's open development model has played a significant role in its rapid growth and adoption worldwide.

Large Standard Library: Python comes with a comprehensive standard library that supports many common programming tasks. This includes modules for file handling, web services, data manipulation, regular expressions, and more. Having such a rich library reduces the need for writing code from scratch. Developers can rely on these well-tested modules to build applications faster and more efficiently. The availability of these built-in tools enhances Python’s flexibility across various domains like automation, data analysis, and web development. It significantly speeds up development time and ensures better reliability.

Free: Python is free to download, install, and use for any purpose, whether personal, academic, or commercial. It is distributed under the Python Software Foundation License, which allows developers to freely use and modify the language. As a FLOSS (Free/Libre Open Source Software), it promotes learning, innovation, and accessibility. Users can study the source code to understand how the language works, or to adapt it for their needs. This affordability and openness encourage its adoption in schools, startups, and large enterprises alike. With no cost barriers, Python remains accessible to everyone.

Supports Exception Handling: Python provides built-in support for exception handling, which improves the robustness of programs. An exception is an event that occurs during execution and can interrupt the normal flow of the program. Python allows developers to manage these exceptions using try, except, finally, and raise blocks. This results in more stable and error-resilient applications. Exception handling helps in identifying, debugging, and responding to unexpected conditions gracefully. It is especially valuable in larger applications where maintaining program stability is crucial.

Advanced Features: Python supports modern programming constructs like list comprehensions, generators, and decorators. These features help in writing compact, efficient, and readable code for complex operations. List comprehensions allow fast construction of lists using a single line of code. Generators are memory-efficient tools that yield values one at a time, ideal for large datasets. Advanced users can leverage these tools to build scalable and clean applications. Such features show Python's capability to support both simple scripting and advanced software engineering.

Automatic Memory Management: Python has a built-in garbage collector that automatically handles memory allocation and deallocation. This means developers don't need to manually free memory, reducing the risk of memory leaks and segmentation faults. The system tracks references to objects and reclaims memory when it is no longer needed. This simplifies development and improves efficiency, especially in large-scale applications. Automatic memory management ensures that resources are used optimally without additional effort. As a result, Python applications remain smooth and responsive over time.

What Can You Do with Python?

You may be wondering what all are the applications of Python. There are so many applications of Python, here are some of the them.

1. **Web Development**: Python is widely used for building powerful web applications through frameworks like Django and Flask. These frameworks simplify backend development by providing tools for database handling, URL mapping, and request processing. They promote clean and maintainable code, enabling rapid development of secure and scalable websites. Python's readability and ease of use make it a popular choice for full-stack development. Many modern websites and platforms are powered by Python-based backends.

2. **Machine Learning**: Python is a dominant language in the field of machine learning and artificial intelligence. With libraries like TensorFlow, Scikit-learn, and PyTorch, developers can build predictive models and intelligent systems. Applications include recommendation engines, face and voice recognition, and fraud detection. Its simplicity helps researchers and developers focus on algorithms rather than syntax. Machine learning in Python powers features on platforms like Amazon, Netflix, and Google.

3**. Data Analysis**: Python is extensively used in data analysis, data science, and data visualization tasks. Libraries such as Pandas, NumPy, and Matplotlib allow users to analyze, manipulate, and visualize large datasets. It's commonly used by analysts to uncover patterns and trends in business or scientific data. With minimal effort, Python can produce meaningful insights through charts and reports. Its ease of use and flexibility make it ideal for both beginners and professionals in analytics.

4. **Scripting:** Python is perfect for writing scripts that automate repetitive and routine tasks. Common scripting applications include sending scheduled emails, batch file processing, and report generation. Its concise syntax allows developers to write powerful scripts with minimal lines of code. Python is frequently used in DevOps and IT environments for task automation. This reduces manual effort and increases efficiency in various system-level operations.

5. **Game Development** : While not the primary choice for high-end gaming, Python is used to develop simple games. With libraries like Pygame, developers can create 2D games for educational or entertainment purposes. Game development in Python is ideal for beginners learning coding through interactive design. It provides a fun way to apply logic, animation, and sound in programming projects. Many use Python for prototyping game concepts before moving to more complex engines.

6. **Embedded Applications**: Python can be used for embedded systems, especially when combined with hardware like Raspberry Pi. This makes it a great tool for building IoT (Internet of Things) devices and robotics projects. Its simplicity enables quick development and testing in resource-constrained environments. Python allows interaction with sensors, cameras, and motors for real-world applications. These embedded solutions are widely used in smart homes, automation, and education.

7. **Desktop Applications**: Python is a strong option for building desktop GUI applications using tools like Tkinter, PyQt, and Kivy. These libraries allow developers to create interactive and visually appealing software. Examples include calculators, notepads, and small-scale inventory systems. Python-based desktop apps are cross-platform and easy to maintain. They are popular in educational and small business settings due to their simplicity.

PYTHON INSTALLATION

1.1 What is Python?

Python is a high-level, interpreted scripting language known for its simplicity, readability, and versatility. It supports a wide range of programming paradigms, including object-oriented, procedural, and functional programming. Originally designed for text processing, system administration, and internet-related tasks, Python has since evolved into one of the most widely used languages across various domains such as web development, artificial intelligence, data science, automation, game development, and more. Its concise and clean syntax makes it easy to learn and use, even for those who are new to programming.

One of Python's most powerful features is its extensibility. The core language is deliberately kept small and straightforward, but its functionality can be greatly extended through a large collection of standard libraries and third-party modules. These modules provide built-in support for tasks ranging from file I/O, regular expressions, and networking to advanced fields like machine learning, computer vision, and web services. This modular approach allows developers to write efficient and scalable code without having to reinvent the wheel. Python is often praised for enabling rapid development and prototyping, which is particularly useful in research and startup environments.

Python is a true object-oriented language, offering full support for classes, inheritance, and encapsulation. Yet, it also allows developers to write code in a procedural or even functional style if preferred. This flexibility is one of the reasons why Python is considered a "multi-paradigm" programming language. It is available on virtually every major computing platform, including Windows, macOS, Linux, and even mobile and embedded systems. There is also Python, an implementation of Python written entirely in Java, which enables seamless integration with Java applications and further expands Python's utility in enterprise environments.

The language was created in the early 1990s by Guido van Rossum, who was then working at the Centrum Wiskunde & Information (CWI) in Amsterdam. His goal was to develop a language that was both easy to learn and powerful enough for advanced users. Python was designed with educational simplicity in mind but built with the robustness required for real-world application development. Van Rossum emphasized a minimalistic design philosophy, which led to Python's famously readable and elegant syntax. This design makes Python not only accessible to beginners but also enjoyable and productive for experienced programmers.

Interestingly, the name "Python" does not refer to the snake, as is commonly assumed. Instead, it was inspired by van Rossum's favorite television show, "Monty Python's Flying Circus." As a result, a playful tone is often found in the language's documentation, tutorials, and community resources. This lighthearted culture contributes to the welcoming nature of the Python community and makes learning and working with Python more enjoyable.

Many seasoned developers report that Python has rekindled their love for programming, thanks to its clear syntax, powerful capabilities, and vibrant community. From novice programmers writing their first "Hello, World!" script to data scientists creating complex machine learning models, Python remains a language of choice. Its widespread adoption, active development, and continued evolution ensure that it will remain at the forefront of software development for years to come.

1.2 The very Basics of Python

There are a few features of python which are different than other programming languages, and which should be mentioned early on so that subsequent examples don't seem confusing. Further information on all of these features will be provided later, when the topics are covered in depth.

Python statements do not need to end with a special character – the python interpreter knows that you are done with an individual statement by the presence of a newline, which will be generated when you press the "Return" key of your keyboard. If a statement spans more than one line, the safest course of action is to use a backslash (\) at the end of the line to let python know that you are going to continue the statement on the next line; you can continue using backslashes on additional continuation lines. (There are situations where the backslashes are not needed which will be discussed later.)

Python provides you with a certain level of freedom when composing a program, but there are some rules which must always be obeyed. One of these rules, which some people find very surprising, is that python uses in-dentation (that is, the amount of white space before the statement itself) to indicate the presence of loops, instead of using delimiters like curly braces ({}) or keywords (like “begin” and “end”) as in many other languages. The amount of indentation you use is not important, but it must be consistent within a given depth of a loop, and statements which are not indented must begin in the first column. Most python programmers prefer to use an edi-tor like emacs, which automatically provides consistent indentation; you will probably find it easier to maintain your programs if you use consistent indentation in every loop, at all depths, and an intelligent editor is very useful in achieving this.

1.3 Invoking Python

There are three ways to invoke python, each with its’ own uses. The first way is to type “python” at the shell command prompt. This brings up the python interpreter with a message similar to this one:

```
Python 2.2.1 (#2, Aug 27 2002, 09:01:47)
[GCC 2.95.4 20011002 (Debian prerelease)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
```

The three greater-than signs (>>>) represent python’s prompt; you type your commands after the prompt, and hit return for python to execute them. If you’ve typed an executable statement, python will execute it immediately and display the results of the statement on the screen. For example, if I use python’s print statement to print the famous “Hello, world” greeting, I’ll immediately see a response:

```
>>>     print ’hello,world’ hello,world
```

The print statement automatically adds a newline at the end of the printed string. This is true regardless of how python is invoked. (You can suppress the newline by following the string to be printed with a comma.)

When using the python interpreter this way, it executes statements im-mediately, and, unless the value of an expression is assigned to a variable (See Section 6.1), python will display the value of that expression as soon as it’s typed. This makes python a very handy calculator:

```
>>>  cost = 27.00
>>>  taxrate = .075
>>>  cost * taxrate 2.025
>>>  16+25+92*3
317
```

When you use python interactively and wish to use a loop, you must, as always, indent the body of the loop consistently when you type your statements. Python can't execute your statements until the completion of the loop, and as a reminder, it changes its prompt from greater-than signs to periods. Here's a trivial loop that prints each letter of a word on a separate line — notice the change in the prompt, and that python doesn't respond until you enter a completely blank line. >>>word = 'python' >>>for i in word:

```
...print
i...
p y t h o
n
```

The need for a completely blank line is peculiar to the interactive use of python. In other settings, simply returning to the previous level of indenta-tion informs python that you're closing the loop.

You can terminate an interactive session by entering the end-of-file character appropriate to your system (control-Z for Windows, control-D for Unix), or by entering import sys sys.exit()

or raise System Exit at the python prompt.

For longer programs, you can compose your python code in the editor of your choice, and execute the program by either typing "python", followed by the name of the file containing your program, or by clicking on the file's icon, if you've associated the suffix of your python file with the python in-terpreter. The file extension most commonly used for python files is ".py". Under UNIX systems, a standard technique for running programs written in languages like python is to include a specially formed comment as the first line of the file, informing the shell where to find the interpreter for your program. Suppose that

python is installed as /usr/local/bin/python on your system. (The UNIX command “which python” should tell you where python is installed if it’s not in /usr/local/bin.) Then the first line of your python program, starting in column 1, should look like this:

```
#!/usr/local/bin/python
```

1.4. BASIC PRINCIPLES OF PYTHON

After creating a file, say myprogram.py, which contains the special comment as its first line, you would make the file executable (through the UNIX com-mind “chmod +x myprogram.py”), and then you could execute your pro-gram by simply typing “myprogram.py” at the UNIX prompt.

When you’re running python interactively, you can instruct python to ex-ecute files containing python programs with the exec file function. Suppose that you are using python interactively, and wish to run the program you’ve stored in the file myprog.py. You could enter the following statement:

```
exec file("myprog.py")
```

The file name, since it is not an internal python symbol (like a variable name or keyword), must be surrounded by quotes.

1.5 Basic Principles of Python

Python is a language that combines simplicity with power, offering features often found only in more complex and specialized programming languages. What sets Python apart is that many of its powerful capabilities—such as dynamic typing, automatic memory management, modular programming, and object-oriented design—were intentionally integrated from the very beginning of its development. Unlike other scripting languages that gradually evolved by patching in features over time, Python was built with a clear and consistent design philosophy. This makes the language not only easier to learn but also more coherent and logical in its structure. It encourages writing code that is readable, maintainable, and efficient, making it ideal for both small scripts and large-scale software development projects.

For beginners, the initial exposure to programming concepts like data types, functions, control structures, and object orientation might feel overwhelming. However, Python was created with learning in mind and is often praised for its "low barrier to entry" into the world of coding. The purpose of introducing these principles early on is not to master them immediately, but to develop a sense of Python's design and philosophy. As you continue learning, these abstract ideas will gradually become more familiar and practical through examples and real-world usage. Python promotes a style of programming that is both elegant and intuitive, and once the foundational concepts are understood, they unlock the ability to write powerful programs with surprising ease.

1.5.1 Basic Core Language

Python is intentionally designed to have a minimal and intuitive core syntax, which makes it an excellent language for beginners and professionals alike. Unlike many other programming languages that present a wide variety of complex syntax choices, Python keeps things simple and consistent. For instance, all conditional operations are handled using just a single structure: if, elif, and else. This makes it easy to learn and apply conditional logic without confusion. Similarly, Python offers only two primary looping constructs—for and while—which are powerful enough to handle virtually any iteration requirement but simple enough to grasp quickly.

Error handling in Python is also designed to be straightforward and uniform across all programs. The try and except blocks allow developers to manage exceptions and errors in a clear and organized way. These constructs make debugging easier and help in writing more robust code. The consistency in the syntax reduces the cognitive load for the programmer, allowing them to focus more on solving problems rather than memorizing complex grammar rules. Despite this simplicity, Python does not compromise on power. Its clean design allows you to build everything from small automation scripts to large-scale web applications and AI models.

What makes this core language approach so appealing is that once you've learned the basic building blocks, you can apply them universally across all Python projects. You're not constantly bombarded with multiple ways to do the same thing—Python emphasizes readability and one obvious way to perform a task. This philosophy, often summarized by the Python Zen principle "There should be one—and preferably only one—obvious way to do

it," empowers developers to write cleaner and more maintainable code. Python's core remains accessible, while its power can be extended through external modules and libraries as needed.

1.5.2 Modules

One of the key strengths of Python lies in its modular architecture. Rather than having all functionality built directly into the core language, Python relies on modules—self-contained packages of code that define functions, classes, and variables. These modules can be easily imported into a program using the import statement. This modular approach allows developers to use only the tools and features they need for a specific task, helping to keep programs lightweight, organized, and efficient. It also reduces the learning curve, as programmers can gradually explore more advanced capabilities as required, rather than being overwhelmed by a vast core language.

The standard distribution of Python already includes a large collection of built-in modules that support a wide variety of common tasks. For example, you can use the os module to interact with the operating system—such as navigating directories, managing files, or launching system commands. The sys module allows access to system-specific parameters and functions, while the math module provides advanced mathematical operations. File handling is made easier with modules like io and csv, and web-related tasks can be handled using modules such as urllib and http. These modules extend the reach of Python far beyond the capabilities of its basic syntax, making it a truly general-purpose programming language.

Beyond the standard library, there are thousands of optional and third-party modules available, many of which are hosted and managed through the Python Package Index (PyPI). These can be installed using tools like pip and enable developers to add advanced capabilities to their programs. For instance, you can create graphical user interfaces (GUIs) using tkinter, PyQt, or Kivy; connect and manipulate databases using sqlite3, SQLAlchemy, or pymysql; and perform data analysis with powerful libraries like pandas and numpy. For those working in web development, popular frameworks like Flask and Django are also available as importable modules. The possibilities are nearly endless.

This structure reflects Python's philosophy of simplicity and scalability. By using modules, Python keeps the core language clean and easy to learn while offering the flexibility

to grow with the needs of the user. You don’t need to understand or include every capability in every project. Instead, you can focus on your specific goal and bring in only the tools you need. This makes Python ideal for both small scripts and large-scale applications, as it ensures efficient memory use and faster execution. Whether you're a beginner writing your first program or a professional developing complex systems, Python’s module system supports your growth and productivity.

Overall, Python's reliance on modules represents a thoughtful design choice—encouraging modular, reusable, and maintainable code. It enables a learning path that grows naturally, allowing users to discover and integrate advanced features as their skills and project demands evolve. This modular design has contributed significantly to Python's popularity across industries and academic fields, making it one of the most versatile programming languages available today.

1.5.3 Object Oriented Programming

Python is a true object-oriented language. The term “object oriented” has become quite a popular buzzword; such high profile languages as C++ and Java are both object oriented by design. Many other languages add some object-oriented capabilities, but were not designed to be object oriented from the ground up as python was. Why is this feature important? Object ori-ented program allows you to focus on the data you’re interested in, whether it’s employee information, the results of a scientific experiment or survey, setlists for your favorite band, the contents of your CD collection, informa-tion entered by an internet user into a search form or shopping cart, and to develop methods to deal efficiently with your data. A basic concept of object oriented programming is encapsulation, the ability to define an object that contains your data and all the information a program needs to operate on that data. In this way, when you call a function (known as a method in object-oriented lingo), you don’t need to specify a lot of details about your data, because your data object “knows” all about itself. In addition, objects can inherit from other objects, so if you or someone else has designed an ob-ject that’s very close to one you’re interested in, you only have to construct those methods which differ from the existing object, allowing you to save a lot of work.

Another nice feature of object oriented programs is operator overloading. What this means is that the same operator can have different meanings.

1.5.4 Basic principles of python

When used with different types of data. For example, in python, when you're dealing with numbers, the plus sign (+) has its usual obvious meaning of addition. But when you're dealing with strings, the plus sign means to join the two strings together. In addition to being able to use overloading for built-in types (like numbers and strings), python also allows you to define what operators mean for the data types you create yourself.

Perhaps the nicest feature of object-oriented programming in python is that you can use as much or as little of it as you want. Until you get comfortable with the ideas behind object-oriented programming, you can write more traditional programs in python without any problems.

1.5.5 Namespaces and Variable Scoping

When you type the name of a variable inside a script or interactive python session, python needs to figure out exactly what variable you're using. To prevent variables you create from overwriting or interfering with variables in python itself or in the modules you use, python uses the concept of multiple namespaces. Basically, this means that the same variable name can be used in different parts of a program without fear of destroying the value of a variable you're not concerned with.

To keep its bookkeeping in order, python enforces what is known as the LGB rule. First, the local namespace is searched, then the global names-pace, then the namespace of python built-in functions and variables. A local namespace is automatically created whenever you write a function, or a module containing any of functions, class definitions, or methods.

The global namespace consists primarily of the variables you create as part of the "top-level" program, like a script or an interactive session. Finally, the built-in namespace consists of the objects which are part of python's core. You can see the contents of any of the namespaces by using the dir command:

```
>>>dir()
['__builtins__', '__doc__', '__name__']
>>>dir(__builtins__)
```

['ArithmeticError', 'AssertionError', 'AttributeError', 'EOFError', 'Ellipsis', 'Exception', 'FloatingPointError', 'IOError', 'ImportError', 'IndexError', 'KeyError', 'KeyboardInterrupt', 'LookupError', 'MemoryError', 'NameError', 'None', 'OverflowError', 'Runtime Error', 'Standard Error', 'Syntax Error', 'SystemError', 'SystemExit', 'TypeError', 'ValueError', 'ZeroDivisionError', '_', '__debug__', '__doc__','__import__', '__name__', 'abs', 'apply', 'callable', 'chr', 'cmp', 'coerce', 'compile', 'complex', 'delattr', 'dir', 'divmod', 'eval', 'execfile', 'filter', 'float', 'getattr', 'globals', 'hasattr', 'hash', 'hex', 'id', 'input', 'int', 'intern',
'isinstance', 'issubclass', 'len', 'list', 'locals', 'long', 'map', 'max', 'min', 'oct', 'open', 'Ord',

'pow', 'range', 'raw_input', 'reduce', 'reload', 'repr', 'round', 'setattr', 'slice', 'str', 'tuple', 'type', 'vars', 'xrange']

The __built-ins__ namespace contains all the functions, variables and ex-ceptions which are part of python's core.

To give controlled access to other namespaces, python uses the import statement. There are three ways to use this statement. In its simplest form, you import the name of a module; this allows you to specify the various objects defined in that module by using a two-level name, with the mod-ule's name and the object's name separated by a period. For example, the string module (Section 8.4) provides many functions useful for dealing with character strings. Suppose we want to use the split function of the string module to break up a sentence into a list containing separate words. We could use the following sequence of statements:

```
>>>          import string

>>>          string. split ('Welcome to the Ministry of Silly Walks') ['Welcome',
'to', 'the', 'Ministry', 'of', 'Silly', 'Walks']
```

If we had tried to refer to this function as simply "split", python would not be able to find it. That's because we have only imported the string module into the local namespace, not all of the objects defined in the module. (See below for details of how to do that.)

The second form of the import statement is more specific; it specifies the individual objects from a module whose names we want imported into the local namespace. For example, if we only needed the two functions split and join for use in a program, we could import just those two names directly into the local namespace, allowing us to dispense with the string. prefix:

```
>>>  from string import split,join

>>>  split('Welcome to the Ministry of Silly Walks') ['Welcome', 'to', 'the',
'Ministry', 'of', 'Silly', 'Walks']
```

This technique reduces the amount of typing we need to do, and is an efficient way to bring just a few outside objects into the local environment.

Finally, some modules are designed so that you're expected to have top-level access to all of the functions in the module without having to use the module name as a prefix. In cases like this you can use a statement like:

```
>>> from string import *
```

Now all of the objects defined in the string module are available directly in the top-level environment, with no need for a prefix. You should use this technique with caution, because certain commonly used names from the module may override the names of your variables. In addition, it introduces lots of names into the local namespace, which could adversely affect python's efficiency.

1.5.6 Exception Handling

Regardless how carefully you write your programs, when you start using them in a variety of situations, errors are bound to occur. Python provides a consistent method of handling errors, a topic often refered to as exception handling. When you're performing an operation that might result in an error, you can surround it with a try loop, and provide an except clause to tell python what to do when a particular error arises. While this is a fairly advanced concept, usually found in more complex languages, you can start using it in even your earliest python programs.

As a simple example, consider dividing two numbers. If the divisor is zero, most programs (python included) will stop running, leaving the user back at a system shell

prompt, or with nothing at all. Here's a little python program that illustrates this concept; assume we've saved it to a file called div.py:

```
    #!/usr/local/bin/pyth
on      x = 7       y = 0
print x/y
    print "Now we're done!"
```

When we run this program, we don't get to the line which prints the message, because the division by zero is a "fatal" error:

```
    % div.py
    Traceback (innermost last):File "div.py", line 5, in ?
     print x/y
ZeroDivisionError: integer division or modulo
```

While the message may look a little complicated, the main point to notice is that the last line of the message tells us the name of the exception that occured. This allows us to construct an except clause to handle the problem:

```
x = 7
y = 0
try:
print x/y
except ZeroDivisionError:
print "Oops - I can't divide by zero, sorry!"
print "Now we're done!"
```

Now when we run the program, it behaves a little more nicely:

```
% div.py
Oops - I can't divide by zero, sorry!
Now we're done!
```

Since each exception in python has a name, it's very easy to modify your program to handle errors whenever they're discovered. And of course, if you can think ahead, you can construct try/except clauses to catch errors before they happen.

5. SYSTEM DESIGN

SYSTEM ARCHITECTURE

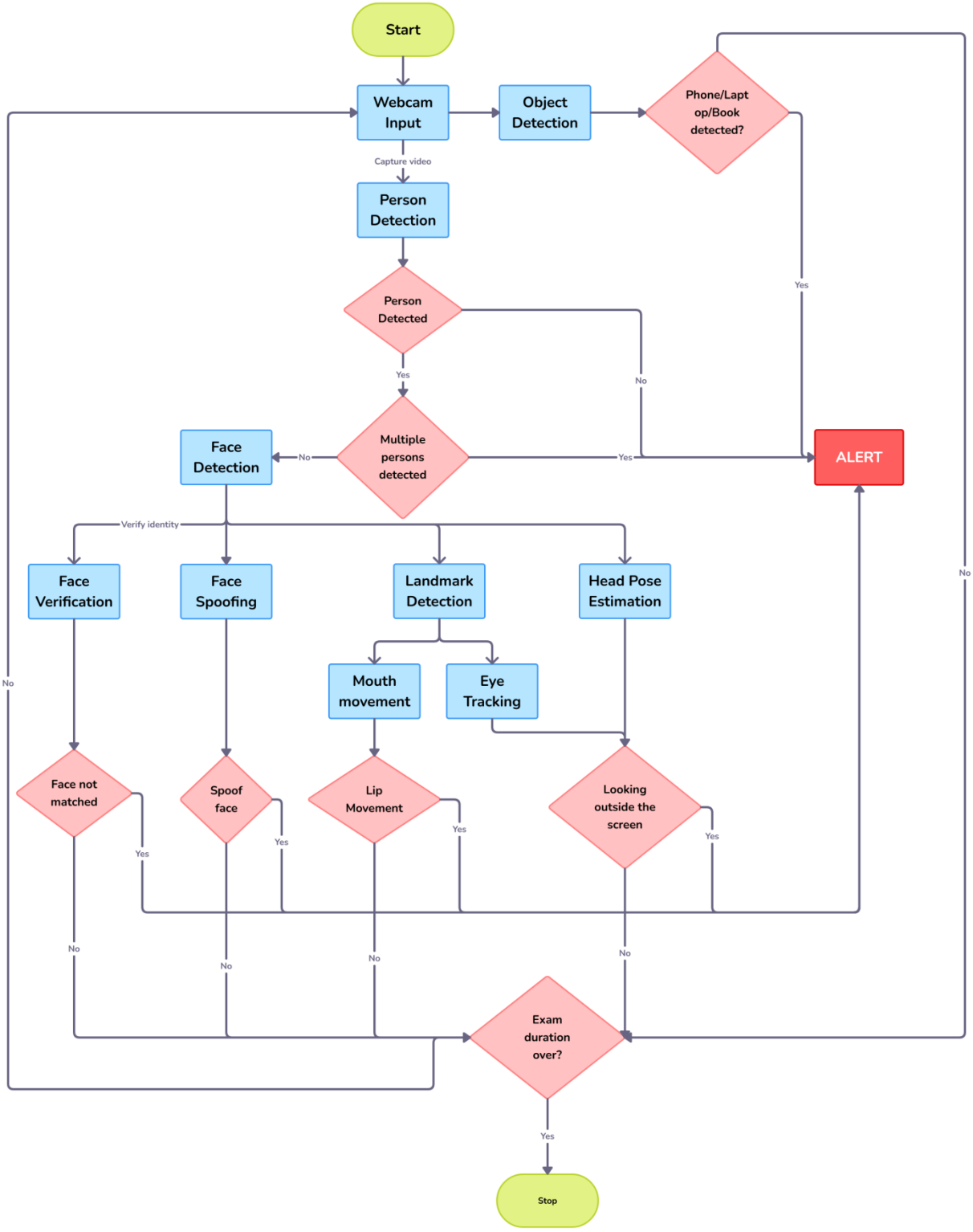


Fig: System Architecture

The Intelligent Online Proctoring System is a computer vision-based solution designed to automate the monitoring of examinees during online examinations. The system leverages multiple machine learning and image processing techniques to detect identity fraud and suspicious behaviors. Using real-time webcam input, the system performs person detection, facial recognition, spoof detection, and facial landmark analysis. These features are analyzed to track head pose, eye movement, and mouth activity — behaviors that can indicate cheating.

The system combines these modules to flag abnormal activities such as multiple people in the frame, looking away from the screen, speaking during the exam, or using banned items like mobile phones. Alerts and behavior logs are generated and displayed on an admin dashboard for post-exam review. The design focuses on accuracy, efficiency, and low computational cost, making it suitable for educational institutions conducting remote assessments. By integrating multiple verification layers, the system enhances the credibility and integrity of online examination processes.

Data Flow Diagram

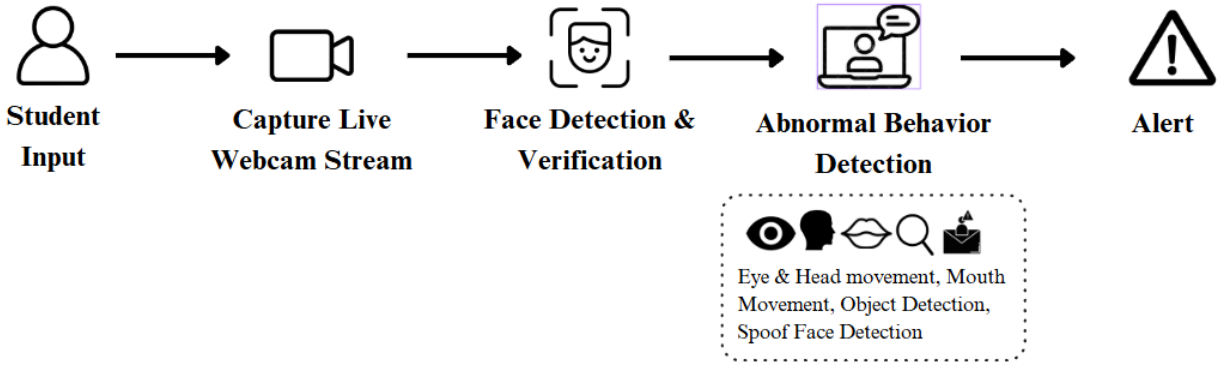


Fig: Data Flow Diagram

6. UML DIAGRAMS

USE CASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

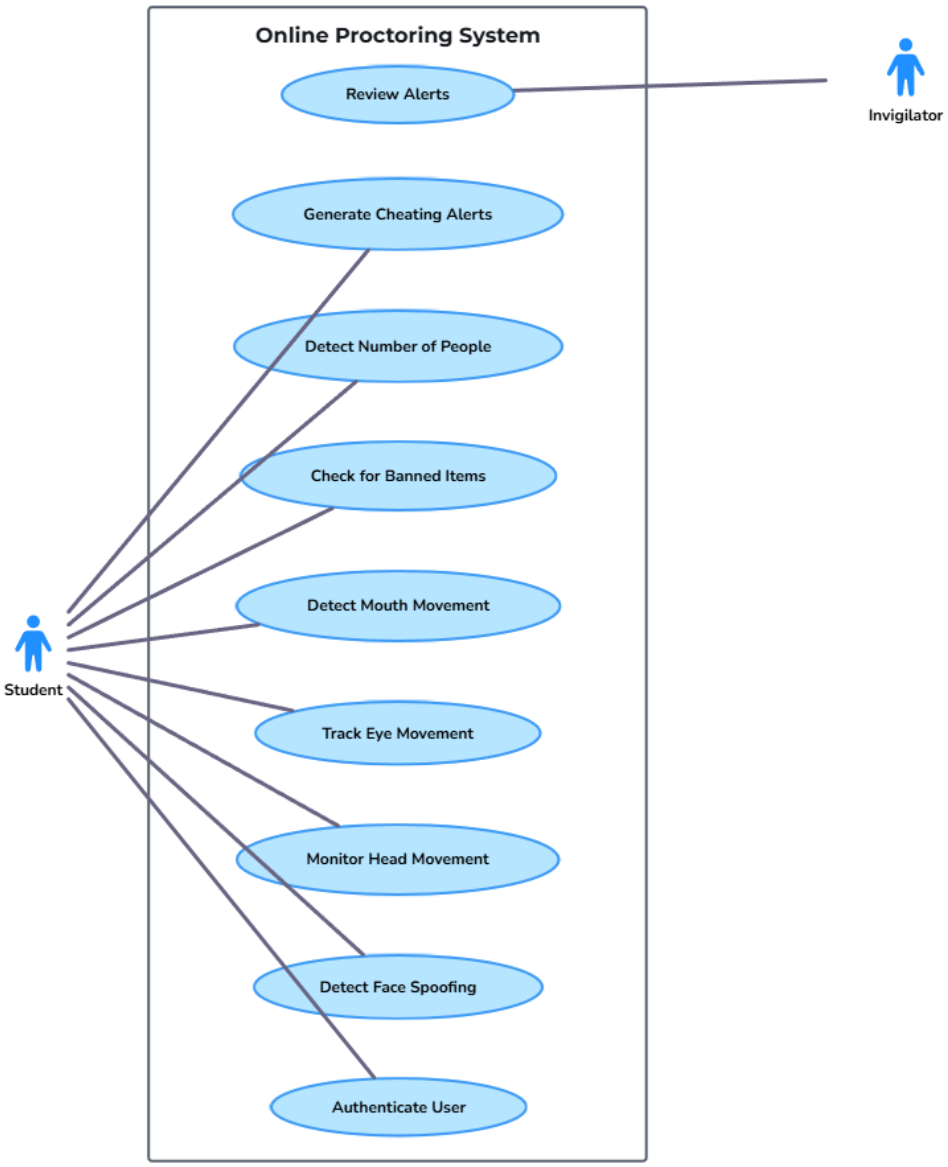


Fig: Use Case Diagram

CLASS DIAGRAM:

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information. Class diagrams serve as a blueprint for constructing software applications by outlining how different objects interact with one another. They are essential in both the analysis and design phases of software development, helping developers visualize and organize the system's architecture. Class diagrams also facilitate communication among team members by providing a clear and standardized representation of system components and their interconnections.

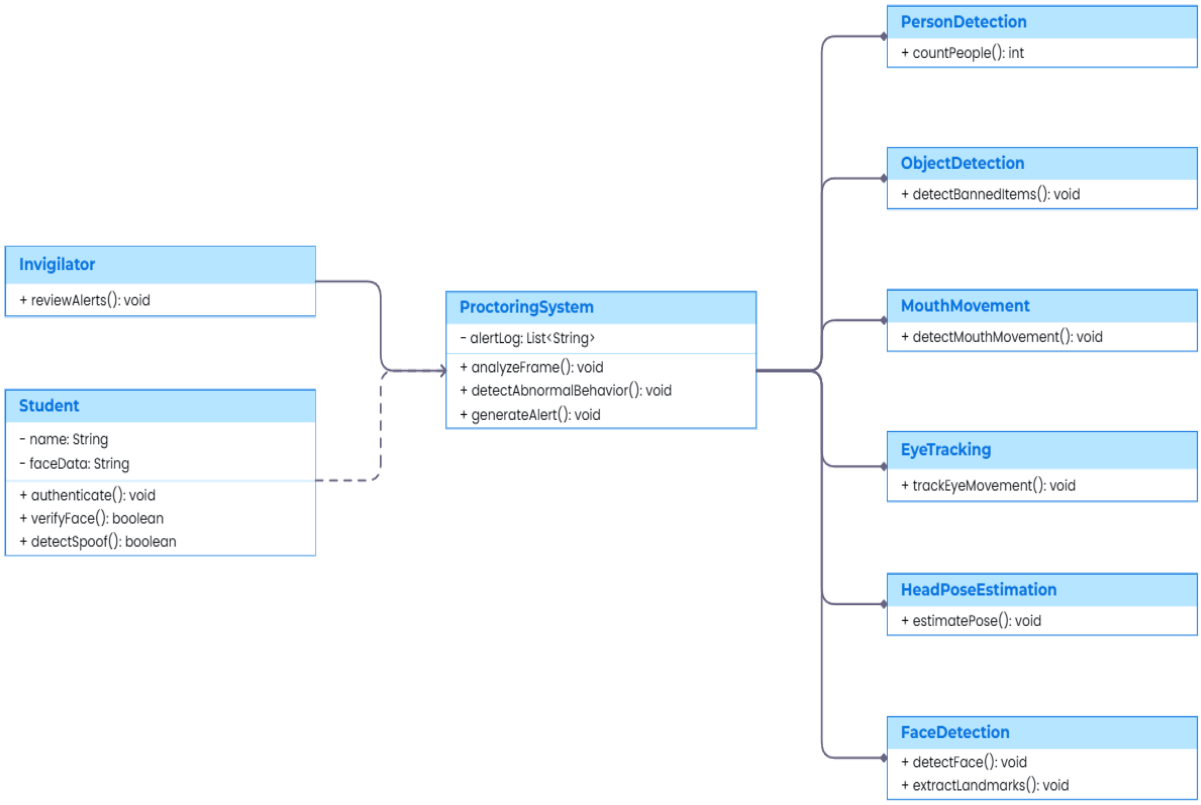


Fig: Class Diagram

SEQUENCE DIAGRAM:

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

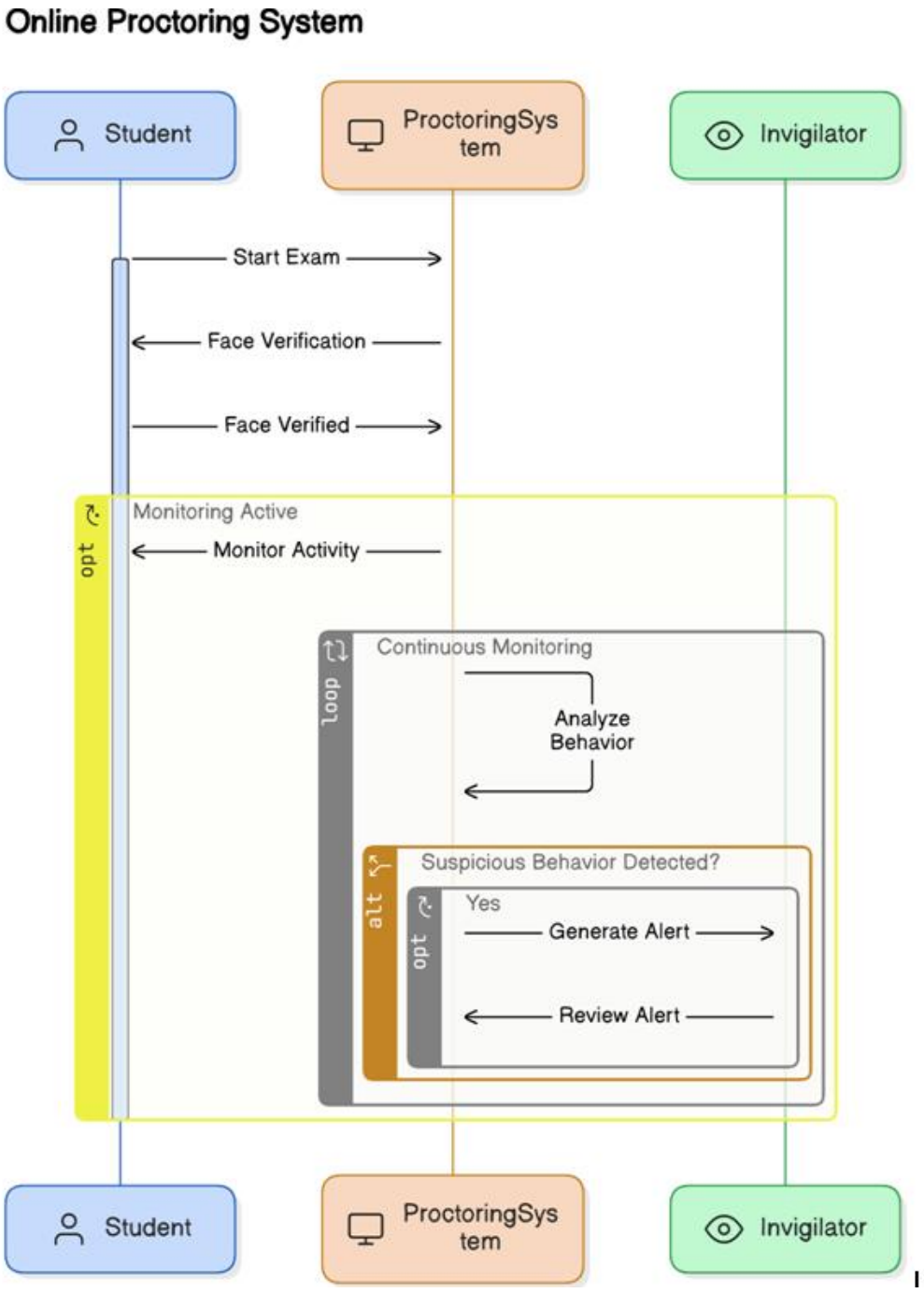


Fig: Sequence Diagram

ACTIVITY DIAGRAM:

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

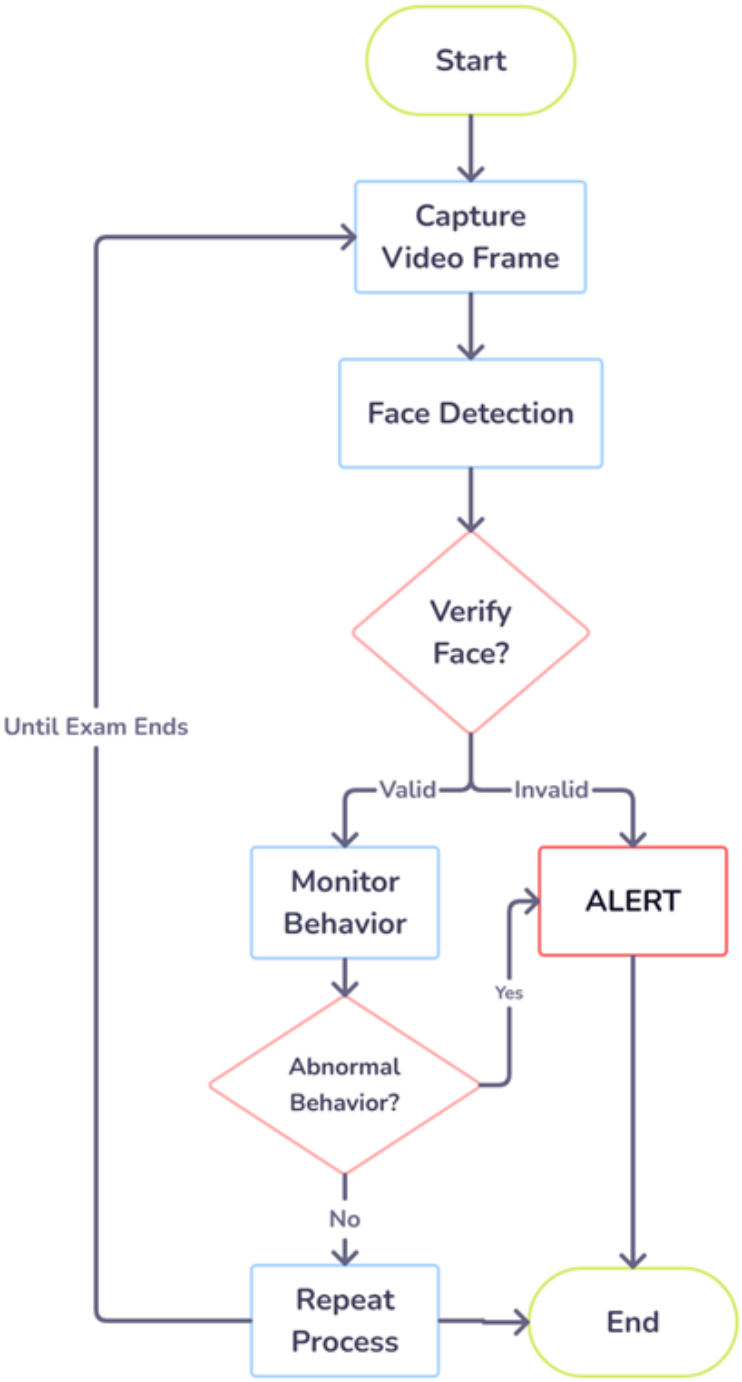


Fig: Activity Diagram

7. SYSTEM IMPLEMENTATION

MODULES:

1. Student

2. Invigilator

The Smart AI-Based Online Proctoring System is designed to automate the monitoring of examinees during online examinations using computer vision and machine learning technologies. The system processes live video feeds to detect suspicious behavior and ensure exam integrity by incorporating multiple modules with dedicated roles and responsibilities.

Once the system is activated and the webcam begins capturing live video input, the Smart AI-Based Online Proctoring System performs a series of intelligent, automated checks to ensure exam integrity. The real-time output of the system is displayed to the invigilator or logged for later analysis, based on the following parameters:

Number of Faces Detected: The system continuously analyzes the video feed to detect how many human faces are visible in the frame. The presence of more than one face is flagged immediately, as it indicates a potential case of impersonation or unauthorized assistance. A warning is issued to the invigilator for verification.

Face Verification Result: Using a pre-trained deep learning model, the system compares the examinee's live face with the facial data stored during the registration phase. If the live face does not match the registered profile, the system generates a mismatch alert, signaling a potential impersonation attempt.

Spoof Detection Result: To prevent cheating using printed photos or pre-recorded videos, the system implements anti-spoofing techniques. By analyzing facial texture and color space features, it determines whether the input is a live person or a static or pre-recorded spoof. If a spoof is detected for several consecutive frames, the session is flagged as suspicious.

Eye Tracking Status: The system tracks the examinee's eye movements using landmark-based ratios. If the examinee looks away from the screen repeatedly or for an extended duration, it is interpreted as potential cheating behavior, such as reading from unauthorized notes or communicating with someone off-camera.

Head Pose Estimation: The head pose estimation model calculates the yaw, pitch, and roll angles of the examinee's head to monitor its orientation. If the head is turned significantly to the left, right, up, or down, and does not face the screen for an abnormal duration, this behavior is flagged for review.

Suspicious Activity Alerts: If any of the above behaviors persist for more than a predefined number of frames (e.g., 10 consecutive frames), the system classifies the activity as suspicious. An alert will get generated.

ALGORITHM:

PRE-TRAINED CNN - DLIB'S RESNET MODEL (FACE VERIFICATION)

This module authenticates the examinee's identity by comparing the live video feed to a pre-registered facial image. It uses a pre-trained ResNet-based Convolutional Neural Network (CNN) from Dlib to generate a 128-dimensional (128D) facial embedding vector. The system calculates the Euclidean distance between the stored and real-time vectors. If this distance is below a predefined threshold (e.g., 0.6), the student is verified; otherwise, an alert is raised. This ensures only registered and authorized individuals can take the exam.

CUSTOM LIGHTWEIGHT CNN (HEAD POSE ESTIMATION)

This module determines the direction in which the examinee's head is oriented — whether they are looking straight, left, right, up, or down. A custom lightweight CNN is trained from scratch to predict the pitch, yaw, and roll angles from the face crop. Unlike landmark-based approaches that rely heavily on visible facial features, this model operates directly on image data, providing robust results even when partial occlusions occur. The model was trained using the Pandora dataset and validated on the BIWI benchmark, achieving real-time performance with minimal computation, suitable for low-resource environments.

PERSON & OBJECT DETECTION (YOLOV3 VIA OPENCV)

To ensure that only the examinee is present and that no unauthorized materials are used, the system uses YOLOv3 object detection. It identifies the number of people in the frame and scans for banned objects such as mobile phones, books, or additional screens. If more than one person or any prohibited item is detected continuously across frames.

8. SYSTEM TESTING

The purpose of system testing is to identify errors and ensure the system functions as expected. It is a comprehensive testing phase to validate whether the integrated components of the "Smart AI-Based Online Proctoring System" meet the intended requirements and deliver accurate results. This system, which leverages AI-based video processing, aims to detect unethical behavior during online exams through modules like face spoofing detection, head pose estimation, eye tracking, and more.

TYPES OF TESTS

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Testing

System testing is a critical phase in the software development lifecycle that ensures the complete and integrated software product meets the specified requirements. This type of testing evaluates the behavior and functionality of the entire system under realistic scenarios. It validates that all modules and components work together seamlessly, and that the system as a whole produces the expected outcomes. Configuration-oriented system integration tests are a common form of system testing. These tests are based on pre-defined process descriptions and data flows. The focus lies on verifying process links, integration points, and the system's interaction with external interfaces. It is often performed after unit and integration testing are completed.

White Box Testing

White Box Testing, also known as clear or structural testing, involves testing the internal structure and logic of the software application. In this approach, the tester has full knowledge of the code, architecture, and logic flow of the system being tested. The purpose is to verify how the system processes input and whether it produces the correct output, while also checking internal operations such as loops, conditions, and branches. It is commonly used to identify logical errors, hidden bugs, and security vulnerabilities. This type of testing often includes path testing, statement testing, and condition testing. White box testing is

especially useful in ensuring that all code paths are executed and validated. It complements black box testing by covering the code-level perspective.

Black Box Testing

Black Box Testing focuses on validating the functionality of the software without any knowledge of its internal structure or code. In this method, the software is treated as a "black box" where only the inputs and expected outputs are known to the tester. The aim is to test how the software behaves under various conditions, ensuring it meets functional requirements. Test cases are derived from requirement specifications and user stories. This approach is effective in identifying missing functionalities, interface errors, and performance issues. It is widely used in acceptance testing, system testing, and regression testing. Black box testing ensures the software meets user expectations without being influenced by its internal implementation.

UNIT TESTING:

Unit testing was performed on individual modules such as person detection, face verification, mouth movement analysis, and eye tracking. Each function was tested to ensure correct input-output behavior. For example, face spoofing was tested to differentiate between a live face and a printed photo, while eye-tracking tests focused on correct classification of gaze direction.

Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- Ensure accurate identification of a single person in the video frame
- Validate correct face verification against the user database
- Confirm detection of abnormal behaviors such as speaking or looking away.

Features to be tested

- Face Spoofing classification (real vs. photo)
- Eye movement tracking to determine gaze direction
- Mouth movement detection to check for speech
- Detection of banned items in the frame

- Authentication through face matching

8.1 INTEGRATION TESTING

All individual modules were incrementally integrated to form the complete proctoring system. Integration testing verified that the modules communicated correctly and processed the video stream cohesively. Special focus was on ensuring that:

- The output of face detection was fed seamlessly into both spoofing and verification modules
- Gaze and mouth analysis received correct facial landmark inputs

Test Results: All integration test cases passed successfully. No interface or logic defects were found during this phase.

8.2 ACCEPTANCE TESTING

Acceptance Testing was carried out with end-users (faculty and student volunteers) to ensure the system's behavior matched expectations in real-world exam simulations. The system was evaluated for reliability, speed, and accuracy under various lighting and user behavior scenarios.

Test Results: All planned acceptance scenarios executed successfully. End-users were satisfied with system responsiveness and detection accuracy. No defects were reported.

8.3 TESTING METHODOLOGIES

The following are the Testing Methodologies:

- **Unit Testing.**
- **Integration Testing.**
- **User Acceptance Testing.**
- **Output Testing.**
- **Validation Testing.**

Unit Testing:

Unit testing focuses verification effort on the smallest unit of Software design that is the module. Unit testing exercises specific paths in a module’s control structure to ensure

complete coverage and maximum error detection. This test focuses on each module individually, ensuring that it functions properly as a unit. Hence, the naming is Unit Testing.

During this testing, each module is tested individually and the module interfaces are verified for the consistency with design specification. All-important processing path are tested for the expected results. All error handling paths are also tested.

Integration Testing:

Integration testing addresses the issues associated with the dual problems of verification and program construction. After the software has been integrated a set of high order tests are conducted. The main objective in this testing process is to take unit tested modules and builds a program structure that has been dictated by design.

The following are the types of Integration Testing:

1. Top-Down Integration:

This method is an incremental approach to constructing the program structure, where integration begins from the top of the module hierarchy and proceeds downward. The process starts with the main control module, which acts as the entry point of the application and coordinates the execution of its subordinate modules. As the testing progresses, modules that are directly called by the main module are integrated and tested in a step-by-step manner.

In this method, the main module is tested first, and any modules it depends on but which have not yet been developed or integrated are temporarily replaced with stubs—simplified implementations that simulate the behavior of the missing components. As more subordinate modules are developed and integrated into the system, these stubs are incrementally replaced with actual modules, allowing for continuous verification of the integration process.This approach helps detect major design flaws early, particularly those related to control and data flow. It ensures that the system architecture is validated from the top level down, promoting stable system growth. Top-down integration also supports early demonstration of working software to stakeholders. However, the reliance on stubs can limit the depth of early testing until real modules are available.

2. Bottom-up Integration:

This method begins the construction and testing with the modules at the lowest level in the program structure. Since the modules are integrated from the bottom up, processing

required for modules subordinate to a given level is always available and the need for stubs is eliminated. The bottom up integration strategy may be implemented with the following steps:

- The low-level modules are combined into clusters into clusters that perform a specific Software sub-function.
- A driver (i.e.) the control program for testing is written to coordinate test case input and output.
- The cluster is tested.
- Drivers are removed and clusters are combined moving upward in the program structure

The bottom-up approaches test each module individually and then each module is module is integrated with a main module and tested for functionality.

User Acceptance Testing:

User Acceptance of a system is a critical success factor in any project. It determines whether the final product aligns with the users' needs and expectations. The system under development is subjected to acceptance testing by maintaining continuous communication with the intended end users throughout the development lifecycle. Feedback is gathered regularly to make necessary adjustments and improvements. This iterative interaction ensures the system is practical, intuitive, and user-friendly. The users' insights help fine-tune the interface and features to match real-world usage. The primary objective is to ensure that the end product delivers on its promised functionality. The developed system offers an interface that even new users can navigate easily and effectively.

To further strengthen user acceptance, usability testing sessions are often conducted during the final stages of development. These sessions allow users to interact with the system in real-time scenarios and provide feedback on any pain points or confusion. This proactive involvement builds trust and ownership among users, increasing the likelihood of successful adoption. Any usability concerns identified are addressed promptly, enhancing the system's efficiency and accessibility.

Output Testing:

After validation testing, output testing is conducted to ensure the system generates correct and usable results. This phase is vital as the utility of any system is ultimately judged

by the accuracy and presentation of its output. Users are consulted to understand their formatting preferences for the data generated by the system. The system is then tested to ensure it produces results in both screen display and printed formats, as required. Outputs are carefully checked to match expectations in content, structure, and appearance. Any discrepancies are addressed through feedback loops. This ensures that the reports and information produced are both accurate and user-centric. Output testing confirms that the system fulfills its reporting and display goals in real-world usage.

In addition to correctness, output testing also verifies the system's performance under various conditions, such as large data loads or concurrent access by multiple users. The responsiveness and clarity of outputs during such scenarios are crucial for system reliability. Output consistency is also evaluated across different devices and platforms to ensure uniform presentation. This includes checking fonts, alignment, color schemes, and data accuracy on various screen resolutions and printers. Testing also involves validating export features, such as PDF, Excel, or CSV formats, which are commonly required for business reporting. Accessibility considerations, such as screen reader compatibility and color contrast, are tested for inclusive usage. Feedback from stakeholders during this phase helps refine layout preferences and content priorities.

Validation Checking:

Validation checks are performed on the following fields:

- Face verification during authentication
- Face spoofing validation
- Eye tracking to ensure gaze is on-screen
- Mouth movement to check for speaking
- Head pose validation to detect looking away
- Detection of banned items like phones or books
- Person detection for single examinee presence

9. SCREENSHOTS

BANNED OBJECT DETECTED: MOBILE PHONE USE DETECTED

To maintain the credibility of the examination, it is essential to monitor for unauthorized devices. The system detects banned objects like mobile phones using the YOLOv3-based object detection framework. When a mobile phone is identified in the examinee's vicinity and appears consistently for over 10 frames, the system raises an alert. This detection acts as a deterrent against using the phone for cheating or external communication. By highlighting the presence of prohibited items, the system ensures adherence to examination rules. It reduces the possibility of using reference materials or contacting others. This safeguard is integral to preserving exam integrity.

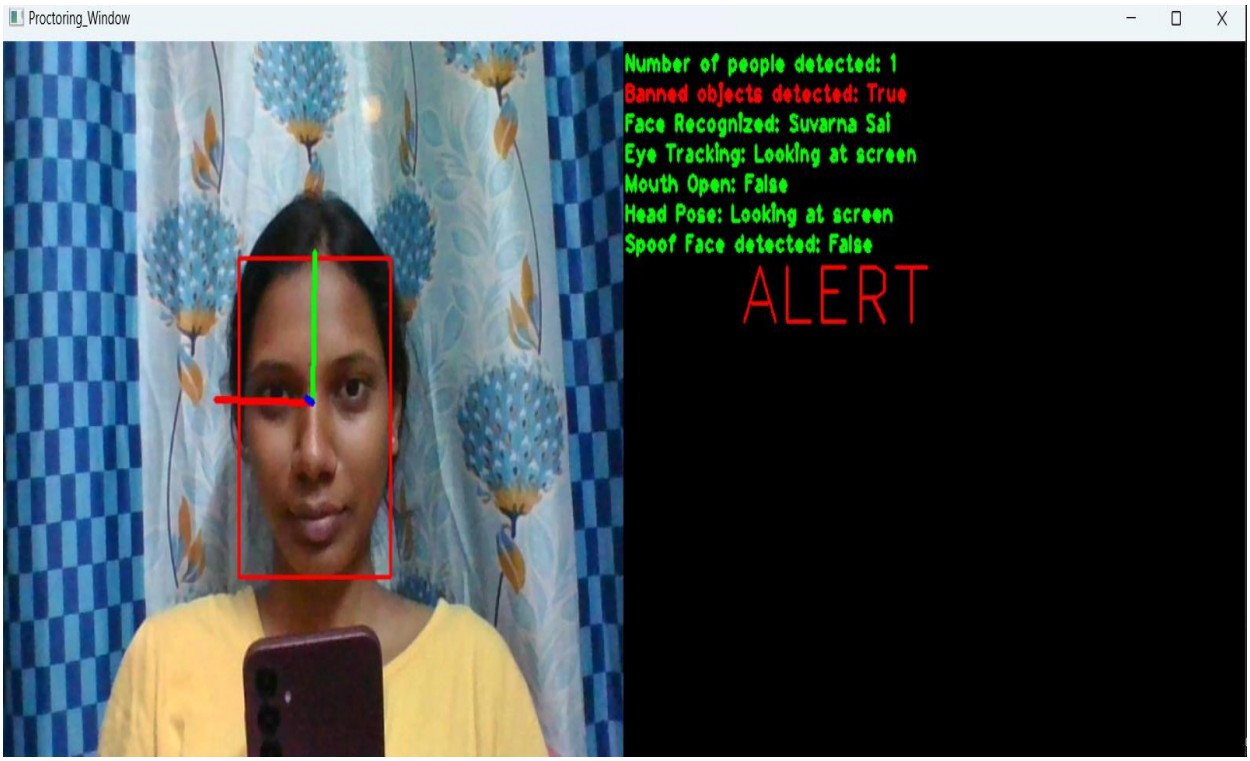


Fig: Mobile Phone Detected

EYE AND HEAD TURNED AWAY FROM SCREEN

Maintaining visual focus on the screen is crucial during proctored exams. The system uses a combination of head pose estimation and eye-tracking to ensure the examinee is not looking away. It employs facial landmark detection and mathematical ratios to determine gaze direction. If the examinee's head or eyes deviate from the screen for an extended period, an alert is generated. This helps identify cases where the candidate might be referencing unauthorized materials off-screen. The detection model is calibrated with thresholds to minimize false positives. Such real-time monitoring reinforces behavioral accountability. This ensures examinees remain attentive and focused.

Fig: Eye and head tracking indicate the examinee is not focused on the screen

MOUTH MOVEMENT DETECTED

Detecting verbal communication is a key aspect of monitoring online exams. The system tracks the examinee's mouth using facial landmarks and computes a lip aspect ratio. When the mouth is detected as open for more than 10 frames, the system flags it as potential speaking behavior. This feature is particularly effective at identifying when candidates are dictating questions or answers. Continuous speech-like motion is classified as suspicious activity and is logged for review. The system is optimized to distinguish between normal facial movements and potential misconduct. It discourages the use of verbal cues during assessments. This supports non-verbal examination conduct.

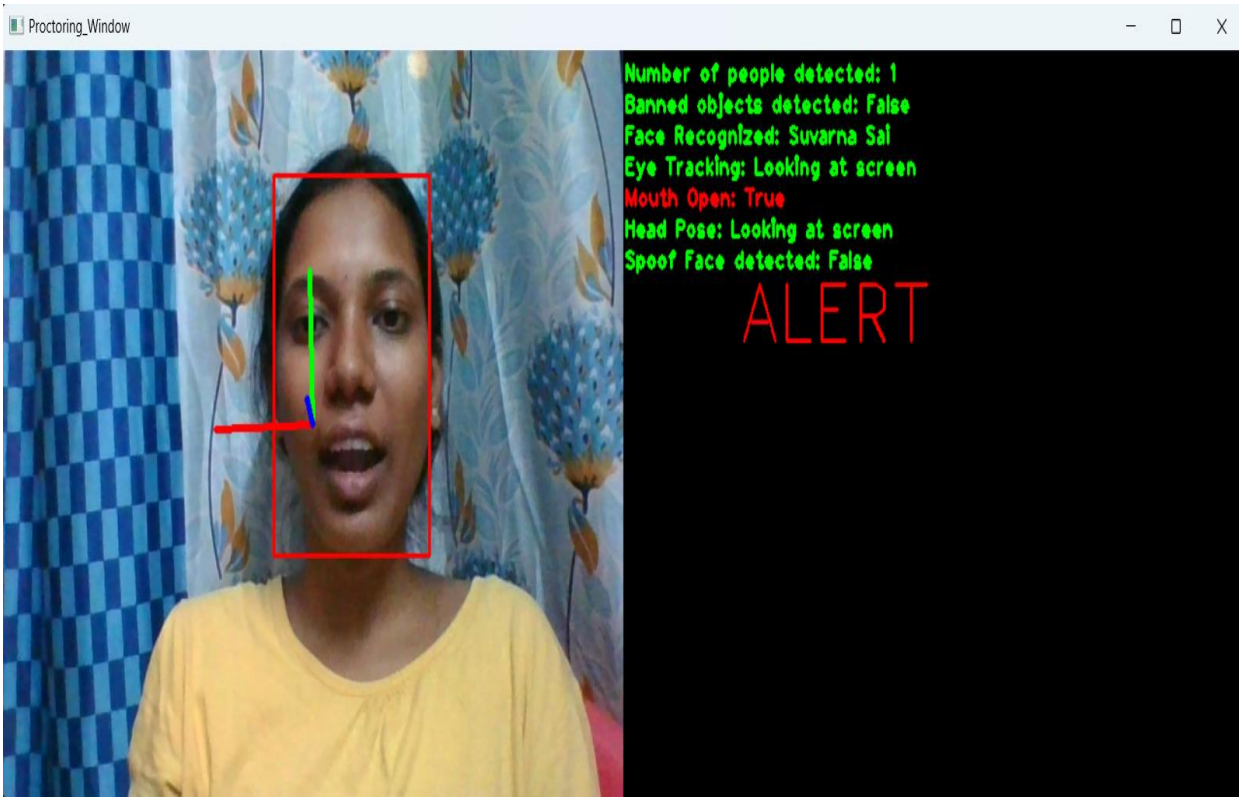


Fig: Student's mouth detected open

MULTIPLE PERSONS DETECTED ALERT

In an online proctored environment, the presence of more than one person in the camera frame raises serious concerns about exam integrity. This alert is triggered when the system detects multiple individuals using the YOLOv3 object detection model. It continuously monitors the examinee's environment in real-time, ensuring that only a single candidate is visible throughout the session. If multiple faces or human figures are identified for more than 10 consecutive frames, the system marks this as a breach. Such behavior could imply collaboration or impersonation attempts. This feature plays a vital role in discouraging group-based cheating methods. The alert acts as a preventive measure to uphold the fairness of the examination process.

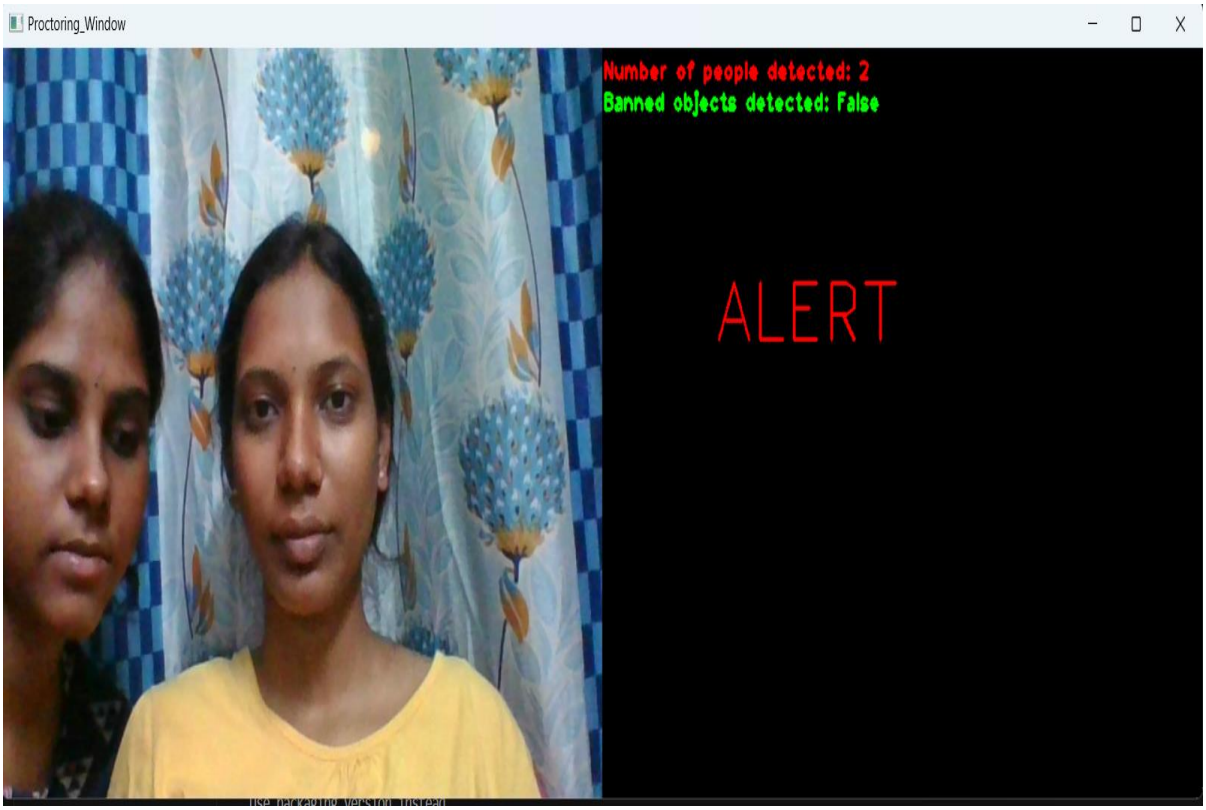


Fig: Multiple persons detected in the camera frame

NO PERSON IN FRAME

The system continuously monitors for the examinee's presence using YOLOv3 person detection. An alert is triggered if no face or body is detected for a set number of frames. This scenario suggests that the candidate may have left the examination environment or obstructed the camera. To ensure accountability, uninterrupted visibility is a strict requirement. This feature helps prevent candidates from walking away or disabling their webcam during the test. It reinforces the importance of constant engagement and supervision. A persistent absence results in a recorded violation. The system ensures that the test session remains actively monitored throughout.

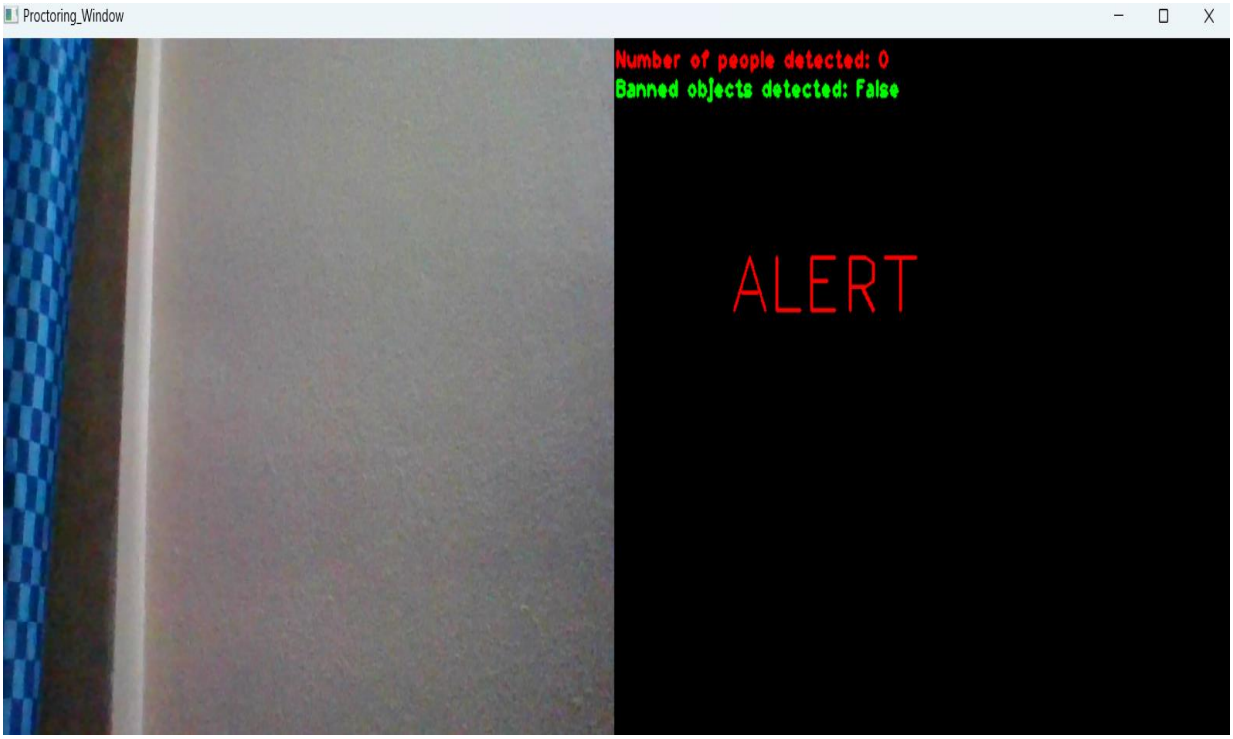


Fig: No person detected in the frame

UNKNOWN IDENTITY

To prevent unauthorized access, the system verifies the identity of the examinee using face recognition. It matches the detected face against a database using pre-trained deep learning models. If the system fails to recognize the face or the similarity score is below the threshold, an authentication failure alert is raised. This ensures that only registered candidates can access and take the test. Unknown users attempting to log in or appear in the frame are immediately flagged. This feature adds a robust layer of security to the proctoring process. It prevents impersonation and protects the exam's integrity.

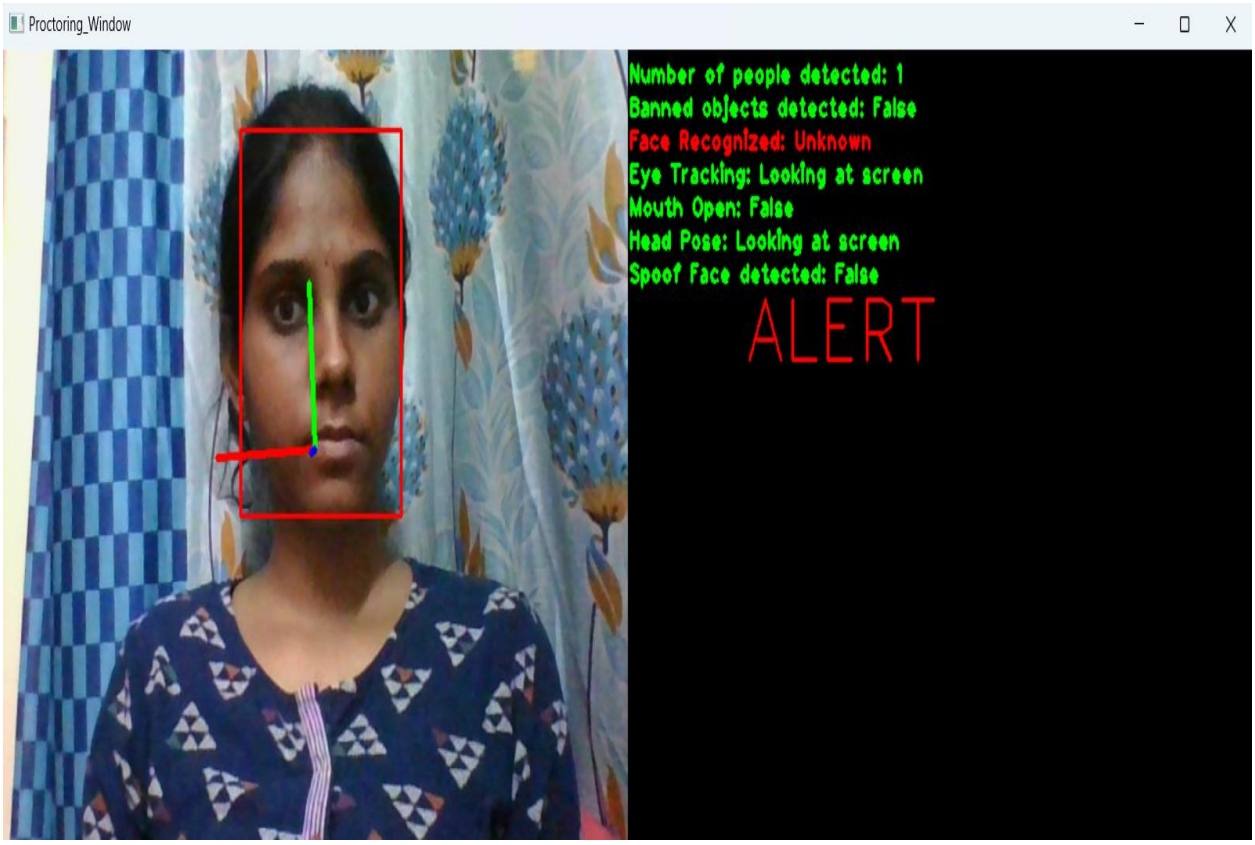


Fig: Unknown user alert activated

SPOOF FACE IDENTIFIED

A major challenge in online exams is verifying that the examinee is a live human and not an impersonator. The system addresses this using a face spoofing detection module. It converts the detected face into different color spaces and computes histograms to distinguish between real and spoof faces. If the face is determined to be a spoof for over 10 frames, the system raises an alert. This prevents attempts to fool the system using photos, videos, or screen images. The detection is lightweight yet accurate, ensuring real-time performance. It enhances the reliability of the authentication process. This feature guards against impersonation and fraud.

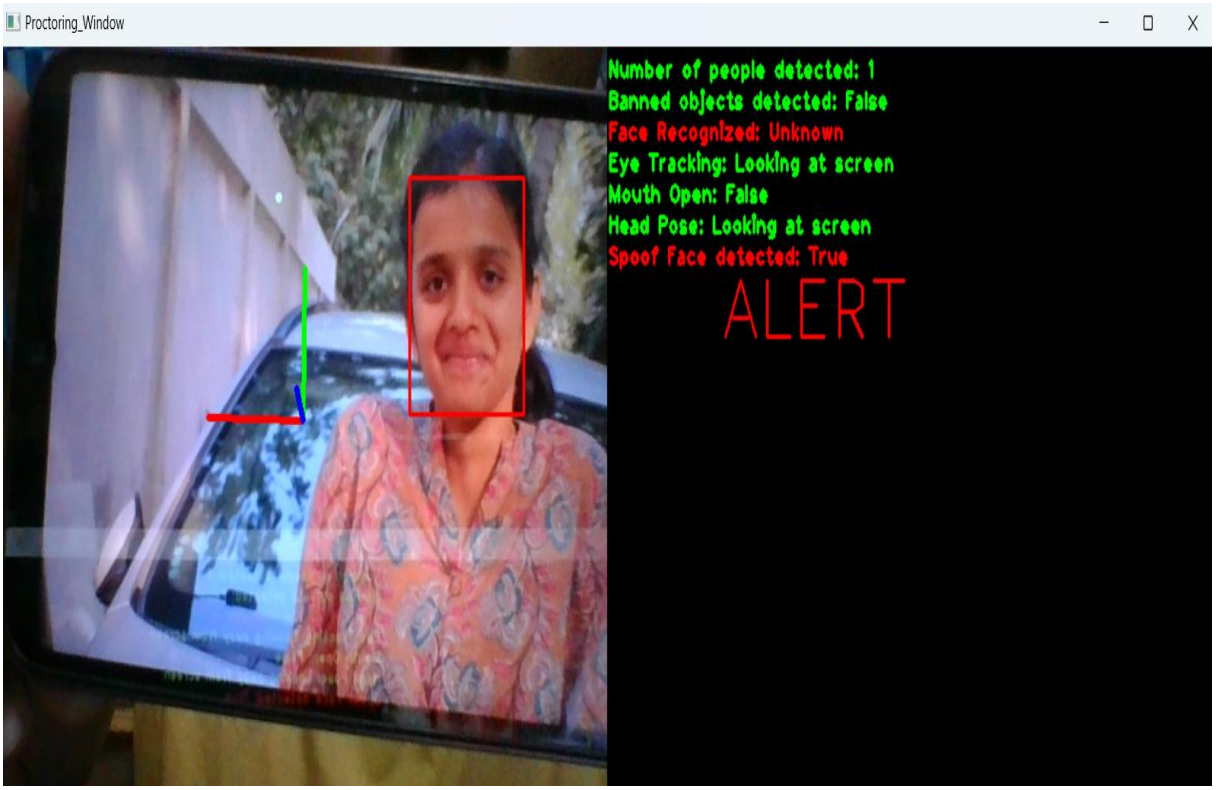


Fig: Detected face classified as spoof

10. CONCLUSION

In this project, we proposed an advanced and intelligent online proctoring system that effectively enhances the integrity of remote assessments. Leveraging a combination of traditional image processing techniques and lightweight deep learning models, the system provides a robust suite of functionalities, including face verification, spoofing detection, head pose estimation, eye-tracking, and mouth movement analysis. This comprehensive approach allows for accurate detection of suspicious behaviors and potential cheating scenarios in a real-time examination setting.

The project successfully balances real-time performance with detection accuracy, making it suitable for deployment in educational institutions with varying levels of hardware infrastructure. Our modular pipeline ensures scalability and ease of maintenance, and the framework's extensibility enables the incorporation of emerging technologies without overhauling the core structure.

Despite these accomplishments, certain limitations remain. Currently, the frame processing speed is limited due to computational overhead, especially with multiple concurrent video streams. Moreover, the accuracy of face spoofing detection could benefit from incorporating deep learning-based liveness detection methods. Similarly, eye-tracking and mouth movement analysis would become more robust and context-aware through the adoption of end-to-end deep gaze estimation models and speech detection modules.

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THANK YOU