**Facial Authentication system for identification and progress tracking in**

**adaptive learning platform**

Project ID: 2023-24-091

Project Proposal Report

Wijesundara W.M.P.S.

BSc (Hons) in Information Technology Specializing

in Data Science

Department of Information Technology

Faculty of Computing

Sri Lanka Institute of Information Technology (SLIIT)

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# DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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# ABSTRACT

The purpose of this study is to investigate the challenges in developing educational technology for primary school students and propose a novel solution using facial authentication.

The research problem is that there are relatively few applications that specifically target primary school students. This is because primary education is a very sensitive subject, and any educational tool used at this level must be robust and reliable. It is also crucial to give each and every primary school student the personal attention they need. Additionally, traditional sign-in systems can be difficult for young children to use, and they can also be a source of frustration.

The proposed solution is to use a novel facial authentication system that allows students to sign in and out from the platform seamlessly. The facial authentication system will generate a unique key based on the student's facial dynamics, which can be used to track their learning progress.

The study will be conducted in two phases. In the first phase, the facial authentication system will be developed and evaluated. In the second phase, the system will be deployed and tracking the student performance over the time. The results of the study will be used to improve the design of the facial authentication system.

The findings of this study not only will contribute to the development of more effective educational technology for primary school students but also in the facial authentication sector too. The proposed solution has the potential to make the sign-in process more efficient and secure for students.

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# INTRODUCTION

The evolution of technology has wielded a transformative impact on various sectors, including education, prompting remarkable developments like online learning platforms and exam software. Despite these advancements, the domain of educational technology tailored specifically for primary school students remains relatively underexplored. This research delves into the multifaceted challenges inherent in this endeavor, identifying the intricate interplay between technology and pedagogy. Primary education, as a pivotal determinant of scholastic trajectory, necessitates educational tools that seamlessly integrate robustness, reliability, and personalized attention. The delicate nature of primary education accentuates the demand for a user-friendly, intuitive sign-in system, unobtrusively ushering young learners into the educational landscape. In parallel, the intricate management of student results databases poses complexities that require both technical expertise and innovative indexing mechanisms.

To address these challenges, the study proposes a transformative solution—a novel facial authentication system that amalgamates cutting-edge technology with pedagogical efficacy. Augmented reality (AR) based gamification techniques serve as the backbone, imbuing the learning process with an engaging and interactive dimension. By enabling students to sign in and out using their facial dynamics, this innovative system redefines the user authentication paradigm, promising enhanced efficiency, security, and user experience. The implementation of facial authentication systems, anchored in facial recognition, introduces a dual discourse of advantages and drawbacks, making precision and robustness paramount. Proficiency across computer vision, facial recognition, facial landmarks, and data encryption emerges as a foundational requirement for the undertaking.

In the landscape of related research, the fusion of facial recognition and educational technology has garnered attention, albeit predominantly through traditional facial recognition databases. As the state of the art reflects an ongoing exploration, this study positions itself as a pioneering endeavor. Distinct from existing approaches, the research advances a novel perspective by focusing on facial authentication in an innovative format. Departing from the conventional database matching paradigm, this approach employs a dynamic facet—facial dynamics—as a basis for both authentication and progress tracking. By bridging the gap between technology and primary education, this novel methodology seeks to overcome prevalent challenges, thus carving an uncharted path for future educational technology paradigms.

# BACKGROUND AND LITERATURE SURWAY

## Face recognition

Facial recognition might be among the earliest cognitive processes employed by humans to identify individuals they are familiar with. Despite the inclusion of additional sensory cues such as speech, gait, and even scent during infancy, the capacity to identify familiar faces emerges right from birth. These factors, along with others, contribute to making facial recognition an intriguing and intricate field of research within biometrics and computer vision[1]. Undoubtedly, facial recognition poses a complex challenge, yet fundamentally, it can be simplified to the task of pattern classification. Numerous methods for pattern recognition have been employed, and novel approaches have also been specifically devised for this purpose[1]. Face recognition technology has several features such as non-mandatory, concurrency, non-contact. In the non-mandatory feature, face recognition system can automatically collect and analyse face images in the unconscious state of the recognition object. This make the recognition method not offensive, and it is not easy to be prevented and cracked because it is not easy to attract people's attention[2]. In concurrency feature, face recognition technology can quickly and simultaneously acquire and identify multiple faces contained in one frame of an image or video, which has incomparable advantages for fingerprint, palm print and other identification technologies[2]. The face recognition system operates without necessitating direct contact with the subject being recognized, encompassing the entire process from gathering facial data to achieving identity verification. Moreover, it can function effectively even when there is a considerable distance between the system and the individual.

## Facial authentication

Face authentication is a biometrics-based user authentication mechanism, which verifies a user’s identity by using information extracted from the user’s facial features[3]. It analyzes distinct facial characteristics such as the distance between the eyes, the shape of the nose, the contours of the jawline, and other unique facial markers to determine a person's identity. This technology has gained significant relevance in today's technological landscape due to its potential applications in various sectors and its ability to provide both convenience and security. Facial authentication has derived from the functionalities of facial recognition. Therefore, facial authentication inherits the limitations of facial recognition. As facial authentication system classifies the facial biometric features confirming the identity which matches perfectly the degree of similarity. It determines the person based on exhaustive verification where the actual biometric features are compared to all registered references and determined which has the greatest similarity.

## Facial authentication in adaptive learning platforms

With the increasing growth e-learning industry, online education demands high quality functions providing different degrees of satisfaction to learners. Through facial authentication in virtual classroom is being increasingly explored for its potential in identification and progress tracking within adaptive learning platforms. Through accurate interpretation of user’s different emotions, facial authentication assures the value of the interpreted actions between positive and negative feedbacks of the users, enhance the educational experience, and provide personalized learning pathways. [4].

Adaptive learning platforms can use facial authentication to ensure that the right user is accessing their personalized learning profile. This adds an extra layer of security by verifying the user's identity through facial features. Furthermore, learning platforms can eliminate the use of traditional passwords and PINs, simplifying the login process and reducing the risk of unauthorized access. In learning platforms where multiple users share a single device, facial authentication can help differentiate between users and load their respective learning profiles automatically.

## Importance of machine learning and deep learning.

Deep learning plays a pivotal role in making facial recognition a robust and effective technology. Deep learning models can learn and extract intricate patterns and unique features of an individual's face from raw image data, without needing explicit human-defined rules. This enables the system to identify subtle differences in facial characteristics that are difficult for traditional algorithms to capture.

The adaptability and scalability of deep learning models make them well-suited for real-world applications of facial authentication, such as in the cases of poor lighting, varied facial expressions, pose variations, and occlusions like glasses or facial hair. Deep learning models can learn to generalize from a wide range of facial variations, making them more robust to real-world scenarios.

## Main challenges and limitations in face authentication.

One of the main challenges of face authentication is the high variability of human faces in terms of shape, size, pose, expression, illumination, occlusion, and makeup. These factors can make it difficult for the algorithms to generalize and cope with different scenarios and conditions. Furthermore, diversity and quality of the datasets that are used to train and evaluate the algorithms causes challenges in facial authentication. Moreover, the complexity and trade-off of the algorithms pauses challenges as the algorithms need to be accurate and robust enough to handle the variability and diversity of faces and datasets, while the algorithms must be efficient and scalable enough to run on different devices and platforms. Despite of the positive outcomes of facial authentication, there might be negative outcomes, where developers of the tasks need to consider the ethical and legal implications and regulations of their work and ensure the consent, security, and rights of the users and subjects.

# RESEARCH GAP

Table 1- Research paper comparison

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Research 1 | Research 2 | Research 3 | Research 4 | Proposed system |
| Facial detection | Yes | Yes | Yes | Yes | Yes |
| Feature extraction | Yes | Yes | Yes | No | Yes |
| Calculations based on facial landmarks | Yes | No | No | Yes | Yes |
| Creating an index | Yes | No | Yes | No | Yes |
| Secure system for record maintenance | No | No | No | No | Yes |

1. **RESEARCH PROBLEM**

The evolution of technology has had a significant impact on every sector, including education. In recent years, there have been major developments in educational technology, such as online learning platforms and exam software. However, there are still relatively few applications that specifically target primary school students.

There are a few reasons for this. Primary education is a very sensitive subject, as it has a direct impact on student performance. Therefore, any educational tool used at this level must be robust and reliable. It is also crucial to give each and every primary school student the personal attention they need. This means that any educational technology must be able to accommodate this requirement.

Another major challenge in developing an educational platform for primary students is the need for a simple and intuitive sign-in system. Traditional sign-in systems can be difficult for young children to use, and they can also be a source of frustration. Additionally, maintaining a database of student results can be a complex task without a person who has the capabilities to handle a database and without a unique key to index them.

To address these challenges, the author proposes to use a novel facial authentication system. This system will allow students to sign in and out from the platform with the help of augmented reality (AR) based gamification techniques. AR gamification techniques will make learning fun and engaging for students. This will make the sign-in process much faster and easier for students, and it will also eliminate the need for them to remember passwords or usernames. The facial authentication system will also generate a unique key based on the student's facial dynamics, which can be used to track their learning progress.

# OBJECTIVES

## Main Objectives

* Develop a facial dynamics-based user authentication algorithm that is robust and accurate.
* Track and record the adaptive learning process of users.

## Specific Objectives

* Design a mechanism to extract facial dynamics using passive biometrics with minimal user interaction.
* Develop a method to identify facial landmarks in challenging conditions.
* Implement an algorithm to generate a unique search index for each user based on their facial features.
* Develop an error handling algorithm to prevent the creation of multiple search indexes.
* Design a system to be personalized without storing sensitive user information in the database.

# **METHODOLOGY**

Figure 1- Overall architecture

The proposed system addresses two main objectives, user authentication via facial authentication, Track and maintain the student performance.

Unlike traditional facial authentication systems that is based on facial recognition, the proposed system eliminates the comparison of the facial features to perform the authentication due to the security concerns. Instead, it generates a key based on a person’s facial dynamics such as the distance between points. It is crucial to implement a robust indexing function with fail safes like the error handling aspects. Due to the unique indexing, the platform can be used anywhere in the world regardless of the device.

Overall, the proposed system replace the traditional login authentication system with a facial authentication system since the primary stakeholder of the system are primary level students who don’t have much experience in these.

# PROJECT REQUIREMENTS

## Functional Requirements:

### User Authentication:

* + Develop a facial authentication system enabling primary school students to sign in and out using their facial dynamics.
  + Ensure accurate recognition of facial features for user authentication.

### User-Friendly Sign-In System:

* Design an intuitive sign-in interface suitable for young children.
* Simplify the sign-in process to prevent frustration among primary school students.

### Database Management:

* + Establish a robust database management system to store student progress and results.
  + Implement a mechanism generating unique keys based on facial dynamics for indexing and tracking purposes.

## Non-Functional Requirements:

### Security:

* + Implement stringent security measures to protect students' sensitive data.
  + Ensure the facial authentication system is resistant to impersonation attempts using photographs or videos.

### Accuracy and Robustness:

* Develop a facial recognition system with high accuracy in identifying students' facial features.
* Ensure the system performs consistently under various lighting conditions and facial orientations.

### Speed and Performance:

* Optimize the authentication process for a seamless user experience.
* Ensure the system maintains performance even under concurrent user activity.

### Usability:

* + Design an intuitive and user-friendly sign-in interface suitable for primary school students.
  + Ensure the system's ease of use, even for young children.

## Expected Test Cases:

### Facial Authentication:

* + Test the accuracy of the facial authentication system in recognizing registered students' faces.
  + Verify the system's response to unauthorized access attempts.

### Sign-In System:

* + Evaluate the usability and intuitiveness of the sign-in interface through simulated usage by young children.
  + Test the system's response to incorrect sign-in attempts.

### Database Management:

* Validate the system's ability to accurately store and retrieve student progress.
* Check the generation and utilization of unique keys based on facial dynamics.

### Security and Robustness:

* + Conduct security testing to identify vulnerabilities, especially photo or video impersonation.
  + Evaluate the system's accuracy under different lighting conditions and facial orientations.

### Performance:

* Perform stress testing to assess the system's performance under heavy user loads.
* Measure the time taken for facial authentication and database operations.

### Usability Testing:

* Engage primary school students to gauge the user-friendliness of the sign-in interface.
* Obtain feedback on the ease of navigating and interacting with the system.

# References

[1] M. Bicego, A. Lagorio, E. Grosso, and M. Tistarelli, “On the use of SIFT features for face authentication,” 2006.

[2] C. Mingtsung and L. Cai, “Research on the Application of Face Recognition System,” 2020.

[3] Y. Li, K. Xu, Q. Yan, Y. Li, and R. H. Deng, “Understanding OSN-based facial disclosure against face authentication systems,” in *ASIA CCS 2014 - Proceedings of the 9th ACM Symposium on Information, Computer and Communications Security*, Association for Computing Machinery, Inc, Jun. 2014, pp. 413–423. doi: 10.1145/2590296.2590315.

[4] J. Valera, J. Valera, and Y. Gelogo, “A Review on Facial Recognition for Online Learning Authentication,” in *Proceedings - 8th International Conference on Bio-Science and Bio-Technology, BSBT 2015*, Institute of Electrical and Electronics Engineers Inc., Mar. 2016, pp. 16–19. doi: 10.1109/BSBT.2015.15.