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AUTONOMOUS MONITORING WITH FACIAL EXPRESSION RECOGNITION AND GAMIFICATION TO SUPPORT BLENDED LEARNING MODEL

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Abstract

Blended learning model is a popular learning model and is trusted by many educational institutions in the world as a more effective model. However, it has several challenges and weaknesses, namely the lack of monitoring and assessment of learning activities during online sessions or asynchronous sessions. This study aims to build an autonomous monitoring system using facial expression recognition and gamification methods to support the learning process with a blended learning model. The result of this research is a design and implementation of an autonomous monitoring system that displays real-time monitoring reports with the concept of gamification. Real-time reports can be used by teachers as one of the assessment points for students. In addition, the applied gamification concept has motivated students to take the distance learning process seriously and quickly because they are competing to get points.

Keywords: Autonomous monitoring, Facial expression recognition, Gamification.

1. Introduction

Blended learning is a mixed learning model between conventional learning models (face-to-face) and learning models supported by technology, especially Information and Communication Technology (ICT). This learning model is believed to be more effective and positively affects the learning process. Many educational institutions in the world apply this learning model. Besides the popularity of this advantageous learning model, there are also several weaknesses, including the lack of control and monitoring by the teacher and the difficulty of the teacher to assess the learning process carried out by students during asynchronous sessions. There are several challenges, especially on the student side which include procrastination, lack of self-regulation, and poor time management which make blended learning models constrained and not in line with expectations [1].

In contrast to conventional learning models in classrooms or during synchronous sessions, blended models during asynchronous sessions are very difficult for teachers to monitor whether the students are learning or not. This makes this model ineffective in practice because students sometimes do not necessarily carry out the assigned learning process. Moreover, even during synchronous sessions via video conference, students can turn off the camera or pretend to pay attention while doing other things such as playing online games. This is because the teacher cannot monitor each student while they are explaining the subject matter. The stated problems underlie this research which aims to produce an autonomous monitoring system that will effectively support the blended learning process. An autonomous monitoring system is needed to ensure that every student takes the distance learning process seriously and optimally. Many lessons have been learned from the COVID-19 pandemic, one of which is the requirement to provide online education facilities. This research is one form of strategy for improving digital capabilities in educational institutions such as in other fields that have formulated new strategies in undergoing the post-COVID-19 period [2-5].

2. Research Method

This research is descriptive-qualitative with a literature review from previous studies and other references. The facial expression recognition and gamification system were developed using an object-oriented approach using the Unified Modelling Language (UML). The main idea of this research is to build a monitoring system that runs automatically using facial expression recognition methods and calculations with the concept of gamification as the monitoring output (report). This research design can be described using a block diagram as shown in Fig. 1.

The explanation of blended learning, autonomous monitoring, face recognition, and gamification are as follows:

(i) Blended learning model, the exact definition is still debatable because of the ambiguity of hybrid learning or flexible learning. In simple terms, blended learning is an integration of face-to-face learning models with online learning [6, 7]. The generally accepted understanding of blended learning is a combination of face-to-face learning models with learning supported by ICT. In practice, this learning model is conventional which is carried out in the classroom but with the addition of learning outside the classroom through online media or applications connected to the internet.

(ii) Autonomous monitoring, which is a function that runs automatically to monitor certain conditions using sensors and intelligent processing systems. If the specified condition is captured, this function will trigger the event for further processing. Dabou stated that autonomous monitoring is used to monitor the environment and critical infrastructure using a wireless sensor network to provide early warning [8].

(iii) Facial expression recognition, which is the result of the development of a facial recognition system using artificial intelligence. The method that is often used for facial recognition is the Artificial Neural Network (ANN) method [9], or a more sophisticated one, the Convolutional Neural Network (CNN). In facial expression recognition, facial features are modelled to determine a person's general expressions such as happy, sad, angry, surprised, and neutral. In this study, the facial expression recognition system uses a JavaScript library with open-source code, namely TensorFlowJS. This JavaScript library is a hardware-accelerated library for implementing machine learning models (Adopted from https://github.com/tensorflow/tfjs/, Retrieved on 20 August 2022).

(iv) Gamification, which is a strategic effort to improve the system by implementing game elements to motivate and maintain user engagement. Gamification can be done by applying game design elements and game principles to systems, organizations, or services. Some examples of game elements include Points, Ranks, Badges, Leaderboards, Missions, and Competitions [10].

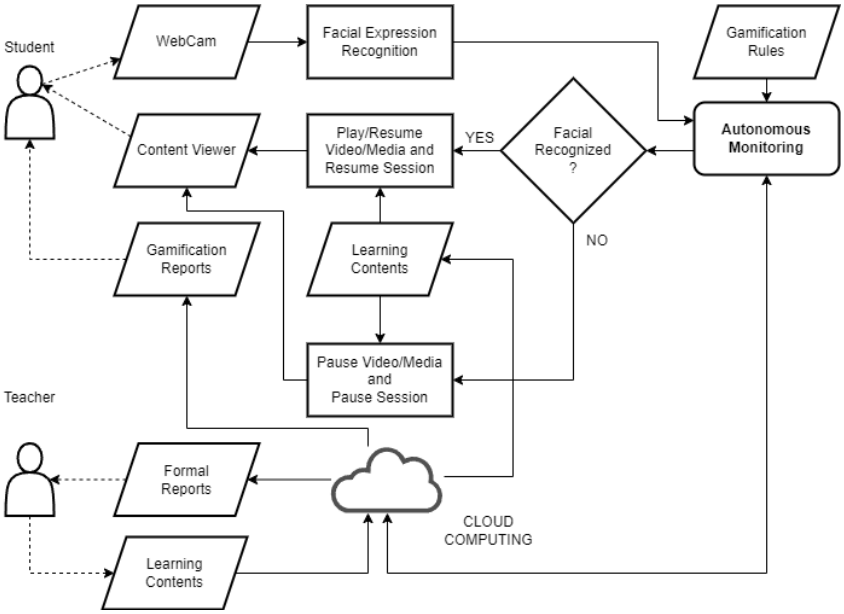


Fig. 1. Research design block diagram.

3. Results and Discussion

3.1. The design of the system

This system is designed web-based to facilitate portability and cross-platform. This system has two user roles, namely students and teachers. Teachers and students

have different access rights. Teachers can access two application pages, namely learning material entries and monitoring reports. Meanwhile, students can access learning sessions and report. The use case of the system is shown in Fig. 2.

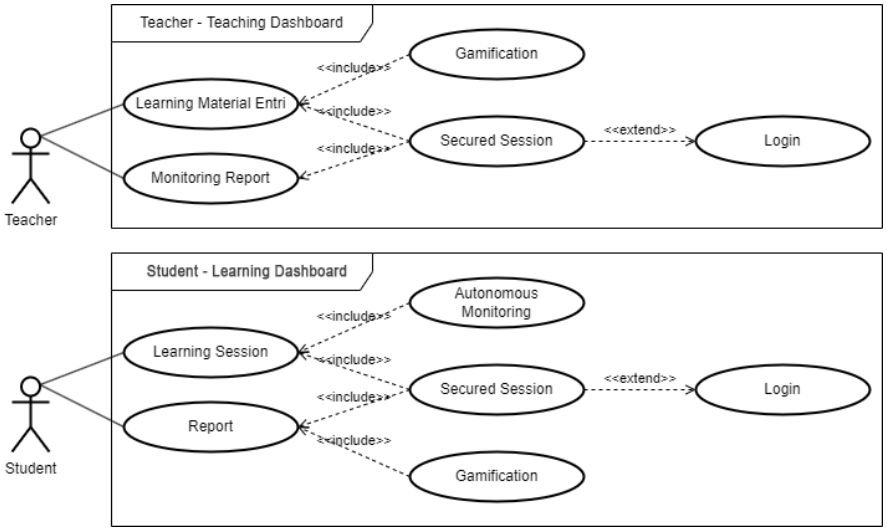


Fig. 2. System use case.

Learning material entries is an application page for teachers that serves to enter subject matter. The subject matter in question is in the form of video content and text-based content. In addition to entering the material, the teacher must also determine the game rules for each material. The rules of the game are in the form of time range entries and student facial expressions that are expected to be detected in that time range.

Teachers can view monitoring results or reports on the monitoring reports page. On this page, the teacher can see the details of the monitoring, points, and learning progress of each student.

The learning session module is an application page intended for students. Students carry out online learning activities through this page. If this page is opened by students, the monitoring process will automatically run and record student learning activities. Students will get points according to the game rules determined by the teacher on this page. In addition, students can also view detailed reports on their learning points and progress. The report page is a page in the form of a podium and leaderboard that displays the point position and progress of each student. The user interface designs for learning sessions and reports are represented in Figs. 3 and 4.

3.2. Implementation

The implementation of this system is done using cloud computing. To support real-time response, this system uses the firebase real-time database service. The use of firebase is not mandatory and can be replaced with other services even using a common database. Figures 5 and 6 are the architecture diagrams and deployment diagrams that are implemented.

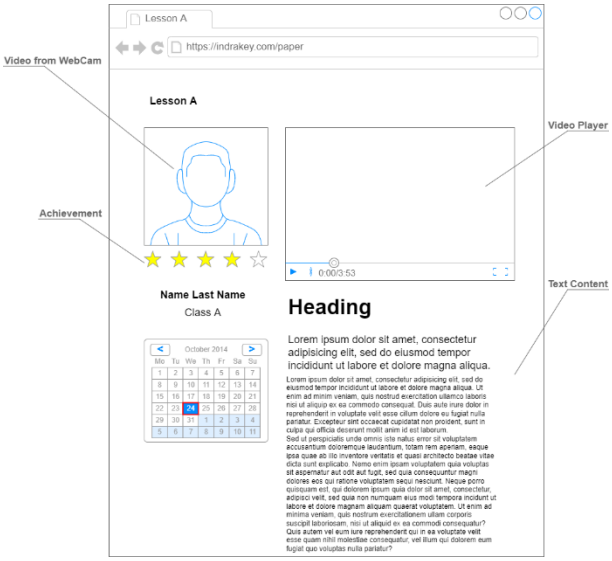


Fig. 3. Learning session UI mock-up.

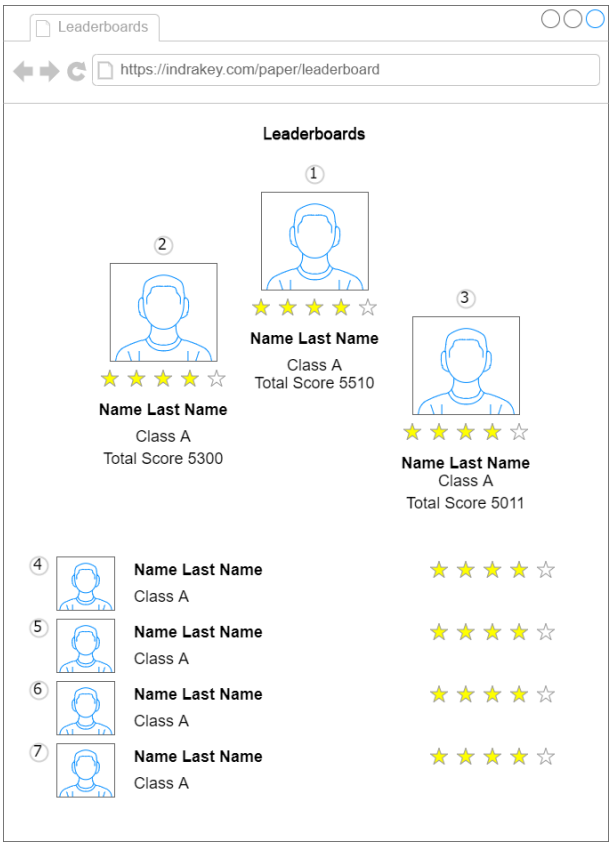


Fig. 4. Reports (Leaderboards) UI mock-up.

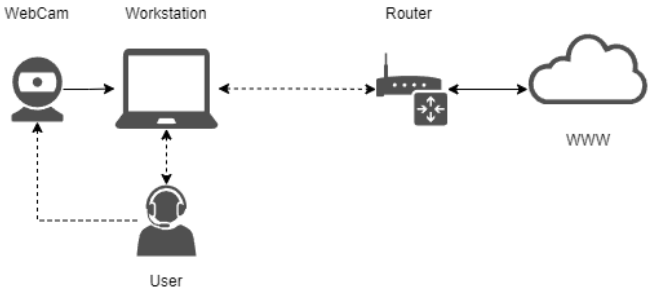


Fig. 5. Architecture diagram.

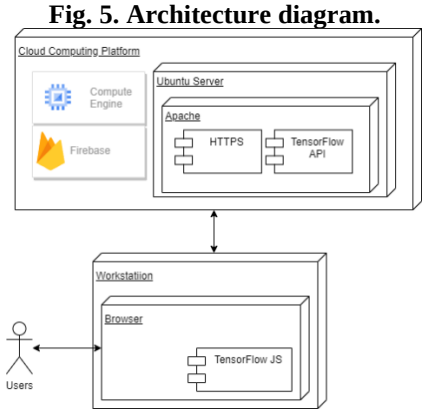
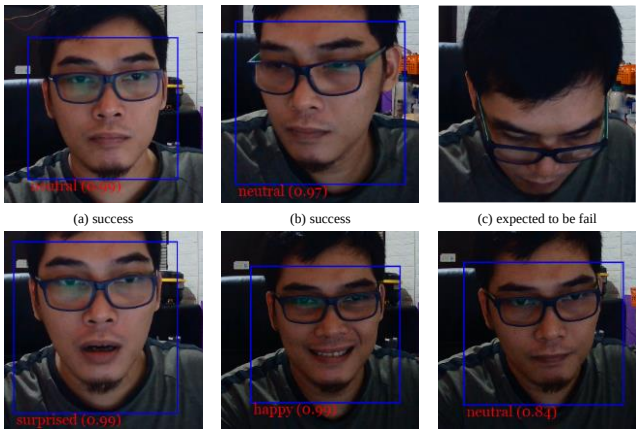


Fig. 6. Deployment diagram.

3.3. Testing

The final stage of this research is the testing stage. The stage is carried out in two test scenarios. The first scenario is testing the facial expression recognition system. This test is done by testing some facial expressions namely neutral expression (a), neutral expression facing sideways (b), neutral expression facing down (c), surprised expression (d), happy expression (e), and sad expression (f) (See Fig. 7).



(a) success (b) success (c) expected to be fail

(d) success (e) success (f) fail

Fig. 7. Expression test results.

The second test scenario is testing the gamification application by entering game rules (see Table 1, as well as Figs. 8 and 9).

Table 1. Scenario II's game rules.

Rule ID	Time Range From	Time Range To	Expected Expression	Points
1	00:00	00:05	Happy	5
2	00:05	00:09	Surprised	5

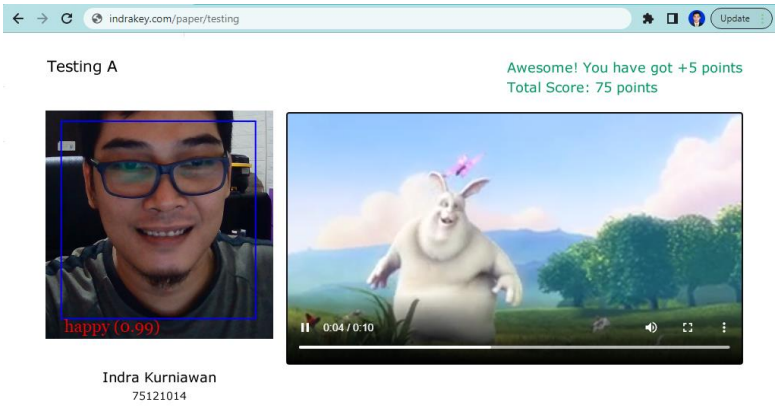


Fig. 8. Rule 1 test result (success).

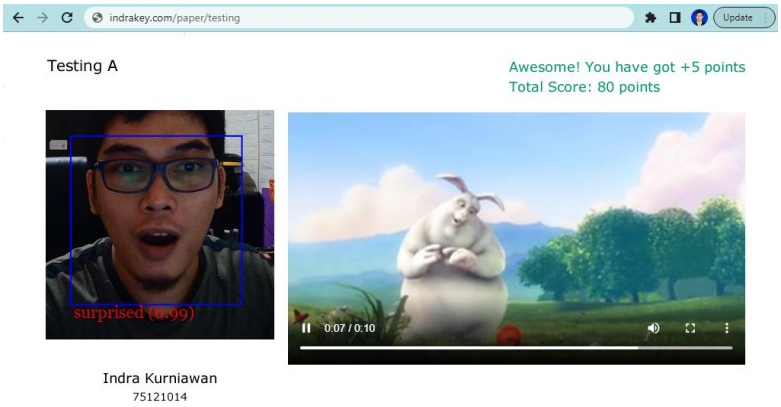


Fig. 9. Rule 2 test result (success).

In this test, the first scenario shows a failure where sad facial expressions are difficult to detect, different from happy and surprised facial expressions. The second test shows a 100% success result where the expected expression is adjusted to the game rules and the application gives the appropriate points.

4. Conclusion

The autonomous monitoring system resulting from this research ensures that students take the online learning process seriously both synchronously and asynchronously

because they feel monitored and assessed. Reports with gamification concepts that can be accessed in real-time, increase students' motivation in learning as they compete for points to improve their position on the ladder board. In addition, this system ensures that no student pretends to pay attention to the lesson.

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