Smart Classroom : Questions and Answering Based on Hand gesture System

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Abstract

With the development of technologies throughout the era, solutions and solutions were implemented to solve multiple problems due to the COVID situation occurring globally in different fields such as agriculture, business, media, and education is no stranger. However, students and educators remain skeptical and unsatisfactory of inconsistent and "less interactivity" online classes. Thus, in this project, we will have implemented hand gestures, question & answering methodology as a smart classroom, to improve interaction and communication between students and lecturers during E-learning. With an integrated system linking one of the most popular programming languages, Python, together with full website development with HTML, CSS JavaScript and multiple other helpful libraries, smart classrooms are implemented to help students and educators to adapt to quiz-based learning. Hence, the testing phase of this development evolves around black box testing, with cause-effect technique being the main method to gather test results. One extra phase of debugging and modification is performed to fix variations and strengthen system validation for bug fixes and feature improvements. The two main modules of the implemented system include Question and Answering module, and Hand detection and recognition module that will be divided equally among team members for development. With visible test results, efficiency and accuracy are positively maintained and welcome for more modifications.It is hoped that the outcome of this project meets expectation and realistically developed into real life application especially in study institutions, where AI and hand recognition methodology meets education.

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Problem Statement

The Covid-19 pandemic has been around for over one years, yet until today, this pandemic has been affecting educational fields including the ways that students learned things and attended classes. Most of the institutions started transforming class conduction, assignments, seminars and tests to online platforms due to ongoing pandemic. The online education possibly can overtake physical classes, but space for improvement is still a long road to go. However, problems navigated through online classes previously has proven to be not less than physical classes, starting from student attendance where both of these correlates with the student's interest in participating activities at online classes. Besides, students are most likely to feel unsatisfied on online quizzes especially google forms due to lack of interactivity. Online courses have proven to offer lesser "interactive" and "mobile"activity such as lab experiments, and the result simply doesn't show an increase in student's performance as expected.

Objectives

The main objective for this research project is to create a special quiz-based system where students can play quizzes that are mostly built around hand recognition and barely touching hardwares. The "virtual gaming" style learning will be the main way of learning for students cooperating with lecturers in a virtual classroom in any of the Question and Answering Scenarios (quiz, tests, etc). Hand recognition will be the indicator that detects and defines values of the gesture for students. Management systems will be implemented as well as complete system design.

The following objectives should be conducted in this researches are:

I. To **improve the motivation** of the students, interest, and **interactivity** of students towards learning via SmartQuiz.
II. To provide an alternative way of learning such as **quiz-based learning.**
III. To **reduce the challenge** of teachers or lecturers in **evaluating** the students' understanding**.**

Design and Methodology

There are two main roles included in this system which are students and admins. Basically, students will be the one answering the questions and the admin will be the one creating the questions. Students and admins are also able to view the results after the students have done the answering the questions. The process model that is used in this system is the agile process model. There are 6 main phases in the agile process model which are requirements, design, develop, test, deploy and review. First of all, the requirements phase will gather the requirements of the system. The requirements will be gathered through research online, questionnaires, interviews, and fact recording. Next, the design phase will carry out the system design such as the user interface for all the modules of the system, system architecture, database design After that, the coding for the system will be carried out during the development phase. During the development phase, the unit test of the system will go through to make sure that each functionality of the system can work without any error. After all the modules complete development, testing for the integration of the system will be executed to test if all the modules can integrate well with each other and even test the integration with the database of the system. The system will deploy to the database during the deploy phase. Lastly, the supervisor will review the system and provide feedback about the system for each of the sprint.

By applying an agile process model, the software can be created and developed within the shortest possible time. The requirements of the system can be changed at any sprint as it is flexible for changing when each sprint is reperating from start to finish. Hence, the bugs and defects can be found easily at the early stage. However, the changing or adding of requirements will require a high skill of coding and knowledge to adopt with the changing of requirements anytime.

Besides, the targeted market for this system is higher education institutions such as universities, colleges and schools. This system will provide the service such as evaluating the understanding of the students through the quiz that was created by the lecturer. To operate this system in its current stage, it contained different minimum hardware and software to operate this system. The **Table 1** below shows the requirements in operation environment:

Table 1 : *Suggested Hardware and Software requirement with specification of Smart Classroom: SmartQuiz System*

Suggested Hardware and Software	Suggested Hardware and Software Specification
Processor	Intel Core i5-7200U CPU@ 2.5GHz 2.70GHz
Operating System	Window 10
Memory	8GB
Resolution	1920 x 1080
Interface	Camera (720p 16:9 30 fps)
Network Connection	Required
Browser	Google Chrome
Platform	Visual Studio Code
Environment	Anaconda
Library	- MediaPipe - Flask - TensorFlow - pymongo[srv]

Construction and Testing

The programming languages used for developing this system is Python, HTML, CSS and JavaScript. The database that is used in this system is MongoDB database which is one of the most popular cloud databases and the development environment will be the same as the operating environment which is mentioned in the design and methodology part. To conduct the testing for this system, the technique cause-effect graph was used to describe the cause and effect relationship and a decision table was created to obtain the test cases which converted from the cause-effect graph. After that the black box testing will be carried out by following the steps that were created in test cases.

Hand Detection and Recognition is the major function of the system. Hence, the system is required to detect the hand of the users and display through the web frame. **Figure 1**, was an example of the hands that were detected by the system. The system not only detected the hands and showed out with the hand landmarks but also classified the left and right hand of the user. With this, it allows users to create different gestures with different hands for providing the instruction to the system. For example, **Figure 2** shows the selection answer with 1 number gesture by using the left hand and **Figure 3** is confirm the answer with holding the palm gesture by using the right hand. With the classification of left and right hand it provides high usability to users as the users do not require much knowledge of IT to operate the system and users should be familiar with the system when the users are able to interact with the system by using human hand sign.

However, the detection of the system will duplicate sometime when detecting the hands. The real time for detection and recognition of the hand is also frequently changing the selected answer. This is because the system will keep detecting for finding the second hand if the user only shows one hand. With this, there may be the possibility of detecting the same hand which means the duplication of detected the same hand will happen and it will affect the user experience when the user is answering the question Besides, the selected answer also changes frequently when the second hand was detected unexpectedly. Hence, to solve this problem we have to minimize the hand detection to one during answering and create some algorithm to let the system understand the use of left and right hand during answering the question. At the same time, the algorithm also reduced the easy change of selection of the answer. At the end, the duplication of the detection is not happening and selection of the answer will be changed only after a few seconds of detection and recognition. Even so, the users are required to detect the hand one by one instead of putting the hands together at the same time.

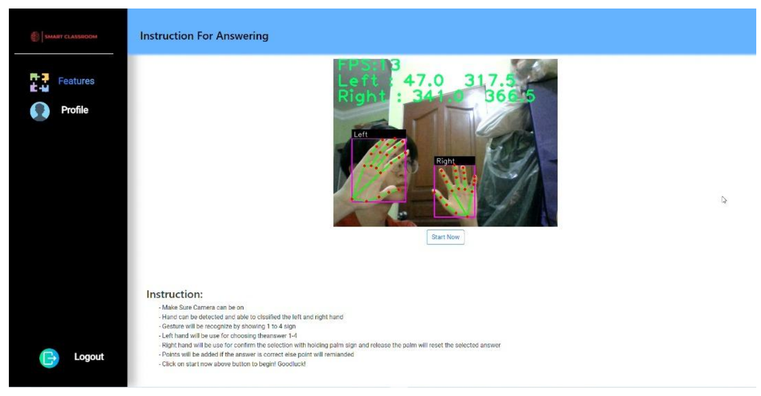

Figure 1 : Hand detection with classification

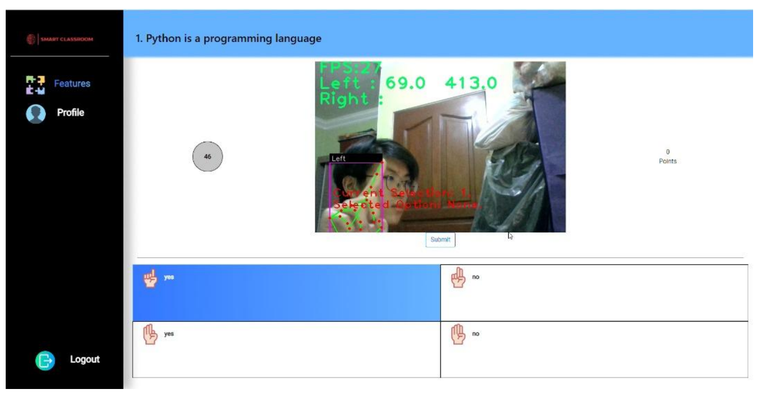

Figure 2 : Select the first answer

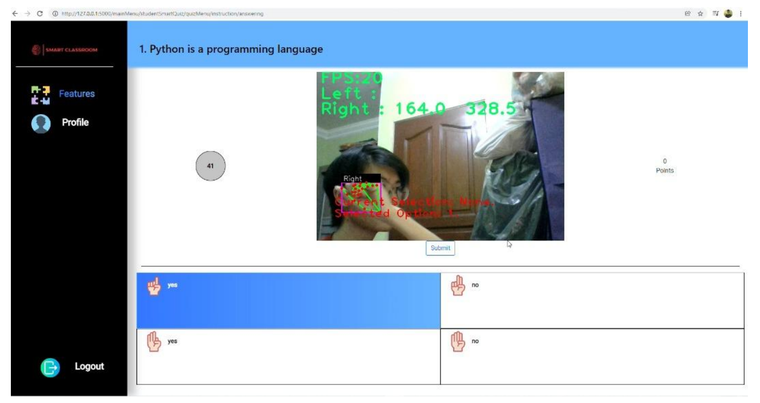

Figure 3 : Confirm the selected answer

Contribution

This Smart Quiz System is arguably the first one ever fully implemented for online classes use. Throughout the research, there haven't been many systems that fit the same requirement as this project did, which consists of a system that integrates website, Python and recognition algorithms for educational use. It is sincerely believed that the system is innovative and could be popular in future trends. Most of the development and researching time goes to the main functionality of this system: the hand detection and recognition. Notably, the system is able to be run on regular or "low-spec" pc. The innovative idea of creating algorithms along with the quiz-based system for educational purposes is one of the best features seen in a while compared to other educational software or web-based systems. As the database exists, it is convenient for administrators to observe and modify accordingly, thus promoting high flexibility. Data is preserved and important credentials are further encrypted for data protection.

Conclusion

As a whole, the project has come out to be a big success. It is convinced that the majority if not all of the objectives are fully achieved, and maximum system proficiency is promised. As per system summary, the system consists of an account module, quiz room module, question module, answering module, hand recognition module and reporting module. The description of module fits the name accordingly. In addition, the database is included in the system development, thus the data is preserved and visible.Most of the development and researching time goes to the main functionality of this system: the hand detection and recognition. Throughout multiple variations of coding the algorithm, enhancements have been made to improve the webcam and the functionality. Notable improvements are the error handling and flexibility of the recognition system allowing students to reset their answer and pick again. This may avoid students from accidentally showing a wrong gesture or answer that ended up losing points. Also, the accuracy and sensitivity of the system is customized to maintain a high performance throughout variations of algorithm implementation directly from the code itself. The system is also tested to be able to run smoothly even on a lower spec PC as long as the user has a webcam on with at least 30fps, which is the bare minimum specification of a webcam on the market right now. Thus, this is a clear advantage that students do not need to own a decent pc to be able to run this application. Testers and future users or programmers can directly observe the modification available in the system. Each module is thoroughly tested and validated, where the system is promised to have high usability and error tolerance. Coding wise, the source code is available on GitHub and is briefly commented.