A DEVELOPMENT OF CLASS PARTICIPATION RECORDING SYSTEM USING FACE DETECTION

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A PROJECT SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENT FOR THE DEGREE OF

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ใบรับรองปริญญานิพนธ์ ประจำปีการศึกษา 2557

คณะเทคโนโลยีสารสนเทศ

สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

เรื่อง การพัฒนาระบบบันทึกเวลาเรียนด้วยการตรวจจับใบหน้า

A DEVELOPMENT OF CLASS PARTICIPATION RECORDING SYSTEM USING FACE DETECTION

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บทคัดย่อ

ปัจจุบัน การศึกษาในห้องเรียนจัดว่าเป็นสิ่งที่ทั้งครูและนักเรียนควรให้ความสำคัญเป็นอย่างยิ่ง เนื่องจากห้องเรียนคือสภาพแวดล้อมหนึ่งที่เอื้อต่อการเรียนรู้ โดยที่ครูและนักเรียนสามารถมีปฏิสัมพันธ์โต้ตอบกันได้อย่างเต็มที่ที่สุด และการเข้าเรียนก็เป็นประโยชน์สูงสุดกับตัวนักเรียนเอง ดังนั้นการบันทึกเวลาเรียนจึงกลายเป็นส่วนที่เข้ามามีบทบาทในการช่วยจูงใจให้นักเรียนมาเข้าชั้นเรียนมากขึ้น โดยปกติแล้ว การบันทึกเวลาเรียนจะใช้การขานชื่อ ซึ่งวิธีการนี้จะใช้เวลานานในชั้นเรียนที่มีนักเรียนจำนวนมาก และอาจขาดความแม่นยำ ไม่ว่าจะเป็นไม่ได้ยินเสียงตอบรับ มองไม่เห็นนักเรียนยกมือ และมีการยกมือแทนเพื่อน ดังนั้นเราจึงแก้ปัญหานี้ด้วยการนำการตรวจจับและรู้จำใบหน้ามาประยุกต์ใช้ในการทำระบบบันทึกเวลาเรียน จากการทดสอบระบบพบว่าระบบนี้ช่วยให้การบันทึกเวลาเข้าเรียนมีประสิทธิภาพ และแม่นยำมากขึ้น อีกทั้งยังเป็นเงื่อนไขที่สามารถจูงใจให้นักเรียนมาเข้าเรียนได้เป็นอย่างดี โดยระบบที่เราพัฒนานั้นสามารถเอาไปติดตั้งในห้องเรียนได้ง่าย เพียงติดตั้งอุปกรณ์เสริมซึ่งก็คือ Web Camera ที่สามารถต่อกับคอมพิวเตอร์ได้ง่ายเพียงอย่างเดียวเท่านั้น จึงมีความสะดวกสบายแก่ผู้ที่ต้องการนำระบบไปใช้งานได้อย่างดี

Project Title	A Development of Class Participation Recording System Using Face Detection	
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ABSTRACT

Studying in the classroom should receive more attention because the classroom is a suitable environment for study which both student and teacher can immediately communicate and have an interaction with each other. Besides, students can get the most benefit for themselves when attend and participate in the classroom. Roll-call is a method that mostly used for the class participation recording. The time that used for this method depends on the number of students; the more number of students, the more time to spend. To find the way that improves the class participation recording process, we decided to use the face detection and face recognition to be the part of this development. In the result of this development, the system can improve the class participation recording accuracy to be more precise and persuaded the students to attend the class as well. Moreover, the system can install to the classroom easily because it is developed in form of the web application and need only web camera for the additional device.

Acknowledgement

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Phichaya Jaturawat

Pasinee Pongmanawut

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Chapter 1

INTRODUCTION

In this chapter we present the background of this project, the objectives, the scope of operations, and expected outcomes.

1.1 Background

Nowadays, many organizations are seriously concerned about the security arrangement to protect the personal data and confidential information. The conventional methods are using ID card or username and password to authenticate person, but these methods cannot use flawlessly because ID card or username and password might be lost or stolen. Thus, the biological information becomes a new alternative to applied in authentication system. The physiological and behavioral characteristics of person are mainly use for this purpose. Fingerprints, iris, hands, veins, etc. are human physiological characteristics that widely used to authenticate person, but they need the special hardware for the usage.

However, a human face is the physiological characteristic that easy to use for personal authentication because face is easier to be seen than fingerprint and iris, and the only necessary hardware is a camera. For this reason, we have an idea to developing the student class participation recording system using face detection and recognition. In the traditional method, every schools or university take a roll call to determine the student presents or absents in class. It is a good alternative if we have a small number of students. In reality, some classroom especially in the university have a lot of students, a roll call will take at least 15-20 minutes of the time that must be the learning hours. It seems like this way did not take too long but it would be better for both students and teachers if we can use this time for another activities such as questions, group discussions, share ideas, or reviewing previous lessons, instead of roll call. Although, we solved these problems by use ID card scanning or student's signature. It is still having flaws and also vulnerable in term of accuracy because the students might be scanned ID cars or signed for their friends. Thus, our system has the main purposes to increase the accuracy of student class participation recording and to save more time that use for this activity. For these reasons, the face detection and recognition system becomes a good alternative because of the uniqueness and arduous characteristics, many problems about student class participation recording might be solved.

1.2 Objectives

1. To study methods for develop a class participation development by applied face detection and face recognition techniques in order to find a better way of recording the student's class participation.
2. To design the system in order to implement the system efficiently.
3. To develop the system for class participation recording and build the individual faces database for capability of face detection and face recognition algorithms.

1.3 Scope of Operations

1. Study how to develop the student's class participation system in form of a web application.
2. Study the face detection techniques to detect faces from photos.
3. Design the system that has a capability to record the class participation, which supports for not over 50 students in a class.
4. Develop the system in form of a web application.
5. Study how to develop and combine the face recognition to the system.
6. Design the system and choose algorithm for face recognition.
7. Develop and combine face recognition module to the system.
8. Students can record timestamp, capture image, and upload weekly assignment.
9. Students can view their class attendance history.
10. Administrator can edit, add, delete, subject and its information (such as time, date, etc.) and manages the image data in the database.
11. The system must be executed in laboratory classroom that have enough computers with web-camera and collect example pictures from students for one semester (15 times).

1.4 Procedures and operations

1. Define the scope of work.
    1.1 Experiments with students in the room of 50 students.
    1.2 Using a computer with web-camera.
    1.3 Using a web-camera to record video for collecting an additional example image.

2. Study face detection and face recognition algorithm.
3. Collect data and study the programming language that must be used to develop web applications.
4. Study the database design and the server that use to collect data and processing.
5. Develop the system within the scope of work.
6. Test, improve, and evaluate the system.

1.5 Expected Outcome

1. To develop the student's class participation recording system in effectively way.
2. The student attendance checking activity will be more convenience and more precise.
3. Prevent the students from record the participation for their friends.
4. This system will help students to have more responsibility to be in class on time.
5. To make a better way to persuade the students to participate in class.

Chapter 2

BACKGROUND

In this chapter we present the face detection and recognition theories with the literature review, WebRTC technology, and our implementation tools such as HTML5, CSS, JavaScript, Python, PHP, SQL server, and related works.

2.1 Face Detection

Face detection is a computer technology that recently gains more popularity and widely used. It was used for determining the location, size and number of the human faces in digital images and ignores anything else that is not human face such an environment. The research has shown that the range of visual properties (something that can be seen by human eyes), such as color and object orientation, are affected the detection ability [1]

Nowadays, we often see the face detection software was generally installed in many digital cameras. It would draw a colored square over the faces of the people in the picture. This method helps to improve the light at the face is proper and to ensure that are able to focus on a face clearly enough. The software performs well for face detection without need of a high performance processor at all. The reason is the detection algorithm that was selected for using in the camera was extremely efficient. Paul Viola and Michael Jones invented a new framework for object detection and refined it for face detection. This algorithm is now well-known as a Viola-Jones algorithm [2]. Viola and Jones are experimented with the features to find out what is the best way of using these features for face or non-face classification. After their experimentation, they decided to use an artificial intelligence (AI) training system that called AdaBoost to build a classifier. This technique is similar to the neural networks, but they redesigned it to combine weak classifier into a stronger one. A weight is assigned into each feature within a classifier, it using to define the accuracy of the classifier. Low weighting means it is a weak feature, and high weighting is means it is a stronger. By an increasing weight of the features that are testing positive for the particular image and if the sum of weights is over a threshold then that image is considered to be a face. AdaBoost is a common way to obtain an entirely of weak classifiers which the accuracy is slightly better than random guessing. A strong classifier is a set of weak classifier that is linear combination weight of weak classifiers as follows:

$$H(x) = \begin{cases} 1, & \text{if } \sum_{t=1}^{T} \alpha_t h_t(x) \geq \delta \\ 0, & \text{otherwise} \end{cases} \quad (2.1)$$

$$h(x) = \begin{cases} 1, & \text{if } \pm f(x) < \pm\theta \\ 0, & \text{otherwise} \end{cases} \quad (2.2)$$

Where x is an input image, $h_t(x)$ is a weak classifier, α_t is a corresponding weight, and δ represents a threshold value. Weak classifiers are selected from the huge number of rectangle features. Each weak classifier $h_t(x)$ consists of a rectangle feature $f(x)$, a threshold θ, and a polarity $\pm$ indicating the direction of the inequality [3].

An example of Adaboost learning with rectangle features.

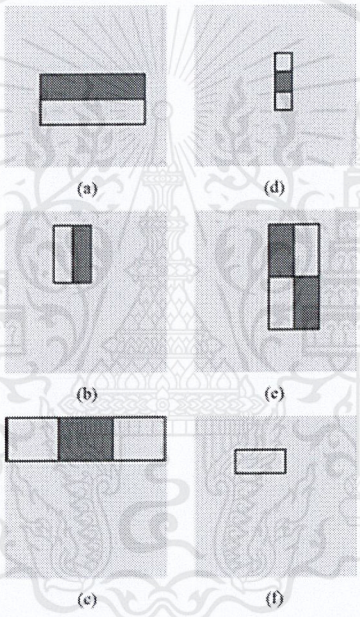

Figure 2.1 Six rectangle feature.

As it happens, when combined two features and properly tuned by AdaBoost into a single classifier, it would passing through 100 percent of the faces with a 40 percent false positive rate (60 per cent of the non-faces would be rejected by this classifier [2].

The effective object detection method that proposed by Paul Viola and Michael Jones is object detection using Haar feature-based cascade classifier. They have adjusted the idea of using Harr wavelet and developed a Harr-like feature [4]. Considers by an adjacent the rectangular regions with a specific location will be displayed in the detection window, and sums up the pixel intensities from each regions and calculate sums for the conclusion result. All that mentioned

above was responsibly by Harr-like features. For the result of calculating between sums, the difference between sums will be classified and subsection categorize of an image [5]. Consequently, we decided to use Haar-Like features as a face detection algorithm because it has a reliable accuracy rate and easy to develop by using a classifier in OpenCV.

2.2 Face Recognition

Face recognition is a popular computer vision technology that can be applied in various ways. It is a technique that was used for identifying person from the digital image or the video frame, by comparing selected facial features in the image and facial features in the image database. Accordingly, face recognition is more convenient method, for using in the security or other identification system. Face recognition has distinct advantages than the other biological characteristics recognition because it can capture the image in specific area and identify person without interaction required.

Face recognition have two main approaches that are geometric and photometric. The geometric face recognition is uses the distinguished facial features to identify person, and the photometric face recognition is uses a statistical approach that distills an image into values and compares the values with templates to eliminate variances [6].

Eigenfaces and Fisherfaces use a holistic approach to face recognition. Data vector images in the form of high-dimensional are not as good as a subset of lower-dimensional that has already been specified and might have useful information [7].

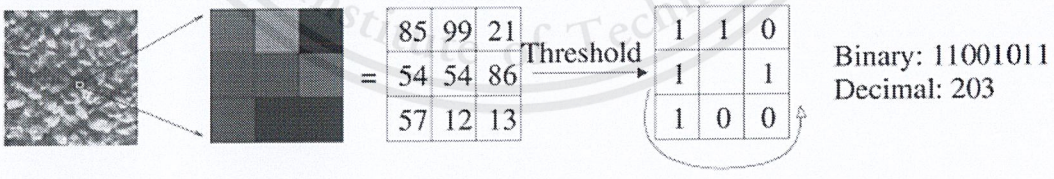

Figure 2.2 LBP operators.

LBP is one of the good methods that originally using for texture description. It is a highly discriminative algorithm and has the advantage of a resistance for variant light in image with efficient computational. This operator assigns a label of every pixel in image by threshold the 3 x 3 neighborhood as showed in Figure 2.2 (later it was improve for the difference size) with the center pixel value and considers the result as a binary number [39]. For using as a face

classification, the occurrences of the LBP codes in an image are collected into a histogram (or called Local Binary Pattern Histograms: LBPH). The classification was performed by computes the simple histogram similarities. However, when considering a similarity of facial image representation results with a loss of spatial information and therefore it should be codify while retaining the locations. The way that efficiently to achieve this purpose is using LBP texture descriptors to build several local descriptions of human face in images and combine them into a global description [38]. Even the local descriptions gained the interesting lately, it is understandable that having the limitations of the holistic representations but these local binary features based methods are more robust against the variations of light changing or human posture than the holistic methods such as Eigenfaces.

Local Binary Patterns Histogram (LBPH) is a good alternative to applied in our class participation recording system because this method available in OpenCV as a Python library, thus it easy to implement and adaptation. We will use it as a recognition module to recognize student's face.

2.3 Class participation

To engage the students to attend in the classroom is an importance part of teaching methodology. Participation in classroom help students gets support and different ideas from their friends. It is an environment that students can apply their knowledge to improve and enhance their association and communication skills. Class participation will give teacher a chance to know the understanding level of students and help teachers get the ideas to manage their teaching, the concept and contents, and adjust the way to persuade them to get along with teaching properly.

In our experience, students often have a passive behavior while studying in class. They have no interest in topic and have no responsiveness to teacher. These reactions arise from students who have low self-esteem, anxiety, afraid to express, afraid to asking or answer, lack of motivation, and lack of confidence. There are the reasons why students are being non-participation in the classroom.

To solve the lack of participation, we need to linked motivation and participation to student's achievement. Students will get points for class participating and for their assignment or homework. Students who gave their responsibility and gave importance to learning are more likely to achieve at higher levels and accomplish their goal.

2.4 Tools

2.4.1 HTML

HTML5 is the latest standard for HTML. It was developed for used as a markup language and specially designed to deliver rich web content without the need of additional plugins, so it helpful for using graphics and multimedia elements. HTML5 also added a several features and new API's that allow developers to use it easier for web applications development. Moreover, HTML5 is a cross platform language that designed to work on many types of hardware such as PCs, Tablets, Phones, TVs, etc. It is made up of a family of technologies [8].

HTML5 markup has been expanded to include some new features, and some improvements with the HTML tags. There are a lot of additions to CSS with CSS3 that gave more ability to design the web pages. The style in CSS3, include many common pattern that are usually using across the web (like text area and the borders that have a rounded corner). And there is an enhancement for JavaScript with an available whole new set of JavaScript APIs. [9]

2.4.2 JavaScript

JavaScript is a useful programming language that popular for using in web application to allow client side scripting and interact with web user. JavaScript can manipulate the DOM to change HTML contents or elements. While web browser is loading the webpage, it also loading the JavaScript code, which typically begins executed just after the page loads. (JavaScript interacts with pages through the DOM (the Document Object Model which is the official W3C standard for accessing HTML elements)

JavaScript APIs (Application Programming Interfaces) gives an access to audio, video, 2D. It contains a bunch of technologies that need to use to build the application [10]. Furthermore, JavaScript can be used in non-web based environments such as PDF documents and desktop widgets.

2.4.3 CSS

CSS stands for Cascading Style Sheets. CSS's Styles is use to determine the way to display HTML elements. The Style sheet has ability to placing outside HTML page, it can save a lot of work, they are stored in CSS files and the problem in HTML can solve by Styles. Tags that contain in HTML is not for formatting a document, it is intended to determine the content of a document. When tags and color attributes were added to HTML3.2 specification, it is a cause of problem as if web developers develop a large web sites, fonts, color information, and attributes

will be added to every single page so it became a long and heavily process. World Wide Web Consortium (W3C) created CSS to solve the problem and all browsers supported CSS today. We also use CSS to help our web-application which has many pages to short the process too.

2.4.4 PHP

PHP is a server-side scripting language designed for web-development but also commonly used as a programming language. PHP is originally stood for Personal Home Page and now it is officially called PHP as a Hypertext Processor. PHP is a robust open source development language which has tools and has flexibility to achieve practically any task, it is embedded, which means that developers can use HTML and PHP by crossing between the PHP code and the interface is very diverse in that it allows everything from the page to communicate with each other. PHP5 has improved the existing functionality and added features that was commonly associated with large architectural of programming language. [11].

PHP has all features of programming languages, such as structural integrity, control variables and attributes, and efficient database access. For example, PHP can associate with other server-side because PHP is the server-side technology. The person who viewing the web page does not have to install an additional program or download additional plug-ins to the browser to make PHP can work, thus it will decrease the inconvenience about the incompatible. It is compatible with the most web browser. Even PHP is classified as a CGI (Common Gateway Interface), it is also a tool that allows web developers to create Web pages based on the information that have been gathered from third sources. Then communicating information via any provided by internet. The true benefit of PHP is the developer can use it with a little or without knowledge about the inside of working between CGI and the database that they are associated with. In less technical sense, this means that PHP gives an opportunity to change the page in website in the last minutes before the user will see when users open the web site via browser. [12].

2.4.5 Python

Python is an example of a high-level language that is the same kind of some other high-level languages such as C, C ++, Perl, Java, Ruby, and JavaScript.

Applications can be written in the form of high-level language and a low level language. The program that was written in form of high-level language has a small disadvantage of high-level language because it will need to be processed before running and this processed will take a

few times. There are a lot advantages of high-level language, first of all programming will be done in short times, the code will be shorter and easier to read and understand. The high-level programming language is also compatible with different kinds of computer without or may be need just a few changes and modifies before use. On the other hand, the low-level language can run on a single kind of computer only [13].

We chose python as a language to develop face detection and recognition module because has a variety of library that easy to apply in the class participation recording system.

2.4.6 OpenCV

OpenCV is an open source computer vision library that released under the BSD license. It can be used without cost for both academic and commercial purposes. Its contain C ++, C, Python, and Java interface and support for Windows, Linux, Mac OS, iOS and Android. OpenCV is designed for efficiently calculations with more than 2,500 optimized algorithms, which are very important to the user in real time and have the advantage of using multicore processors. Here we use python library from the OpenCV for implement face detection and face recognition module [14]. From the OpenCV Python Tutorials, Face Detection using Haar Cascades is uses in this development with this algorithm and the rectangle features. About face detection, OpenCV contains pre-trained classifiers for face features such as the eyes and facial expression like smile, etc. OpenCV provided many face recognition algorithms as a face recognizer function that are Eigenfaces, Fisherfaces, and LBPH with python library, personal identification and recognition development would be easier.

2.5 WebRTC

WebRTC enables web browsers with Real-Time Communications (RTC) capabilities via simple JavaScript APIs [15]. It is an upcoming standard which has the objective to able the real time communication among web browser in peer-to-peer architecture.

The IETF RTCWeb, W3C, and WebRTC are working groups that work together to determine both APIs and basis communication protocol for setting up and handling a reliable communication channel that passing between pairs of web browsers [16]. The overall WebRTC architecture was showed in Figure 2.3.

The WebRTC architecture [17] involves at least three parties; one application provider and two peers. WebRTC helps the media and data flow directly between browsers without any intervening servers. For this ability, the web applications (client-side) that typically implement in

combination of HTML and JavaScript can interact with the local context (web browsers or mobile applications) through the WebRTC API. This API provides a set of function, such as a connection management, encoding/decoding capabilities, media control, firewall, etc., that implement in JavaScript too. WebRTC API allowed the browsers and the scripting language to interact with media devices (microphones, web cameras, and speakers), processing devices, and transmission functions.

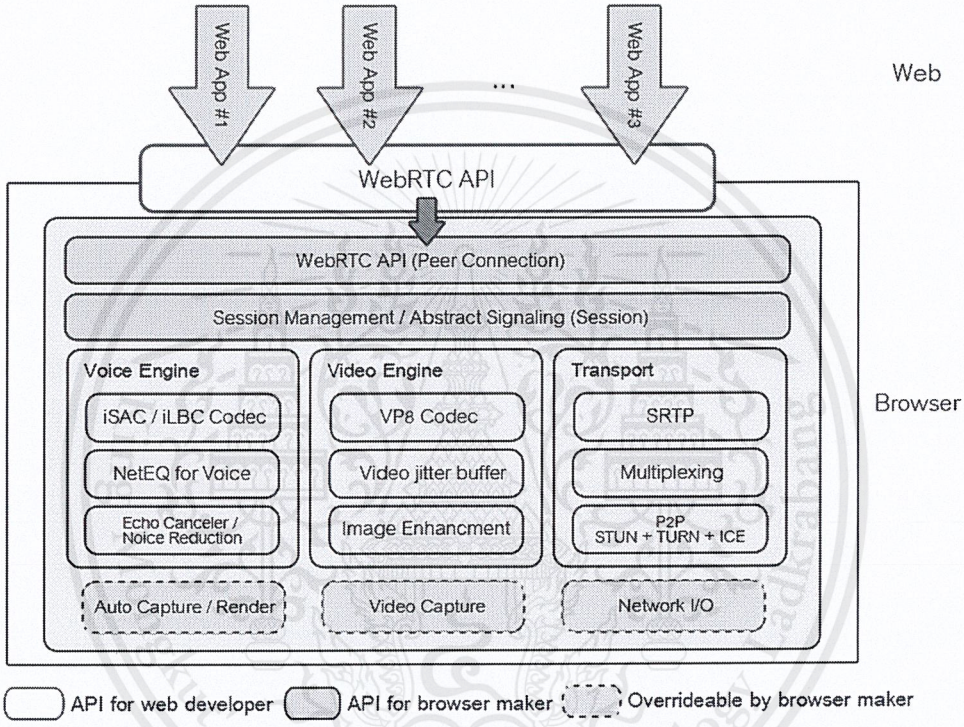

Figure 2.3 WebRTC Overall Architectures

The peer-to-peer nature of WebRTC means that the optimal performance is extractedfrom the available network which increases the chances of a more positive e-learning experience [18]. Here, WebRTC is an important technology with a procedure to collect pictures and build an image database. While students check in their participation in class by taking their pictures and upload it to server, this also helps us to make an image database.

There are many advantages of WebRTC for web application development [19, 20], first, it is free open source API that already existed in most of all available browsers. Second is platform independence, any browsers that support WebRTC with any operating systems can create a real-time voice or video connection to another WebRTC device or to a WebRTC media

server. Third, WebRTC always on the data encryption, the Secure RTP protocol (SRTP) as depicted in Figure 2.4 has been used for encryption and authentication of both voice and video. The last important advantage of WebRTC is it able to working without the need of installing additional software or plug-ins.

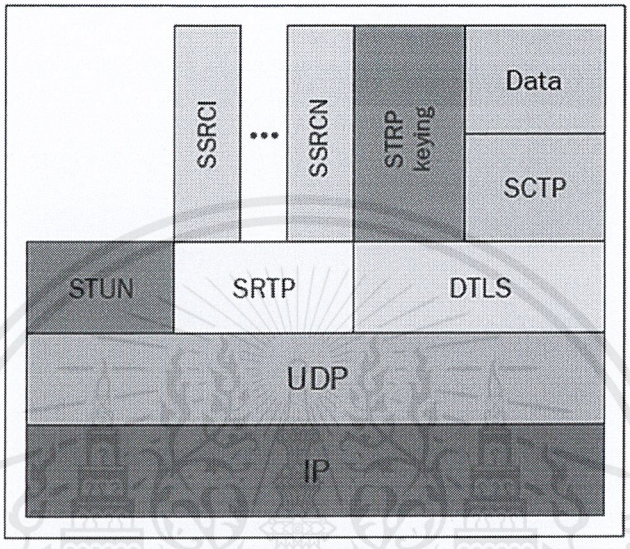

Figure 2.4 The WebRTC protocol stack.

For these advantages, we purposed the way that convenient to collect the user's face image using the web application with WebRTC technology. It can help to collect the user's face image from anywhere. So, the construction of user's face database would be easier.

2.6 Image Database

Image Database is the database that was created for reference face images. It contained with a lot of face images for every person who are system users. In the class participation recording system development, face images refer to student's picture that will be used to detect face, crop, and used as a training set for face recognition method. For good recognition rate, face images database that were used to be training set must be collect in different times, face position, and face expression. And it should have enough amounts of face images each person. The procedure of the way that uses for collecting pictures and creates database was mentioned in Chapter 3.

2.7 SQL Database

Databases are not only play an active role in many applications, but they also often play a critical role. If the data is not properly stored, it may become corrupted and the program will be unable to use. The database is like the foundation of a building: without a strong foundation, even the best crafted building will fail [22].

The basis of the MySQL database is a structured collection of records or data stored in computer systems in a manner that can be easily to restore data quickly. In MySQL, SQL stands for Structured Query Language. This SQL language is broadly based on English and has been used in other databases such as Oracle and Microsoft SQL Server; it is designed to be easy to requests from the database via a command such as:

```
SELECT title FROM publications WHERE author = 'Robin Nixon';
```

Figure 2.5 Example of SQL query command

There are three main ways to interact with MySQL: by using the command line as depicted in Figure 2.5 via the web interface, phpMyAdmin and a PHP programming language.

Designing database properly before creating is so important, we would not have to go back and change by extracting some tables to include others and moving columns about to achieve a reasonable relationship so that MySQL can be easy to use [23]. By using a program such as phpMyAdmin, MySQL would be much quicker and easier to use to access and manage tables. The functions within MySQL would be significantly reduce the time required for the implementation of complex commands.

We use database to store data such as student info, assignment, study table, activity log, section time, homework upload, and homework date. For student's homework and assignment, we collect a name and file type of their files to database but the original file which is laying on the server in the student ID's folder. For the image data, we collect from student's participation in class when they take their pictures. This activity will record the log on table named "activity log" in the database and the picture will sends to the server by system and stored in student's folder, which is lying on the server too.

As a result of trying out our system with 150 students and collecting their pictures once a week for 15 times, we are also made an image database to develop the detection process in the next procedure.

2.8 Related Works

2.8.1 Face Detection

Face detection is to find that picture has a face or not. If there are any faces in the picture, it will determine the position of the image and the size of the image. To track the face, determined by the location of the target face and position of the previous location and previous information will allows the continuous image frames [24], [25].

Lang and Gu [26] studied an algorithm of face detection based on Adaboost which is automatically generates cascade classifier, named AM-CC. Adaboost's basic philosophy is weight voting, by reducing weight of samples when they're correctly and increase when misclassification. The feature subspace method is mapped face image to one feature space and distinguishes face or non-face, used PCA algorithm. AM-CC (using traditional Adaboost) has three major parts. First, extract face's rectangle feature. Second, weak classifier and combined several weak classifier into strong one. Third, cascade multiple strong classifier. They conducted experimental to comparison used three different database with three algorithms. The result is AM-CC has better detection rate and detection average time than the two other methods. So it can be applied to real-time face detection system.

Lee et al [27] proposed efficient methods for reducing false detection rate in face detection. This method has 4 steps. First step is the real image acquisition and processing, by reducing the light variation. Second, face candidate used Haar-like features with Adaboost algorithm. This method can find face and reducing non-face from face candidate. Third, prepare skin color by adjustment of transfer matrix with constraints and make to genetic algorithm variables. Then determined face similarity and scoring. Finally, determined it is face or not. The results showed it can reduce false detection rate in face detection is finding optimal color space for representation for face detection. This method overcomes the problem of false detection and can accurate face detection.

Zakaria and Suandi [28] presented the combination of Neural networks and AdaBoost methods for face detection in static images. This method uses Haar-like features to draw a picture of the face. AdaBoost algorithm is used to speed up the face detection. It also produces high false

positives. The neural network used for the final state to check and verify the face in the image, it able to reduce the false-positive. In the experiment on four different databases, the result reveals that the proposed method achieves lower detection rate than the original cascade Adaboost method. But it can achieve lower false-positive too.

Hamdy, Elmahdy, and Elsabrouty proposed a new idea for face detection for Drowsy Driver Assistant System. In application for detection and recognition, the human face is regarded as one of the most popular styles in the pattern recognition. The detection is the key of this work because the main objective is the system that can detect the position of the driver's face and alerts them when their eyes start to close. They succeeded in using Skin-Tone extraction techniques as an image pre-processing step and then apply PCA rules for face detection, but the output will be in their further work [29].

Luo, Tsai, and Liao modified and improved the AdaBoost algorithm for rapidly face tracking in the video sequence. This scheme performs well for solve the problems of initialization and lost tracking. They presented a method to achieve the face detection and the tracking of human faces in real-time applications such as robotic systems. They combine face detection based on Adaboost and the object tracking method using Kalman filter. This method is successful to implement in the robot system by used the combination of the Local AdaBoost Face Detection (LAFD) and Kalman filter for face tracking, it has shorter execution time than using the Global AdaBoost Face Detection (GAFD) because LAFD did not scan the whole scene. The Kalman face tracking can track the face up to the last frame and produce the region of interest (ROI). Their conclusion by using ROI, the LAFD will be speeded up [30].

2.8.2 Face Recognition

Hermosilla et al study the comparative about face-recognition methods for Human-robot Interaction (HRI) applications using long wave infrared images. The purpose of their work was to be fulfilled the comparative study in the past and make it to be more complete, By comparative studies in the past by propose a comparison of face recognition using thermal imaging (long wave infrared, 8-12 μm). Using these thermal images may overcome limitations such as reliance on condition of illumination and facial expression. In conclusions, the analyzed methods have been selected on the basis of their suitability for HRI and the performance in their previous comparative studies. The comparative of their study includes aspects such as variable illumination, facial expression variations, facial movement observation such as talking, and

glasses. The result from their study about comparing the face recognition using thermal image was intended to be the guide for the developers of face recognition systems using HRI [31].

Chin et al, present a framework for face recognition from video and they are operated face detection algorithm that are able to achieve high accuracy and detection rates of face detection in their video input, but not burdening the tracking face form the face recognition. In order to improve their face representation and perform recognition online, using SVD or PCA to increase the improvement of an updating procedure. They improved and differentiated the linear subspaces to accomplish a robust recognition from video and also a framework for online computing. Their results demonstrate the effectiveness of their method. Base on their framework, they performs face recognition from video with the ability to conduct online training and classification improved by which they are able to complete online training and classification while still resistant to changing of posture. [32].

Turk and Pentland [33] presented a principal component analysis (PCA) method of face recognition have been s- dimensional vector faces in the training set of each PCA M may be a T-dimensional vector space based on compatible with the direction of maximum variance in the original image. This new space will be reduced by regular dimension (TS) and face defined by subspace basis vectors of a face. To find a set of weights, all images of well-known faces are performing onto the face in the area of image because the weights express the contribution of each vector. To identify unknown images, the image projected onto the surface to find weight as well as the way to find set of weights from a well-known face images. By comparison, a set of weights for the unknown faces with the known faces of the weight of both type of faces can be identified. If the image is a vector of random variables are defined as PCA eigenvectors of the diffusion matrix ST [34].

Turk and Pentland described an approach to the detection and identification of human face in near-real-time system using Eigenfaces. This approach has advantages in its speed, simplicity, learning capacity, and relative insensitivity to small or gradual change in face image. For the calculating eigenfaces, the main idea of the PCA is to find the vectors which best account for the distribution of face images. These vectors define the subspace of face images and they are a linear combination of the original face images, refer them to eigenfaces. The eigenfaces can be used to detect faces and classify the face images. In real-time recognition, they used motion blobs to decide if the motion caused by person moving and to determine head position, then sent the

image to face recognition module. The result of their recognition experiment, the light changing cause a few errors, while size changing made the dramatically drops of performance.

2.8.3 WebRTC

Elleuch [35] explore some existing conference models and analyze different media topologies that enable multi-party communication between participants within IP based networks. And introduced new multimedia conference models that comply with WebRTC based browsers technology. WebRTC API is inherently integrated on a lot of web Browsers and strongly coupled with HTML5 technology to enable signaling exchange between communication participants over the internet by using WebSocket technology. Even if WebRTC based browser can communicate directly within conference using the PeerConnection function,it is still necessary to use Web Server that support conference. They use abstract message protocol that used by WebRTC Browser to support both Voice (VoIP) and Video (MmoIP) communication services. So they can identify the difference component that should be integrated to support conference control/administration and distribution among participant in both VoIP and MmoIP services.

Chapter 3

SYSTEM ANALYSIS AND DESIGN

In this chapter we present our system analysis and design. We identified problems and analyzed the procedures that was included the proper methodology that we will use to implement the system.

3.1 State of the problem

At present, most of schools or universities were using a roll-call to check and record whether students are coming to class or not. The roll-call way will take 10 to 15 minutes or more. It's depends on the amount of the number of students in class; the more number of students, the more time to use. By calling every each of the student's name to verify and sums the total number of students that attended to class. The problems of this methodology were the time and the student themselves. The time refers to the time that should be used for teaching, exchanging question-answer, or exchange argument. The problem about the student themselves is they can record the class participation for their friends.

To solve this problem, it can be done by the RFID tags, but it still have a breach that the student can cheat such as checking name for their friends. With RFID tags, even if they are not the owner of a tag, the student can use any tags to verify and record the attendance. From this weakness, it will be hard to know that the real owner of a tag was coming for real. So the face detection was decided to use in this development of class participation recording system.

The important part before proceeding to the face detection is to create the image database. The image database is the database which contains the student picture. To collect the picture to create the image database, collect by letting the student take a picture of them using the web application that was developed to record class participation. And the pictures of the student will be sent to the server and stored in the database. This collection process is collected for 15 times, 1 time per week. So we got the picture with several of facial expression in different time.

Taking a picture of the student one by one will take too much time and it is hard to make an additional appointment for all students to come and captured more of the picture of them. Therefore, in the web application, WebRTC is the technology that help to solve the problem about collecting student's picture and make all students can take pictures in the same time.

Although letting the students take a picture of them can obviously show that they are actually attend in class, but we need to make the system more completed. After we found the appropriate way to create image database and successfully collect example images from students, the recognition system was developed to records the student class participation by take a picture without login for the user authentication. The system with the face recognition will detect, identify, and record the attendance by letting the student take a picture only and wait for the system to process and inform the result.

3.2 System analysis and hypothesis

As we mention in the first of introduction of this class participation system, the method that using in present is roll-coll. The advantage of roll-call is the students must come to classroom by themselves to answer their name and must be in class on time. The disadvantage is this method will take time as much as the numbers of students are present. Sometimes they will answer their friend's name and teacher would not know if he missed to see the students that own the name. And another reason is this method cannot persuade the students to come to class efficiently enough.

The system that we decided to develop uses the benefit and advantage from the old method, to make students come to class by themselves only. The part that we make an adjustment is to use a face-detection process to enhance and improve to accurately verifying students by the pictures of their faces.

To evaluate the system we decide to test with one subject in Information technology faculty. This class has 3 sections of students, 50 students per section and testing once a week for 15 times. To record class participation of student, we use WebRTC to help the system so it can run simultaneously. In term of possibility, it is possibility to make the students to check and record their participation because they will be persuade to do by the scores and the different that our system will make between students who come to class on time and who do not.

According to the information about important of class participation in that we mentioned the previously subtopic. The students, who have a responsibility, an attention to learning, and a greater expectation to be accomplishing their goal or to be successful, are more likely to achieve at higher levels.

3.3 System Requirement

System requirement is a requirement of the functionality that the system supposed to be. It can be divided into two categories; Functional requirement and Non-Functional requirement.

3.3.1 Functional Requirement

1) Class Participation System can authentication user login.
2) Class Participation System can verify and give students an authority to check in class.
3) Class Participation System can capture a student picture.
4) Class Participation System can upload student's picture.
5) Class Participation System can upload student's assignment.
6) Class Participation System can upload student's homework.
7) Class Participation System can display class participation record.
8) Class Participation System can display uploaded assignment record.
9) Class Participation System can display uploaded homework record.
10) Class Participation System can support the administrator to create or edit the student table.
11) Class Participation System can support the administrator to create or edit the homework due date.
12) User can log out from the system.
13) Recognition system can recognize the student's faces.
14) Recognition system can notify that student is successfully checked for their class participation.

3.3.2 Non-Functional Requirement

1) The system can run smoothly.
2) The system can operate stably and correctly.
3) Users can understand the symbolic and system features.
4) The system is a user friendly system, easy to use, simple, and understandable.
5) The system always has a data backup.
6) The system is attractive to use.

3.4 System design

The system design is to bring the system needs to be structured (called-blueprint) and create a system that can be actually worked. It is a step of the design features of the application or the properties of systems in order to be suitable for use before start to develop the system.

3.4.1 System architecture

From the previously problem, we designed the remote user's image collecting system to solve the problem and provide more convenience for collecting user's images. This system was developed in form of web application. It consists of two major parts that are client-side and server-side.

The client-side consists of two components that are camera and web browser. The camera is the first important thing for this system. In this case, web camera was recommended because it easy for connect to the computer. For the web browser, we use the API called WebRTC technology that in the most of now available browsers. The two main functions in WebRTC API that we used are getUserMedia( ) and toDataURL( ). The getUserMedia( ) function was used to request access to media devices (web camera) directly. We use toDataURL( ) function for convert the captured image into the base64 DataURL.

The main component on server-side is the MySQL database that use for contain the user information and the image database for storing the images that were collected from the system. We use base64_decode( ) function in PHP for decoding the DataURL into jpg image file. We have face detection module for image pre-processing and face recognition module for students identification.

From the Figure 3.1, the system works following these steps. First of all create direct web camera connection via getUserMedia( ) function, this function allows to connect the web camera without additional installation. When users capture their image from the web camera, the image would be converting into base64 DataURL and sending through HTTP protocol to the server. Then, the DataURL will be decoding into jpg image file on the server-side before tagged user ID and storing in the database separately for each person. Then, all of the original images would be passing through face detection process for image pre-processing and cut out the nonessential components in the image, leaving only students face. The face image is identified in face recognition process and recording class participation.

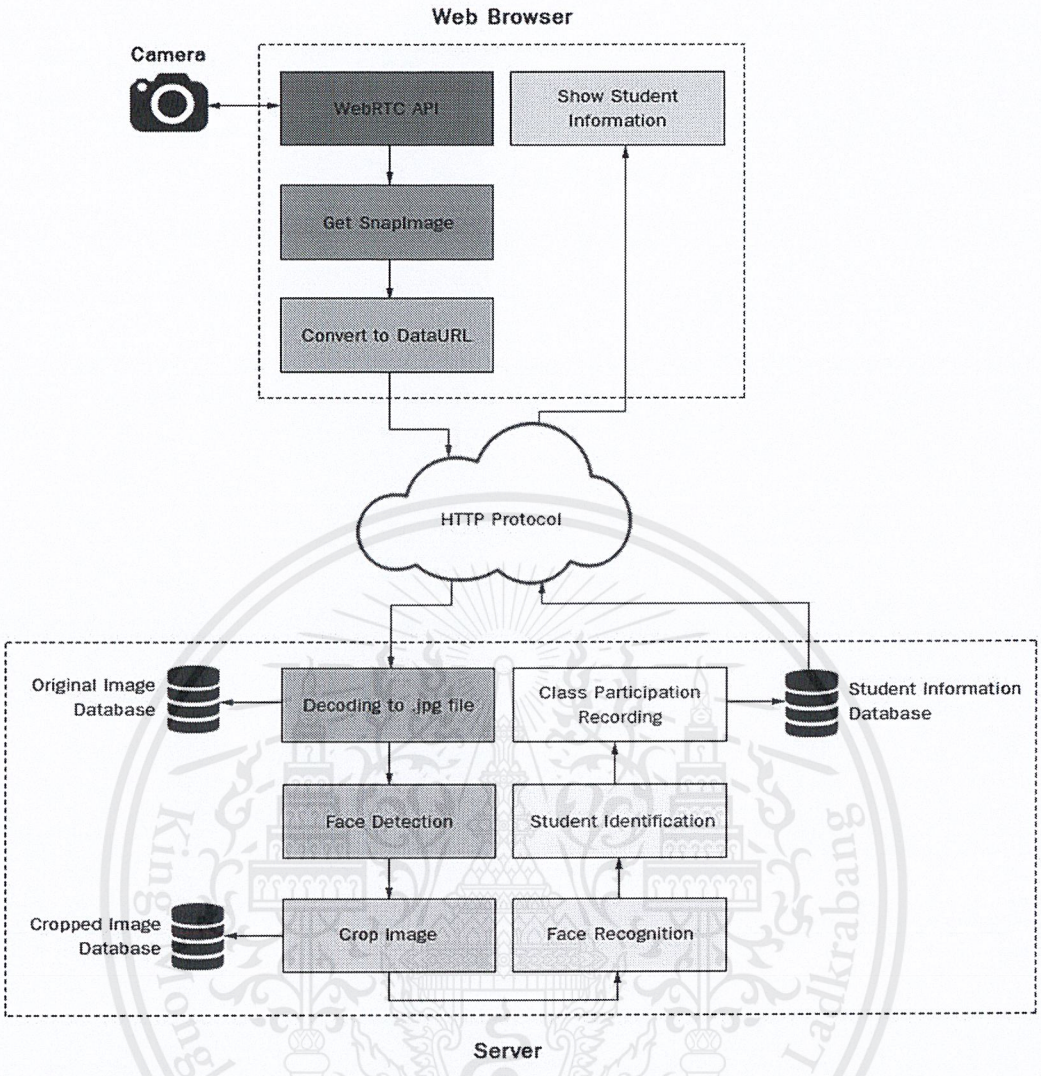

Figure 3.1 System Architecture

3.4.2 Use case diagram

Use case diagram is a diagram that shows about the operation of the system using by user. The user is defined as an Actor and the actors in this system are student and teacher. The main purpose of the use case diagram is to write the whole story of what the system can do. This use case diagram is created from the requirement which is mentioned in system requirement (at subsection 3.3).

3.4.3 Activity diagram

Activity diagrams present the work flows of activities within the system, which are Login, Take a Picture, Upload Picture, Upload Assignment, Upload Homework, View the Records, Create/Edit (Study Table or Homework Due Date).

3.4.3.1 Login

The system that we design, users does not have to register. The username and password will be generated by the administrator. So they can take the username and password to login to the system without register. Students must fill in the username and password form to login then click the Login Button to submit form. This user authentication login is to allow user to view their records on the web application which including class participation recording, assignment upload, and homework upload. The activity diagram for Login was shown in Figure A-1.

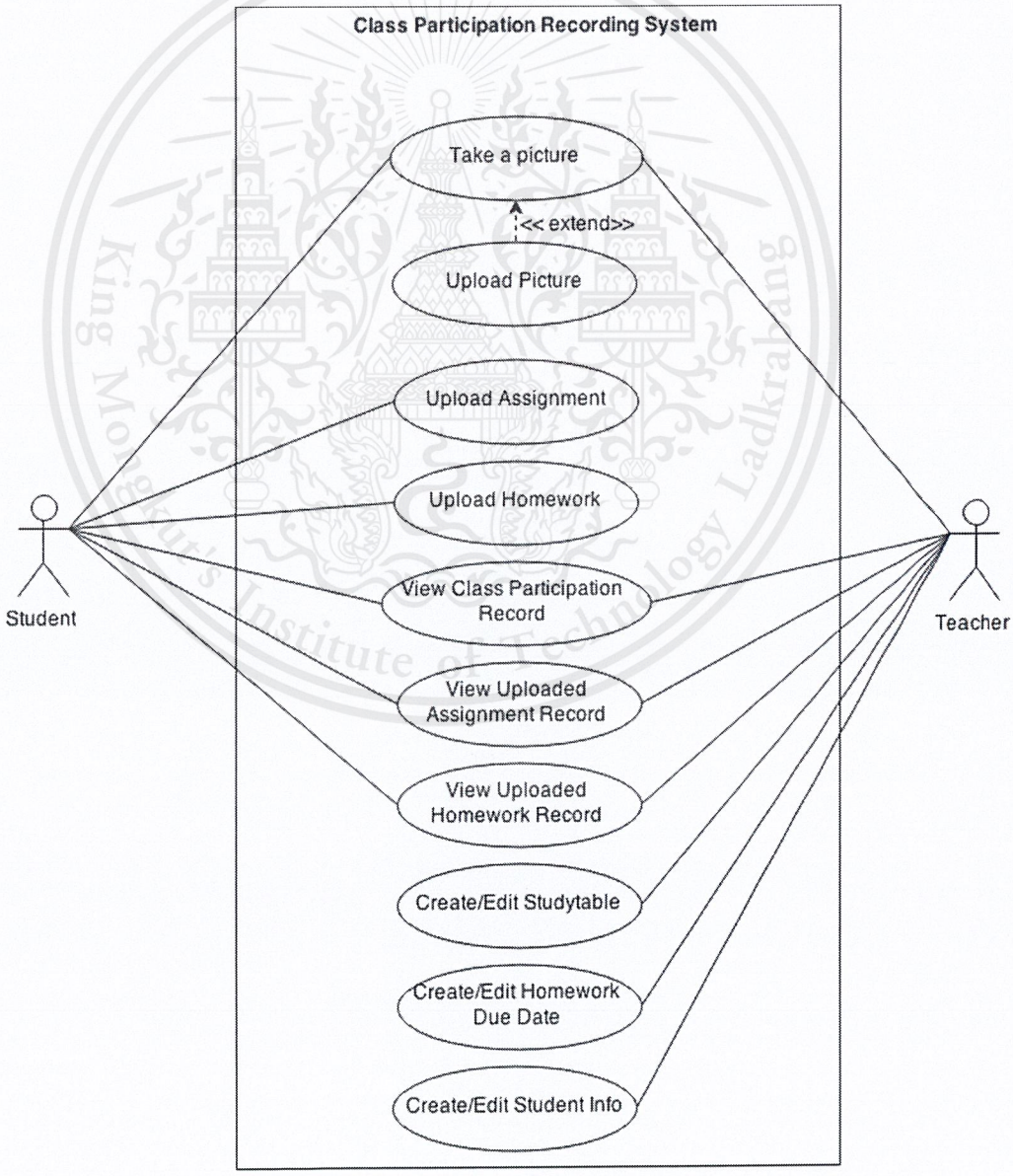

Figure 3.2 Use case diagrams

3.4.3.2 Take a picture

Students have to take a picture of themselves to record that they are actually attending to class by click the Allow button to allow the camera access and clicking the Capture Button to take a picture, but for this activity the student don't have to login to the system If the student does not satisfy with their picture, they can retake the pictures by click the New Button. The activity diagram for Take a picture was shown in Figure A-2.

3.4.3.3 Upload Picture

To finish the class participation record, after the students taking their picture they must upload it to the server from the system. They can retake the picture if they are not satisfied with the picture. The activity for Upload Picture was shown in Figure A-3.

3.4.3.4 Upload Assignment

To upload an assignment, students must login to the system. Then the system will check the time and date to grant an authority to upload their assignment. The activity diagram for Upload Assignment was shown in Figure A-4.

3.4.3.5 Upload Homework

To upload homework, students must login to the system. Then the system will check the time and date to grant an authority to upload their homework, as same as the way to upload their assignment. The activity diagram for Upload Homework was shown in Figure A-5.

3.4.3.6 View Records

The students can see all their record by this activity. Of course they must login to the system before they can choose to view the records. The activity diagram for View Records was show in Figure A-6.

3.4.3.7 Create/Edit (Study table, Homework Date, and Student Info.)

This activity is present for the administrator to manage, create and edit the study table, homework date, and student info. The activity diagram for Create/Edit as depicted in Figure A-7.

3.4.4 User interface design

We decided to design user interface to be simple, easy to understand, and easy to use. In our system that in form of web application, we place the function that user can choose to do on the left of web page. The component about student information, class participation record, and any record will be display on the right of web page. The result of our user interface design will be showing in the result in the next chapter.

3.4.5 Database design

3.4.5.1 Database Requirement

1) Contain student information; Name, Surname, Student ID, Username, Password, Section.
2) Contain student's works; Assignment, Homework.
3) Contain uploaded pictures and categorize by student ID to make an image database.

3.4.5.2 Entity Relational Diagram (ER Diagram)

There are eight tables in this database that was created for this system which contains with admin, student, studytable, section, homework, activity_log, assign_upload, and hw_upload as shown in figure 3.3.

3.4.5.3 Data dictionary

Data dictionary details describe in the Table 3.1.

Table 3.1 Data dictionary of all tables in the database with descriptions.

Table Name	Description
activity_log	This table is contains student class participation records.
assign_upload	This table is for storing the student's assignment.
homework	This table is contains a homework due date.
hw_upload	This table is for storing the student's homework.
section	This table is contains a student's subject sections.
student	This table is contains a student information.
studytable	This table is contains study table. (week, date)
admin	This table is contains the administrator information.

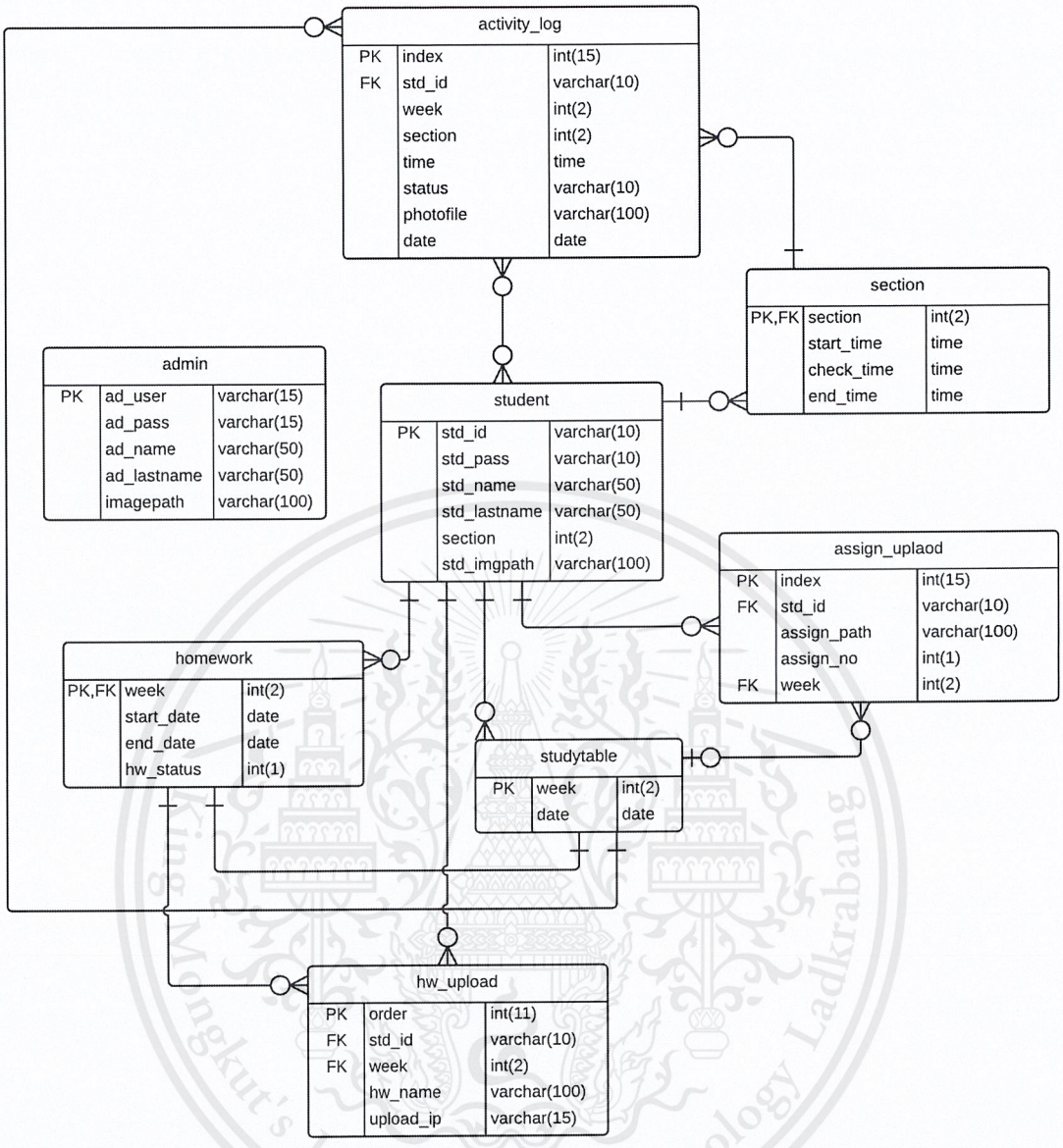

Figure 3.3 ER Diagram

3.5 Methodology

This section described about the methodology and the theories that we applied to the student class participation system for each module which comprises of the image database, face detection module, and face recognition module.

3.5.1 Image database

The study found that an image database creation can be done in several ways. There are advantages and constraints in each method as summarized in Table 3.2.

Table 3.2 A comparison of image collecting methods.

Methods	Advantages	Constraints
Let the users come and take a photo in specific time and place.	- Good for a small number of users. - Easy to control the factors that affect the photo quality such as light, face angle and expressions.	- Not flexible for increasing the users.
Using previously taken user's photos	- Good for a large number of users - Not required user comes in person	- Unable to control the quality of pictures. - Difficult clustering if it is not digital files. - Increasing the number of users is not easy.
Using image collecting system.	- Good for large number of users. - Not required user comes in person. - Clustering images of each user automatically. - Flexible for increasing the users.	- Difficult to control user's posture and some factors that affect the photo quality

Accordingly, the development of the web application that can be used for collecting images is the most challenge and has many advantages for applying in student class participation recording system. The system must be able to provide the convenience of images collecting and support for many students using in the same time, and it must be clustering and stored the images of each student separately to make it easier for using in the face recognition process.

We use WebRTC API that available in most recent browsers such as Google Chrome, Firefox, and Safari. It helps the image capture process easier because this API can connect to the input devices such a web camera directly without the additional plug-ins. When the image was captured, it would be converting into base64 DataURL and sending through HTTP protocol to the server. Then, the DataURL would be decoding into jpg image file on the server-side, tagged user ID, and storing in the database.

The images management process, firstly, we are clustering image by user ID and then stored it separately by the user in the folder. Not only the image clustering but this application also needs an appropriate method to indexed images file for efficient retrieval in the system that developed for online using. Hence, the XML (Extensible Markup Languages) for image indexing was decided to use. XML is considered as a standard for exchange the information over the internet, because of its data self-describing and flexibility for representing many kinds of information by using a tree structure [36]. Because of these reasons, XML is the proper method for image indexing in the web application as well. When the images were indexed, we have to choose the proper method to query the images for using in face detection and recognition process in next procedure. The method that we choose to implement is Path_MD. It was proposed by Musleh et al [21] to answers XML simple path query efficiently. When using this method, the XML data was stored as simple path using Dewey code numbering scheme. Each element of XML has its dimensional and index that would be computed based on its information. All paths are represented as a point in an N-dimensional space when N equals to the number of levels in XML tree. The multidimensional space would divide into a set of hyper rectangles, and their elements would be pointers to disk blocks. When querying, it significantly reduces hard disk access. That is the reason why this method can help to reduce execution time and increase accuracy for our system to query image paths.

3.5.2 Face detection module

Face detection module will be used in the image preprocessing phase before create a training data and prepare the input image before recognition process. This module allows us to extract human face that appeared in the image for convenience using in the next process.

The detection algorithm that we decided to use is Haar-Like feature proposed by Viola-jones. It represented to be the most successful technique for the object detection and provide an attractive tradeoff between accuracy and evaluation speed. Our face detection module will be developed by using Haar-Like cascade classifier that already trained in OpenCV which have many classifiers that suitable for using in our system. The classifier that we chose are 'haarcascade_frontalface_default.xml' for face detection and 'haarcascade_eye.xml' for the eye position detection in order to align all face in line. This method helps the face recognition more efficient.

3.5.3 Face recognition module

Face recognition module is an important module of this work because it will be used for identify student for recording their class participation.

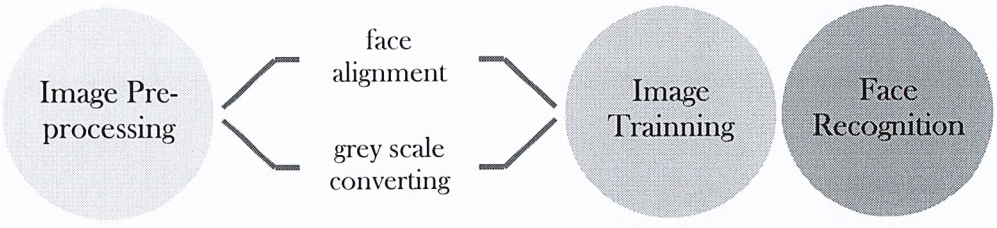

Figure 3.4 Face recognition module work flows.

As depicted in Fig.3.3 the process start from the image preprocessing steps, both of the image in database and the input image will be preprocessed in the same way. After human face was extracted by face detection module, all of the face will be aligned the eyes position and converted to grey scale image to increase the accuracy of the recognition. Then, the image in database will be used for model training to make the model able to identify student. We do a simple comparative of face recognition accuracy of three recognition algorithms (Eigenfaces, Fisherfaces, and LBPH) with three example datasets.

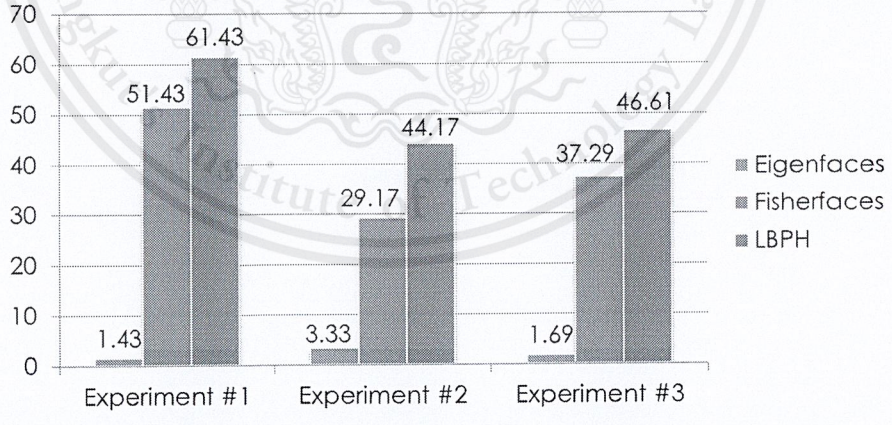

Figure 3.5 Results of comparative of face recognition accuracy.

The result shows in Figure 3.4, LBPH has a better precision than the other methods because LBPH can work well even the light position uncertainly. Thus, we decided to use Local Binary Patterns Histograms (LBPH) in OpenCV as our recognizer model.

Chapter 4

RESULTS AND DISCUSSION

In this chapter we present the way we implemented the student class participation recording and the result of the system implementation as we analysis and design in the previous chapter, and then discuss about problems that we found and the solutions.

4.1 Implementation

We implemented system using a combination of HTML and JavaScript for web application on client-side, and we use PHP with MySQL database for the system on the server-side. In our web application, WebRTC technology was mainly used in image capture process. The important function is getUserMedia, we use this function for request web camera access from user. In application testing, we use only web camera on desktop PCs as a tool to collect the student images in the laboratory without other optional devices. All of students need to register and get username and password for their account. Afterwards, they can log in to the system to view their class participation records, and the assignment and homework upload records by themselves.

As the research [37] showed the image quality depends on the connection speed, the class participation recording system was decided to perform on the high speed connection such as LAN or WiFi. Thus, the image size that we chose is VGA resolution (640*480 pixels) because it can send through the LAN or WiFi efficiently. Moreover, this image resolution contains enough face details and has a good quality. Even if the smaller size is better in less memory usage, less network bandwidth for file transfer, and less execution time, but it not has enough face details for use in face detection and recognition process. In spite of the bigger image must contain more details but it tradeoff for resources usage too. We will use this system in image collecting process to create an initiative student database before deployed the student class participation recording system. All collected images would be stored in the database separately for each student and automatically record the image taken time and date.

After collecting process, all of the images in database must be taken to preprocessing process that consists of the face detection, image alignment, and image grey scale converting. This process was implemented by using the Python script with libraries in OpenCV. Such as Haar cascade classifier for face and eye detection to extract and align student face, and

IMREAD_GRAYSCALE for converting the image into gray scale mode. Then all the images in the database will be used as a training set for face recognition module that was used for identify students. We use Python script with OpenCV library to create an LBPH face recognizer model, trained it, and kept the model in an XML file.

Every modules will be evaluated, the image database will be assessing the quality by evaluate the facial size in the images, the angle of face, the face apparent without anything cross over or eyes closing, the image sharpen, the image brightness and light position. The image assessing would be taken by manual looking and test in face detection module for facial extraction. However, this evaluation process is not enough precision for image quality assessing but it can used as a criteria to assess the overall system. Furthermore, the image collecting method would be evaluated by the number of users that can use the system efficiently and the number of the good obtained images. The face detection module would be evaluated by a detection rate when using this module in image preprocessing process before creating the image database but does not include the input image in face recognition module. To assess the face recognition module, we using recognition rate from the input images from the student in the classroom.

4.1.1 System component specifications

1) Computer's specification

- Operating system: Windows, Macintosh
- Browser: Google Chrome, Firefox, and Safari
- Monitor resolution: 1024x768 pixel or more

2) Web-camera's specification

Resolution at least 640x480 pixels

3) Other system's specification

- The system must have enough memory space.
- The system work efficiently.
- Desktop monitor that has a build in web-camera or installed web-camera device.
- System can support 50 students simultaneously.
- Students can upload their picture, assignment, homework to server via image collecting system.
- System can interact with user correctly.

4.2 Implementation results

This section describes our implementation results in image database creation, the face detection, and the face recognition module. Then, shows the screen capture of the system for student and administrator and describes the interface.

4.2.1 Image database creation and face detection result

The result of the conducted implementation we obtained the 148 user's face database that contains about 8-11 images each person. The images were collected in the same laboratory environment but not have many constraints. Thus, the images are very difference.

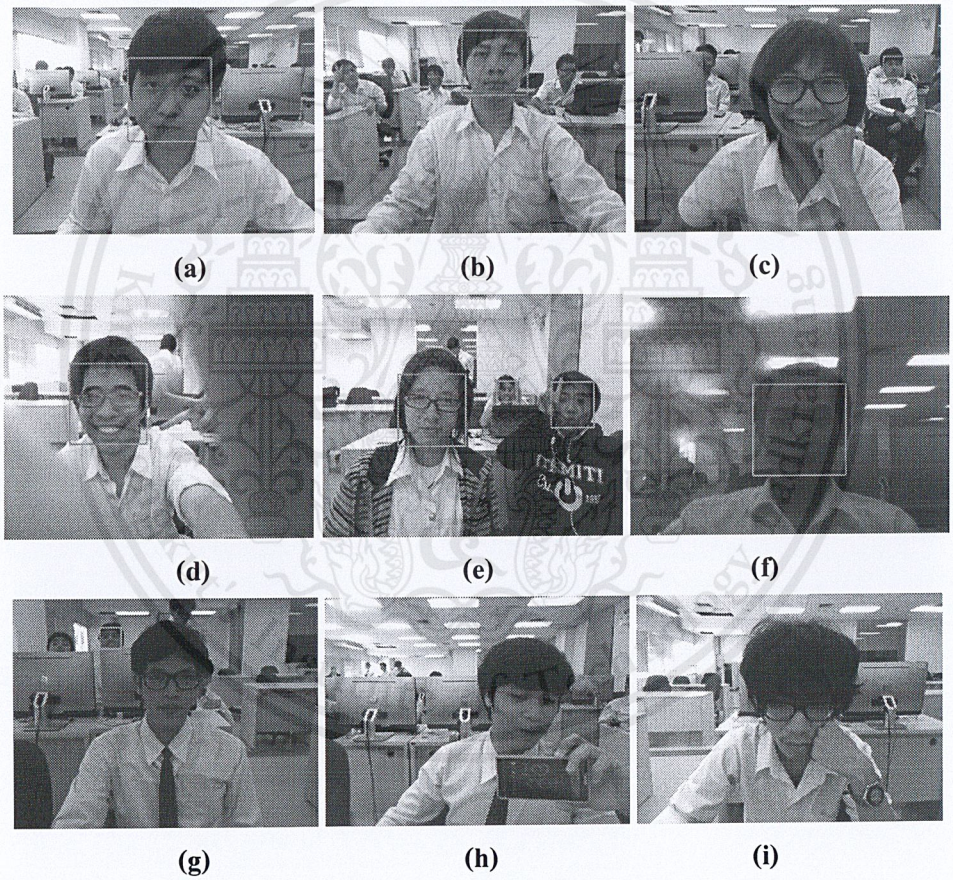

Figure 4.1 Example images of student in classroom

Mostly of the collected images have a good quality similar as depicted in Figure 4.1(a) and (b). It is a full straight face without obscured object and has enough brightness. But for Figure 4.1(b) the facial size is smaller than we expect from the VGA resolution. In Figure 4.1(c) and (d) were classified into fair quality because the face was obscured by glasses, user's hand, and

forelock but these images still have a good facial size and enough brightness, though the face in Figure 4.1(c) and (g) cannot detected. The Figure 4.1(b), (c) and (e) are the example of the images that not have only one person. For this case we assumed the person who has a biggest facial size is the owner of the images. Although the images were collected in the same room, but the light position was not the same. Figure 4.1(f) is the example of the image that blurry and not has enough brightness even if we can see the face in the image and detected but the quality is not sufficient for use in recognition process, this image was classified into a bad quality. The Figure 4.1(h) and (i) are the example of the images that have the inappropriate face angle and have the obscured objects on face, so they are cannot detected and classify to bad quality.

Table 4.1 Face detection rate using Haar-Like features

	Amount of images	**Percentages (%)**
Total collected images	1,628	100
Detected images	1,249	76.72
Unavailable images	379	23.28

Table 4.2 The result of using image collecting system in classroom.

Available images	**Amount of users**	**Percentages (%)**
8 – 11 images	105	70.95
4 – 7 images	30	20.27
0 – 3 images	13	8.78

The table 4.1 shows the face detection using Haar-Like features result, we using only the images in database as a test set and got 76.2% of total images that can detected student faces and available for using in the next procedure. Moreover, the image collecting process got 90.22% of users can use the system correctly and have the images as good as we required at least four images as depicted in Table 4.2. The interesting thing is 70.95% of users have an available image more than eight; the more images in database gave more precise in recognition. These numbers show that our system is efficient for collect image from many users via the internet at the same time.

4.2.2 Face recognition result

The table 4.3 shows the face recognition rate when using LBPH face recognizer in OpenCV. The experiments were conducted 11 times with difference student image sets. The average of the recognition rate is 48.18% with 61.43% as a maximum rate and 37.19% as a minimum rate. This method is not quite well for using in the student class participation recording system because it has a low accuracy.

Table 4.3 Face recognition rate using LBPH Face recognizer

Experiment #	Total images	Recognition rate	Percentages (%)
1	70	43	61.43
2	120	54	45
3	118	56	47.46
4	118	50	42.37
5	115	55	47.82
6	121	45	37.19
7	112	50	44.64
8	42	25	59.52
Average recognition rate (%)			48.18

4.2.3 Application

This is the screen capture of the class participation recording system that consist of two parts, student system and admin system. The student system is the system that we provided for student to display their information, class participation recording and upload assignments and homework.

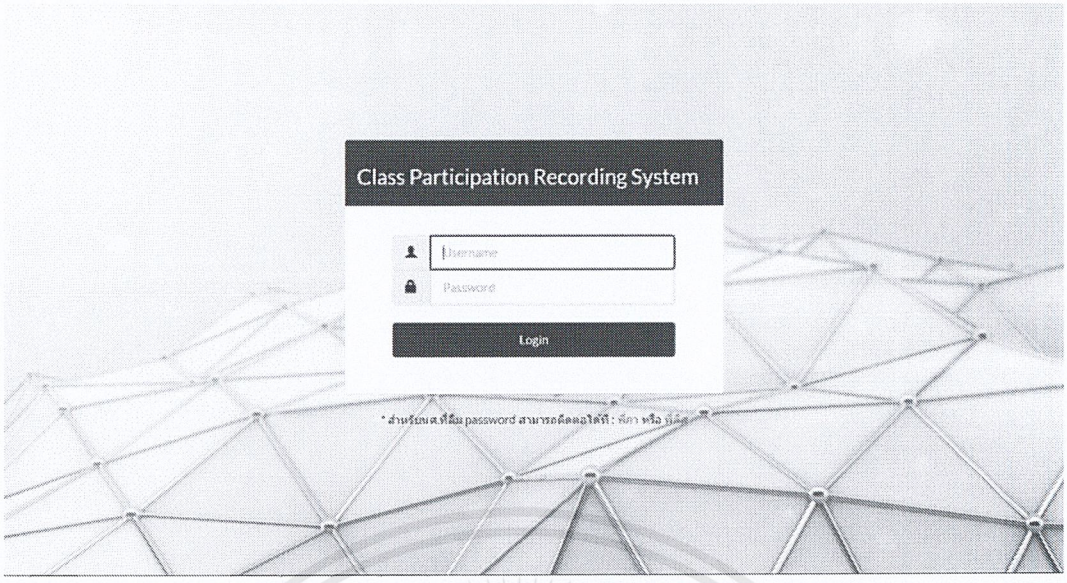

Figure 4.2 Main page

As shows in Figure 4.2 this is the page for the system login, the students must using their username and password that provided by the system admin to login.

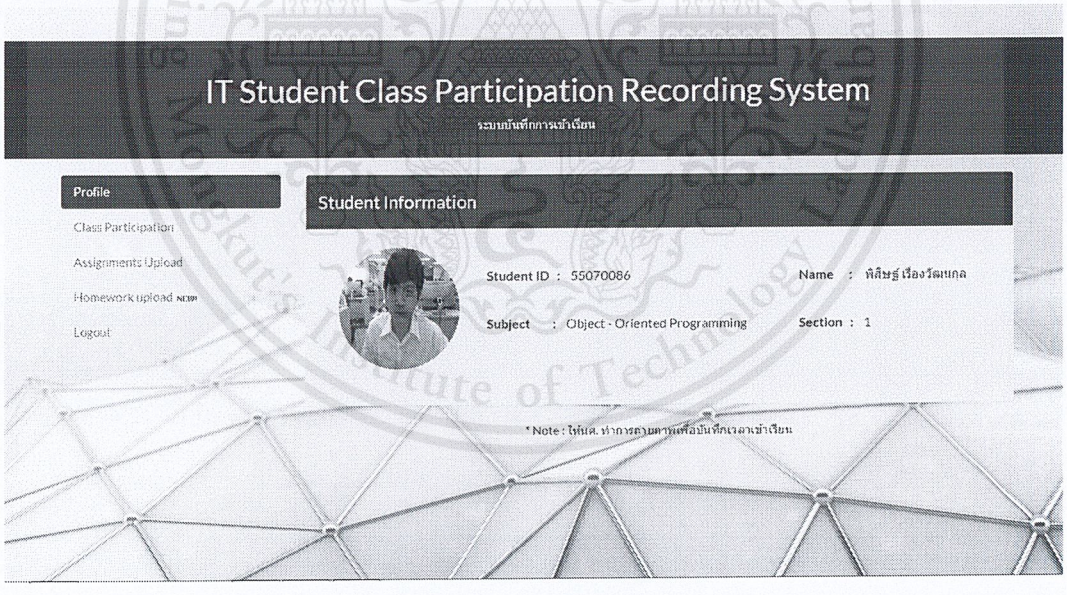

Figure 4.3 User information display

From Fig.4.3, it is the page shows student information that is student ID, student name, subject, and section. For the image collecting system, students have to record their class participation in this page by capture their images.

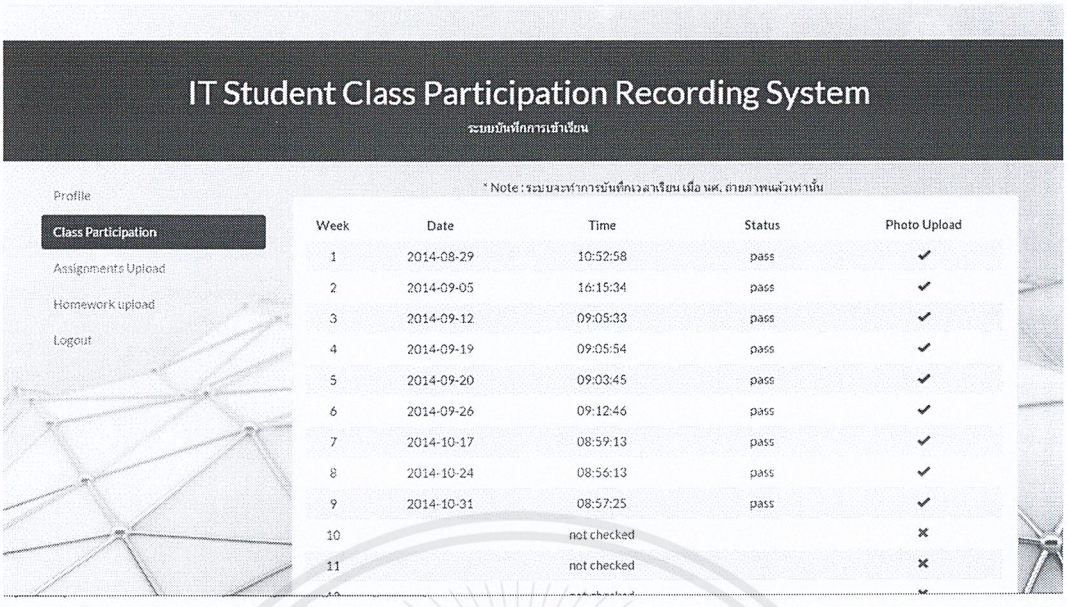

Figure 4.4 Class participation records display

Figure 4.4 depicted the page that shows all the student's class participation records that consist of week, date and time when user attend class, status (pass or late), and the photo upload status.

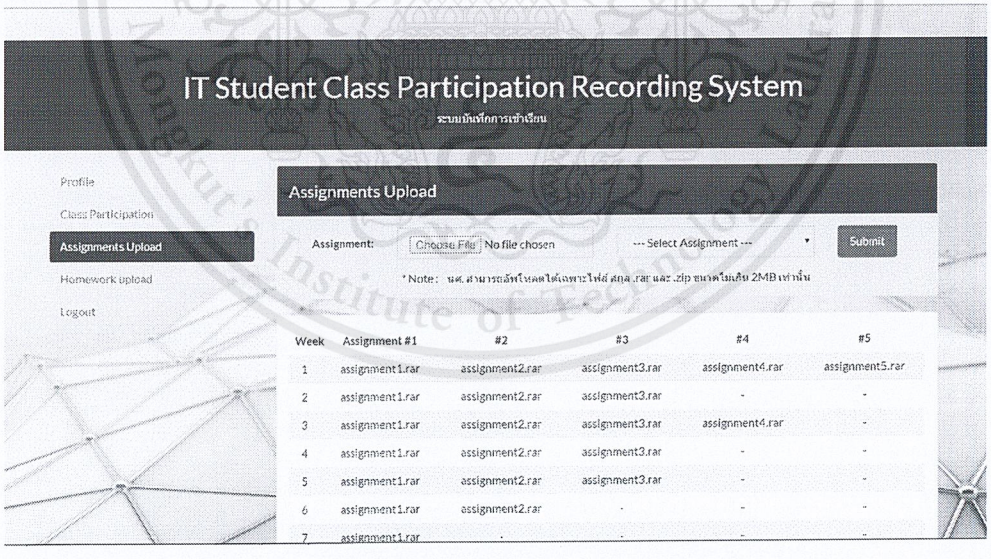

Figure 4.5 Assignment upload and uploaded history display

Figure 4.5 shows the page of the student assignments upload, it shows the entire student's assignment upload record consist of week, 5 assignments, and assignment filename. The assignment upload system allows using on a specific date.

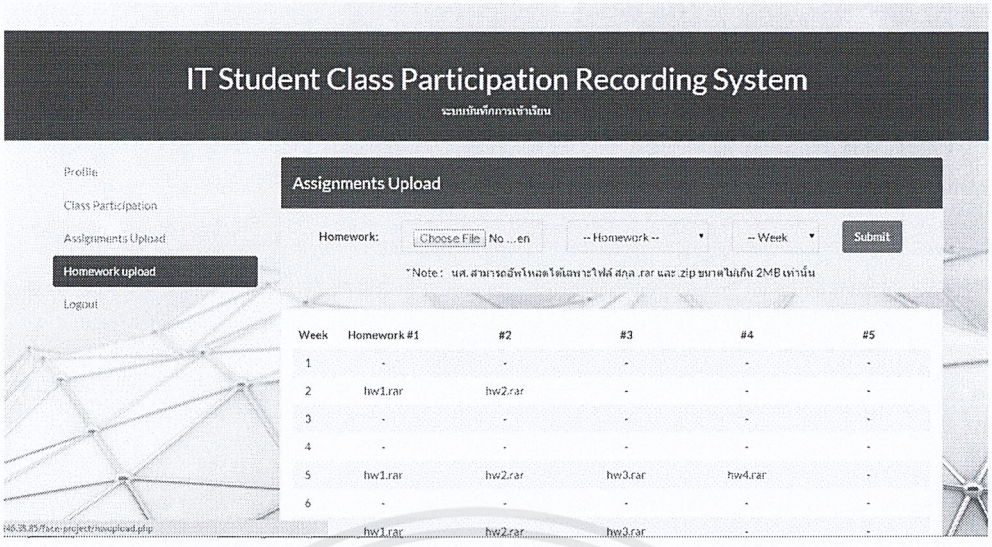

Figure 4.6 Homework upload and uploaded history display

This page shows the entire student's homework upload as depicted in Figure 4.6, it consist of week, 5 homework, and homework filename. The homework upload system allows using on a specific date.

The other parts is admin system that we provided for teacher to display class participation record, assignments and homework upload record, and information management.

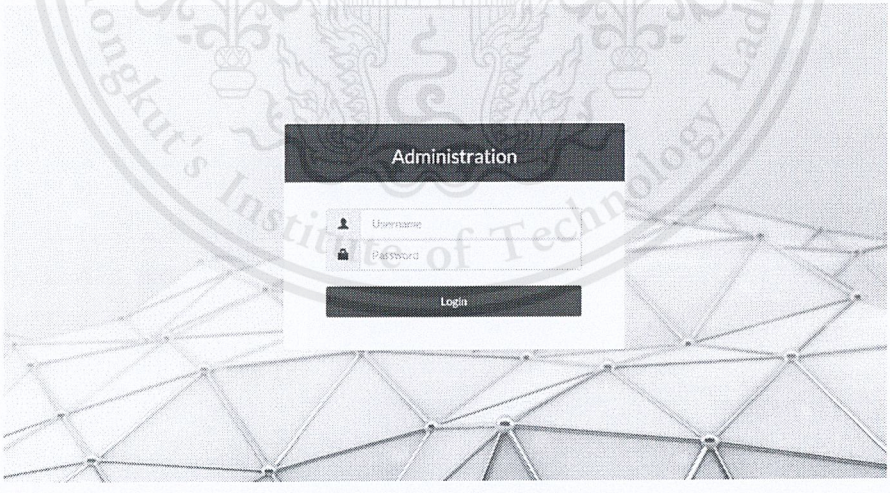

Figure 4.7 Main page for administrator.

As depicted in Figure 4.7, this is the main page for system administrator or teacher to login to the system, by using their provided username and password.

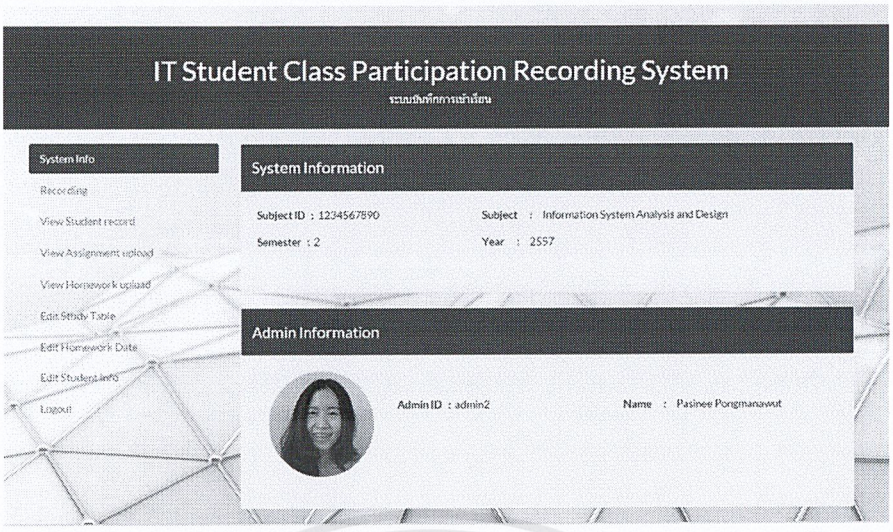

Figure 4.8 System and admin information display.

Figure 4.8 shows the info page that has system information such a subject ID, subject name, year, and semester. Also has administrator information such as admin ID, name, and admin's picture.

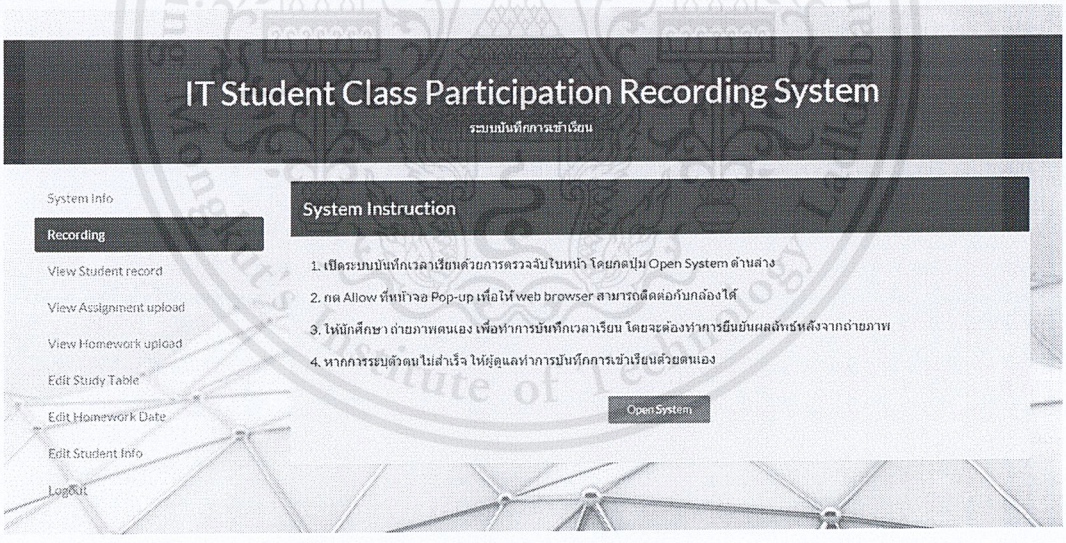

Figure 4.9 Recording system.

Figure 4.9 is the student class participation recording page that contained system instructions and the button to open the recording system.

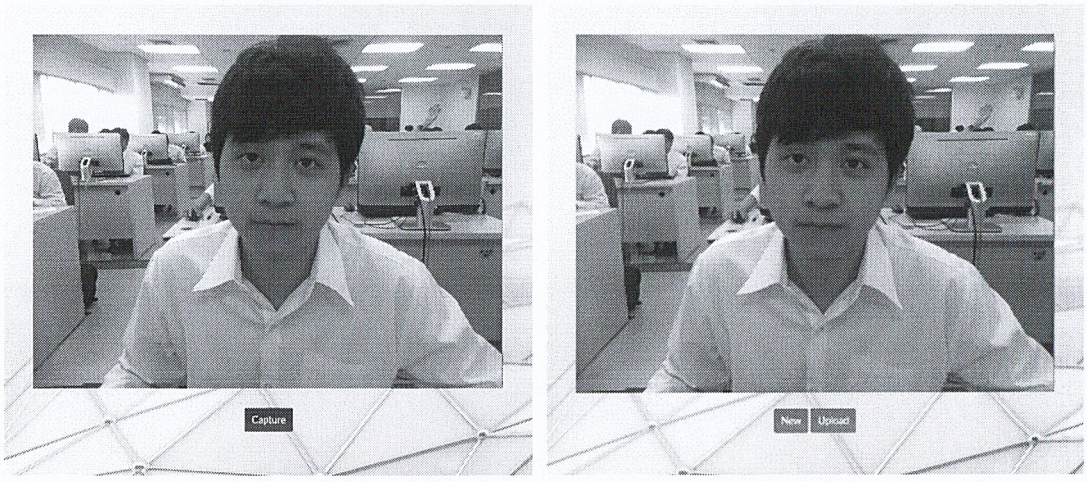

Figure 4.10 (a) Capture image, and **(b)** Upload image

Figure 4.10 (a) is a capture image page for take the input image to the recognition system, but before send the input image to the recognition module the student can check the quality of the image such a blurry capture and can re-take if they are not satisfied by clicked a "New" button as depicted in Figure 4.10 (b).

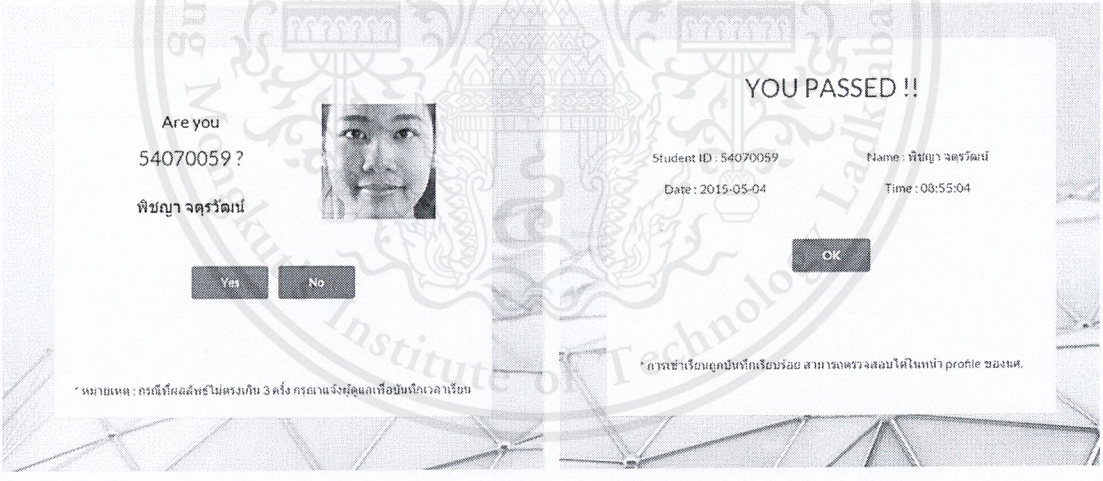

Figure 4.11 (a) Show recognition result, and **(b)** Finish recording.

The student recognition results page shows in Figure 4.11 (a). If it is the correct result chose "Yes" button and it will lead to the Figure 4.11 (b) that shows the student details, date, and record time. But if it is incorrectly result chose the "No" button, it will return to the capture page to re-capture image.

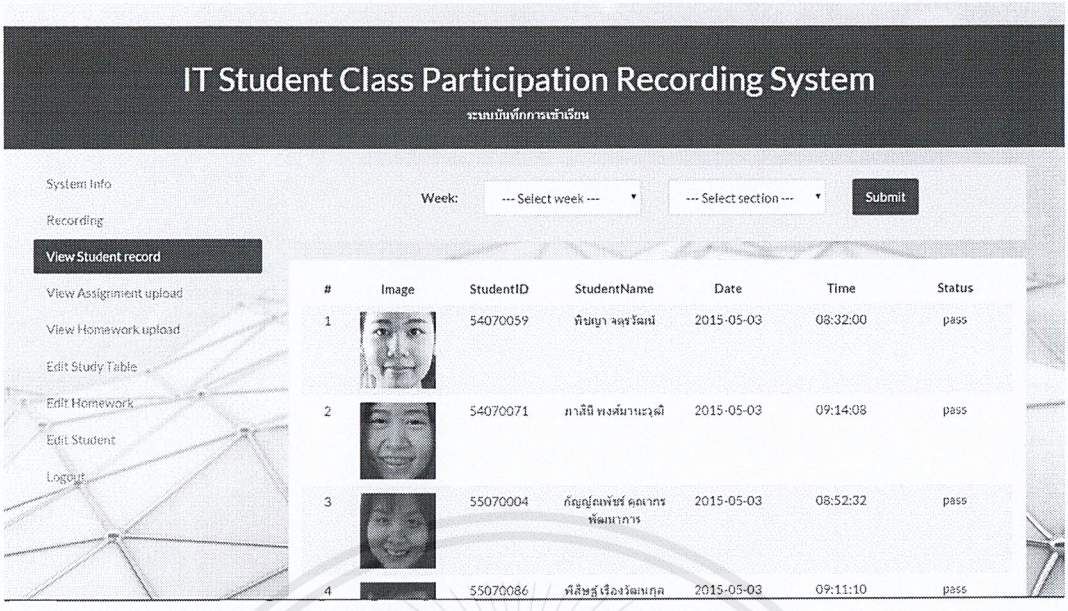

Figure 4.12 View class participation record

Figure 4.12 shows the class participation records page that can display all the students' class participation record by week and section with the student information such a student ID, student name, record date and time, status "Pass" or "Late" and student image.

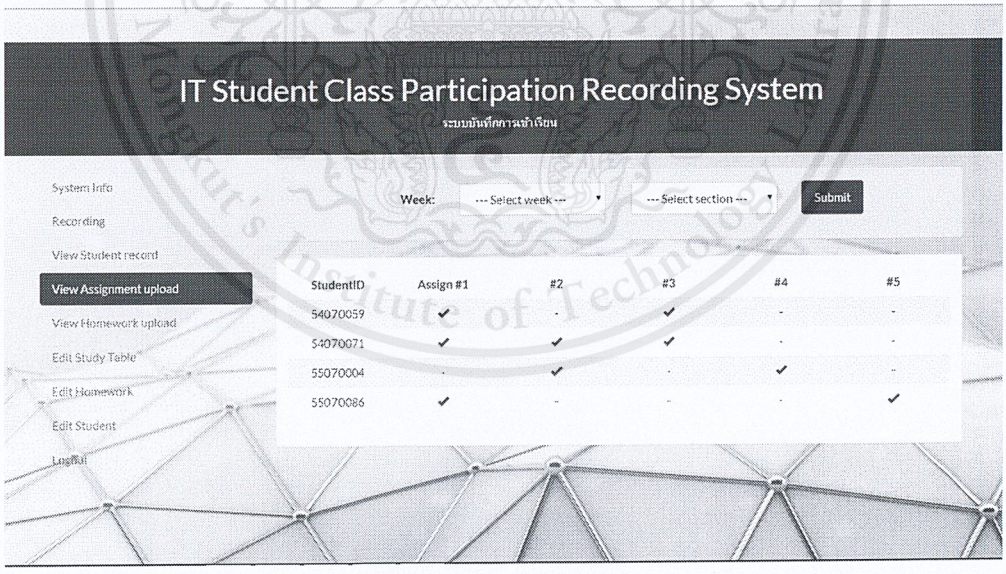

Figure 4.13 View assignments upload.

The assignments upload record viewing depicted in Figure 4.13, which can show the upload records by week and section. It displays student ID and five assignments, the green check marks means the file already uploaded.

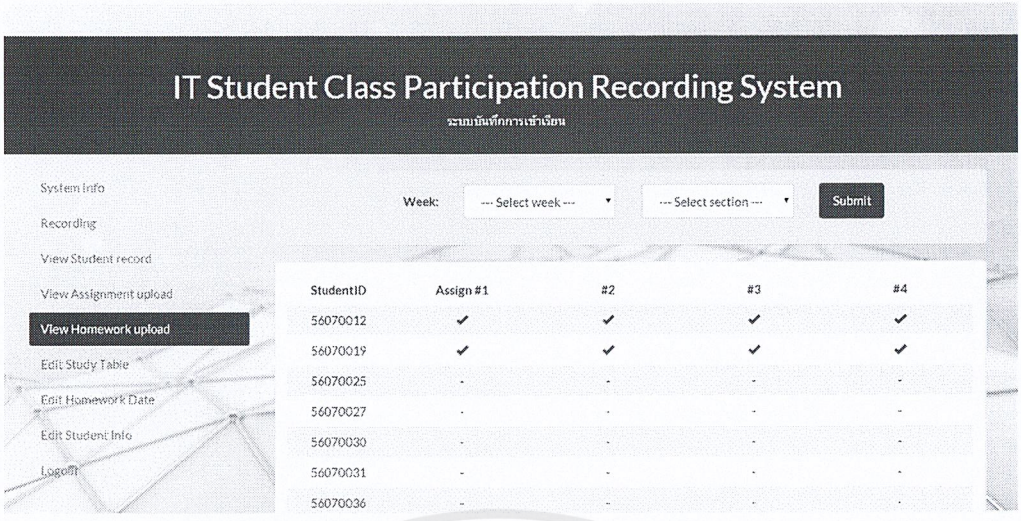

Figure 4.14 View homework uploads.

The homework uploads records viewing depicted in Figure 4.14, which can display the homework upload records by week and section. It displays student ID and five homework list, the green check marks means the file already uploaded.

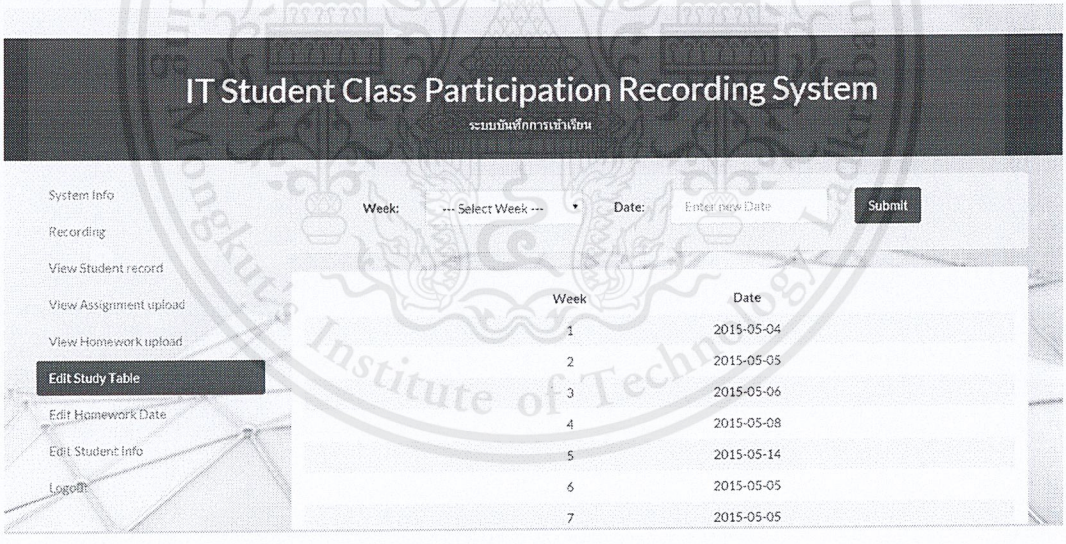

Figure 4.15 Study table management.

Figure 4.15 shows the study table management page that use for add and edit the study table by selecting week and date (will open as a calendar when click), if the week information does not already existed it will be added automatically.

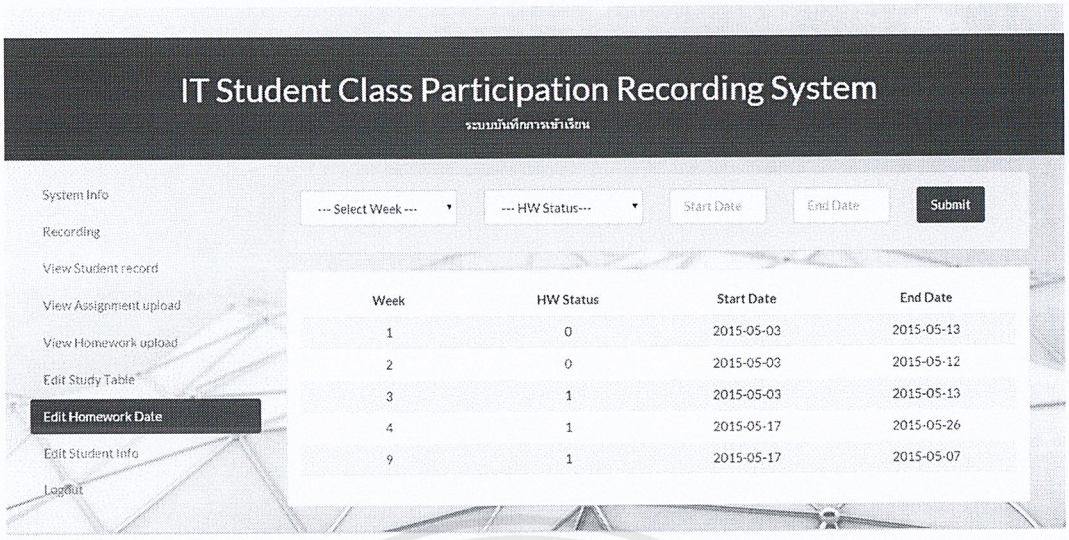

Figure 4.16 Homework dateline management.

Figure 4.16 shows the homework dateline management page that use for add and edit the available date for uploading student homework, by selecting week, homework status, start and end available date (will open as a calendar when click), if the week information does not already existed it will be added automatically.

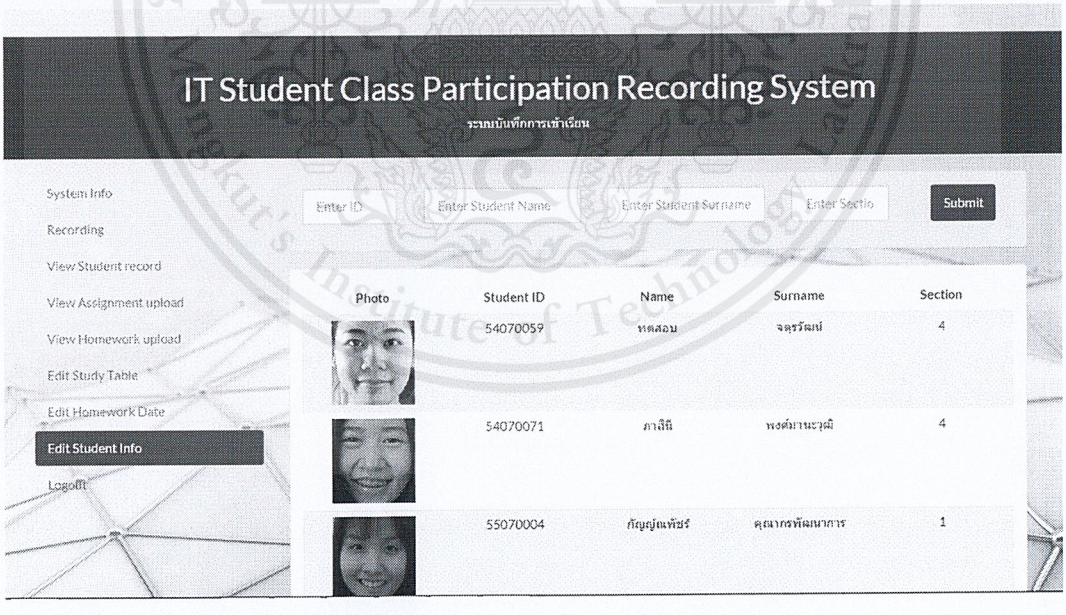

Figure 4.17 Student information management.

Figure 4.17 shows the student information management page that use for edit the student information such as name, surname, and section by insert the student ID and the information that want to edit.

4.3 System Evaluation

The system would be evaluated the performance of system usage according to the criteria as follows. First, the ability to record student class participation. Second, the ability to created student face database. Third, face detection accuracy in image preprocessing process. Finally, the accuracy of student faces recognition.

The ability to record the student class participation was evaluated by the accuracy of student recognition rate in face recognition module. As depicted in the implementation result Table 4.3, average of the recognition rate was fair precision (48.18%) because the lack of appropriate image preprocessing method and some example images were not a full frontal image and also have glasses and fringe. For the image database creating using image collecting system on web application, it works well for collecting student image. It can get enough images and quality of the collected images quite well. The face detection module using Haar-Like features also works well as depicted in Table 4.1, the detection rate was 76.72% so if we improve the image quality and user posture it will helps the face detection more accurate. The face recognition module using LBPH face recognizer in OpenCV has a low accuracy that depends on the factor as we previously mentioned. Thus, the better image preprocessing and image quality will improve the recognition rate.

4.4 Discussion

From the result of this implementation, we found this way is a good idea to record the student class participation but it also has many factors that need to be controlled. First is the image database creation, quality of the image is the most affected factor for the detection and recognition. The image collecting system that we use takes a few times to capture the image and it can be used by all students in the classroom at the same time from any computers. Thus, we can recording the student class participation precisely and get enough users' images in short time for the face recognition process. However we found some the limitations that we cannot control such as light position and user's postures. The web camera must have a good quality. Second, the face detection and recognition algorithm that was chosen for applied in the system. It should suitable for the implementation conditions. Finally, is the image preprocessing method that should suitable for the face detection and recognition algorithm to obtain the good accuracy.

Chapter 5

CONCLUSION

In this chapter we present the summary of our research and development of a class participation recording system using face detection, the conclusion of implementation results that was described in previous chapter, including our future works.

5.1 Summary

From the study, we found the class participation recording using face detection is the effective way to record the student class participation and can motivate the students to attend the class. The proper method to implement the system is a web application because it convenience to use in any computer any classroom without software installation. Moreover, after we study existing face detection and recognition algorithms to find the most appropriate algorithms for implement in our system. We found Haar-Like feature is an efficient method for face detection because it has a high precision and can work well even device has low processor. In case of face recognition algorithms, we study three algorithms that are Eigenfaces, Fisherfaces and LBPH. We compare recognition rate by using three datasets and the result showed LBPH got the best recognition rate.

Then we designed our system in client-server environment. For the client side, the additional device that needed is only web camera and it unnecessary to install the camera driver because we use WebRTC technology for access through web camera directly. On the server side, face detection module will be implemented by using Haar-Like features algorithms and face recognition module will be implemented by using LBPH because this algorithms is always use for pattern and texture classification. Thus LBPH is an algorithm that good for using in unstable environment such a light and shadow changing.

In the primary stage of implementation, we developed our system in form of web application as we designed and using WebRTC technology for recording student class participation by captured their images. This is the appropriate way because it can capture student image in web browser on any computers without additional installation. The images that we collect were stored in the folder separately for each student, so this helps the creating of student image database easier. Although we have a convenience to record student class participation and collect the user's sample image, but we cannot control the postures and the environment. Besides,

our primary system is having limitations to use in the computer laboratory classroom only. Our secondary stage is a development of class participation recording system. We chose the Haar-Like features as a face detection algorithm for extract student face in the images in preprocessing step, it done very well to detect faces and got detection rate to 76.72%. And we use LBPH face recognizer in OpenCV for face recognition module because this algorithm has the advantage of using variant light condition. Our system can work well to create a student image database but the accuracy of face recognition still under our estimate; it got about 48.18% recognition rates. Thus, we still cannot use the system in the real classroom but the percentage is not too bad it can improve the precision to reach the appropriate point.

Accordingly, in our future work we will control the factors that affected the face detection and recognition process. And then we will improve the image preprocessing process by using more appropriate method for prepare the image before create the training set.

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Appendix

Appendix A

Activity Diagram

1. Login

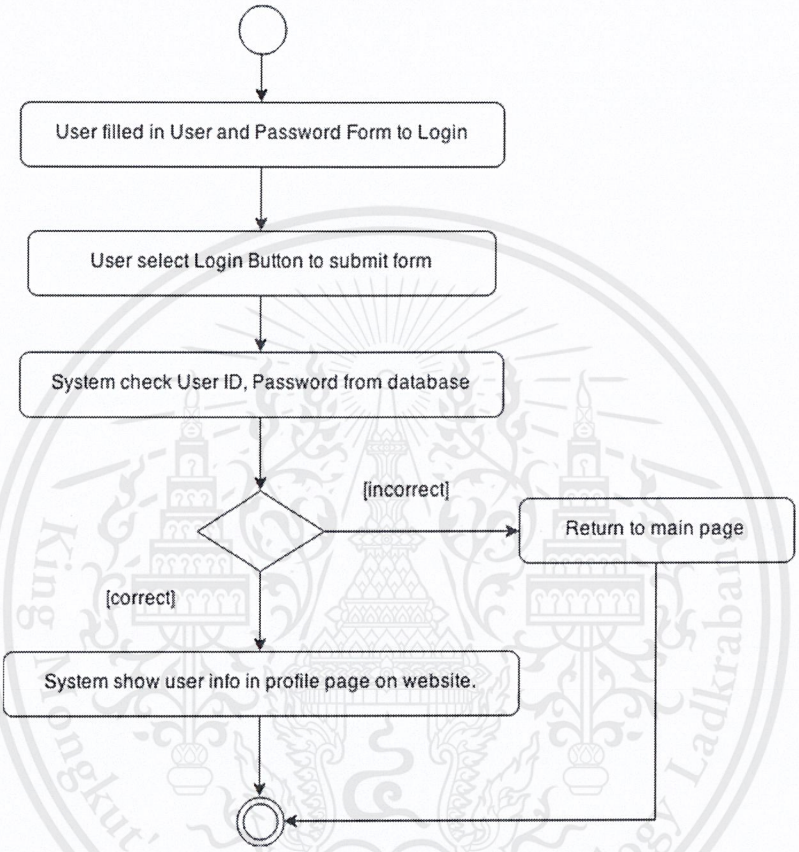

Figure A-1 Activity diagram for Login

2. Take a picture

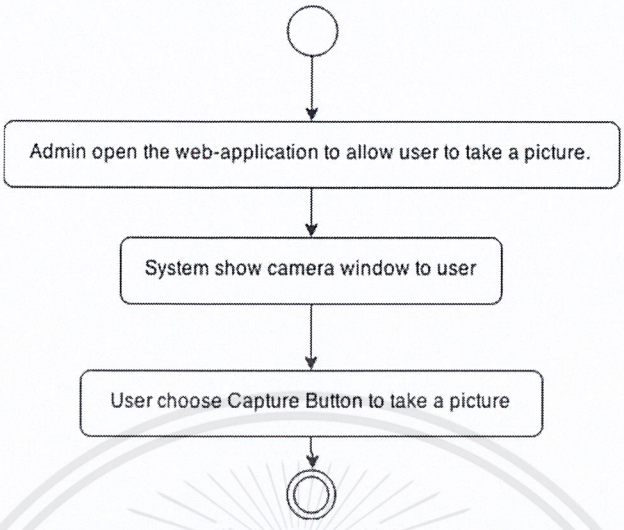

Figure A-2 Activity Diagram for Take a picture

3. Upload Picture

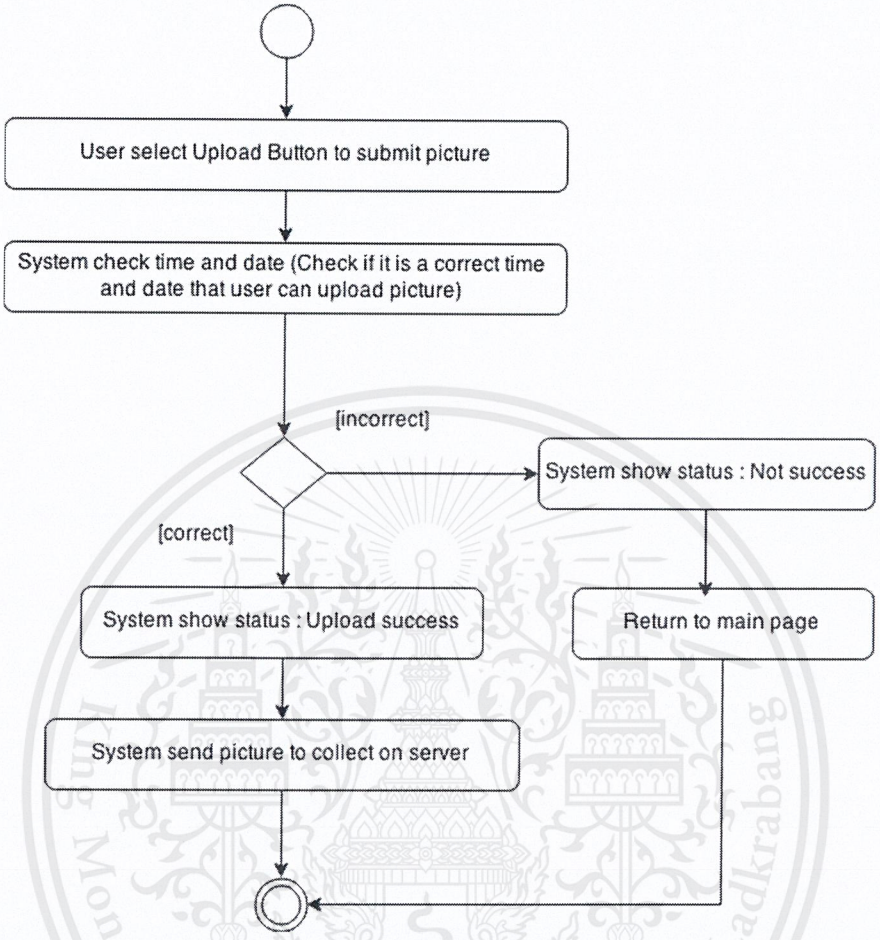

Figure A-3 Activity diagram for Upload Picture

4. Upload Assignment

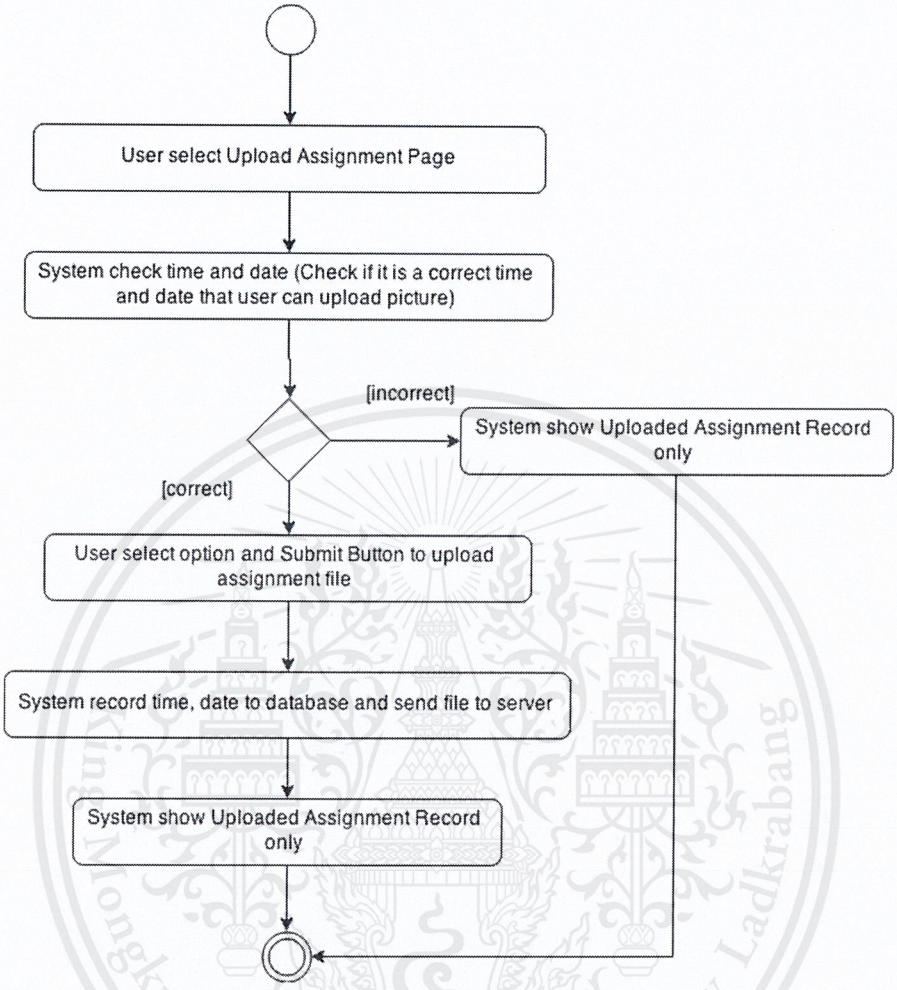

Figure A-4 Activity diagram for Upload Assignment

5. Upload Homework

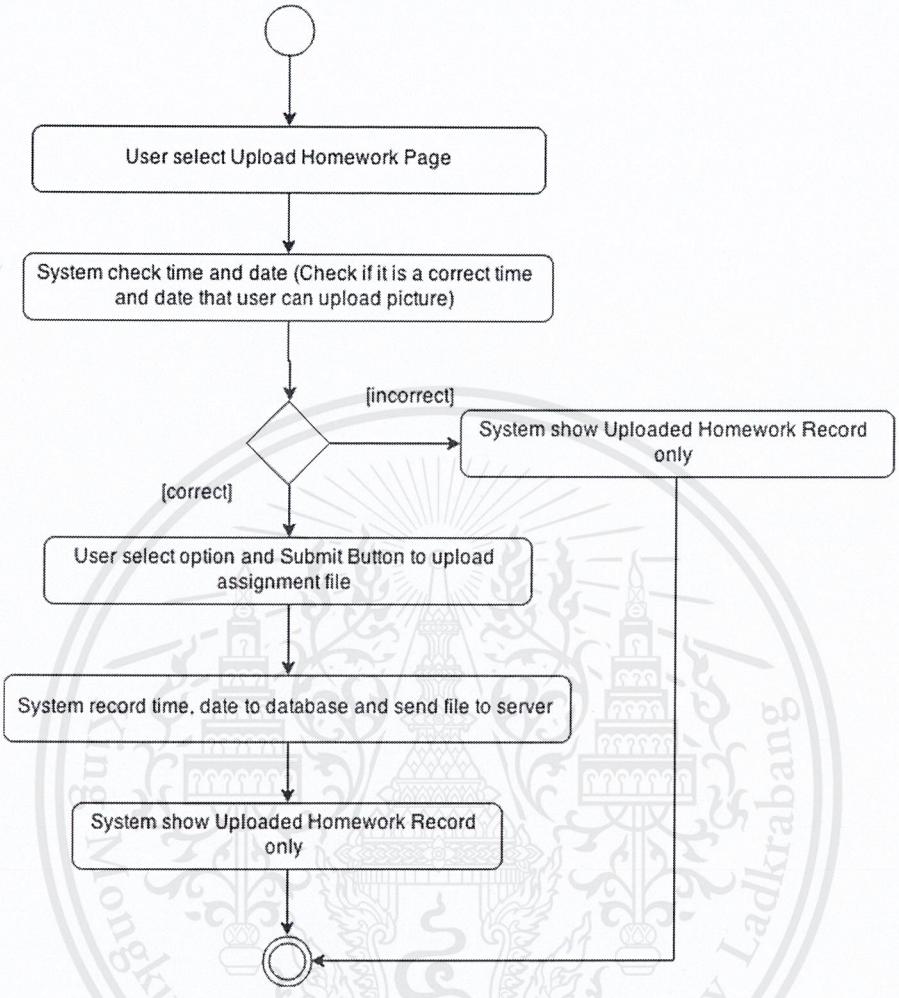

Figure A-5 Activity diagram for Upload Homework

6. View Records

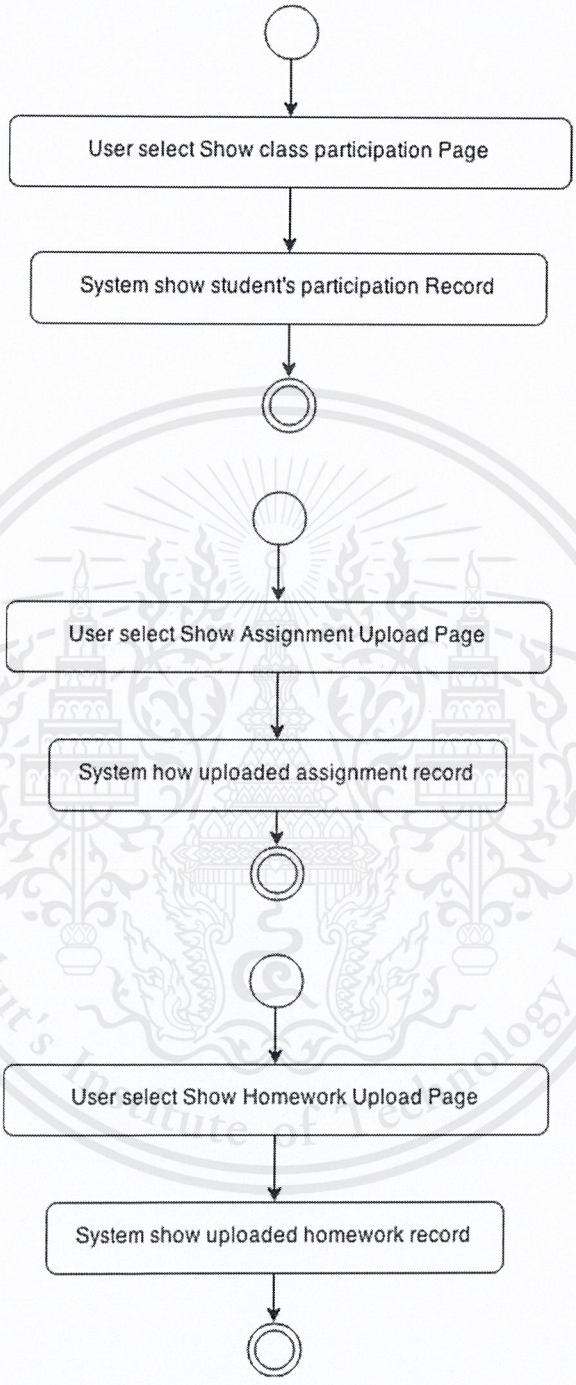

Figure A-6 Activity diagram for View Records

7. Create/Edit: Study table, Homework, Student Info

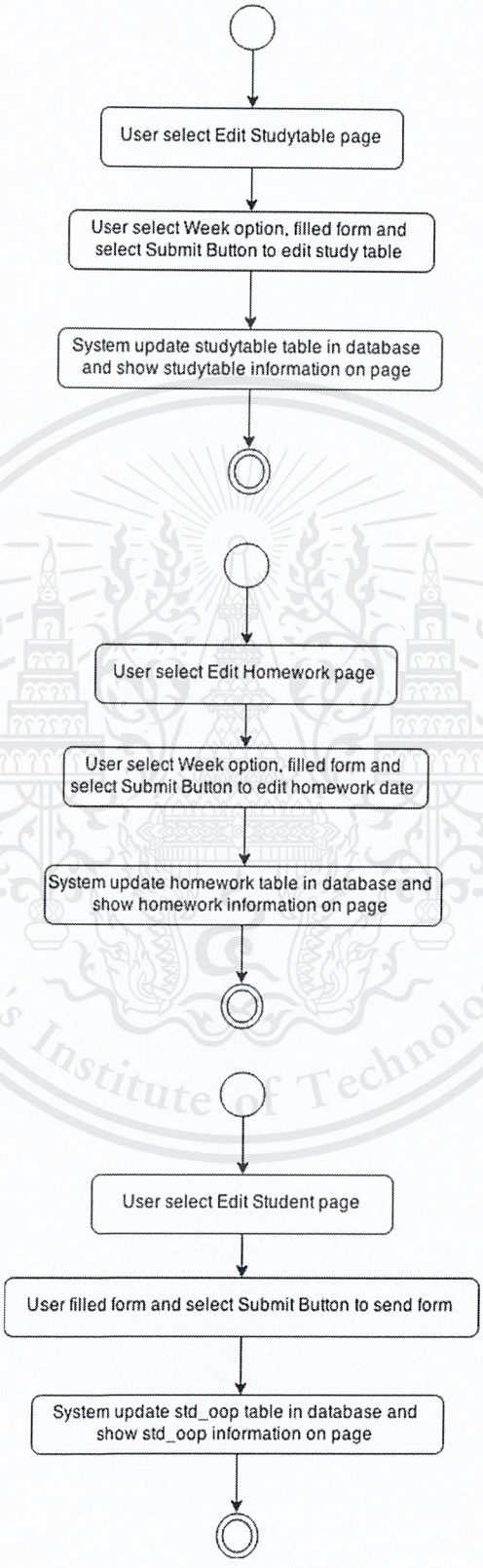

Figure A-7 Activity Diagram for Create/Edit Study table, Homework, and Student Info

Biography

Name	:	Miss PHICHAYA JATURAWAT
Date of birth	:	17 August 1993
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