TELE – THERAPY SYSTEM

BY

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ABSTRACT

Nowadays, more and more people suffer from health problems due to their daily activities, for example, overwork or overloading their body for activities, so people choose to take primary care or physical therapy. However, if the physical therapy is not performed correctly, it will result in even more injury, so patients, therefore, need specialist treatment. We recognize the problem of the process and timing of attending physical therapy at the hospital. The aim of this study is to minimize the patient's time and cost. Including the use of human resources in the hospital for maximum efficiency. Moreover, we focus on frozen shoulder disease as it is a common disease. By the way, the process is prepared in the form of a system that helps in the physical therapy of the patient. This study combines the knowledge that we have learned over 4 years: Android Studio, Microsoft SQL Server Management Studio, python, image processing, etc.

The system of this study is divided into 2 parts. The first part is an application on an android operating system for the hospital to collect patient information including physical therapy appointments. The second part is a self-training session that uses image processing to analyze and find parameter to provide a help physiotherapist.

The results show that the system can be an intermediary between the hospital and the patient, as well as indicating parameter such as the angle of the patient's arm evaluation and as the help for physiotherapist including practicing physical therapy of the patient.

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Miss Kultida Paoviman

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Symbols/Abbreviations	Terms
BME	Biomedical Engineering
SIIE	School of International Interdisciplinary Engineering Programs

CHAPTER 1
INTRODUCTION

1.1 Statement and significance of the problems

Nowadays, our bodies are used in daily life or doing activities but rarely take care of themselves. For example, sitting in front of the desk all day without physical activity movement may result in health problems such as office syndrome [1], migraine, or frozen shoulder. These behaviors result in people having physical therapy to treat their pain, even though in a serious accident, even undergoing surgery will also need physical therapy after surgery.

While new patients who need physical therapy treatment cannot walk directly into the hospital or clinic to received treatment. A medical record department must be first contacted to complete the history and basic information of patients after that the medical record department will assess the results and refer the patients to the physical therapy department [2]. Sometimes there are might be discrepancies in the evaluation results because the medical record department is not an expert in physical therapy or a delay due to the number of coming to the hospital or clinic, before receiving treatment.

These situations make it complicated for patients who need physical therapy. There is a cause of a delay in treatment and might be ineffective from treatment. Moreover, nowadays the world including Thailand suffers from the situation of COVID-19 that causing patients to face more obstructions [3]. So, our group has an idea to create a system that can be used as an intermediary between the hospital and the patient where the system is in the form of a mobile application that collects patient information, appointment, and questionnaires for the patient. Besides, our system that can give some parameter about testing and can help the physiotherapist then can monitor the patient's physical training by patients at the patient's home.

1.2 Objectives

1.2.1 To reduce the duration and cost of patients by using image processing method
1.2.2 To reduce the steps between patient and medical records
1.2.3 For the use of human resources Less but more efficiency
1.2.4 To analyze the patient’s body in the remote treatment for the physiotherapist
1.2.5 To help patients to do physical therapy by themselves

1.3 Hypothesis to be tested

This mobile application can help the patient to conduct physical therapy sessions more conveniently in using the service. Whether it is basic contact information, fast information processing, and clear patient appointment. This system also can reduce time and cost for patients, additionally can help patients to practice physical therapy that we focus on the frozen shoulder by themselves at home.

1.4 Scope of study

1.4.1 Create mobile application

1.4.2 Collect the patient information who performed the physical therapy, and processed the rehabilitation

1.4.3 Learn information about physical therapy and knowledge of frozen shoulder

1.4.4 Do the system for practicing of physical therapy of patient

1.5 Expected or Anticipated Benefit Gain

1.5.1 Expected that our system can be an intermediary between the patient and the hospital.

1.5.2 Expected to be able to help patients reduce the cost and the number of visits to the hospital as little as possible.

1.5.3 Expected to be able to assist the patient to do some basic physical therapy on their own.

1.5.4 Expected that our study will be useful for physiotherapist as much as possible.

CHAPTER 2
LITERATURE REVIEW

This chapter attempts to review the relevant literature and research related to the study such as physical therapy, frozen shoulder, medical records, questionnaires, ICD-10, Android Studio, Microsoft SQL Server Management Studio, Python Programming, the python's standard library, Image Processing, and Deep Learning including deep learning library for human body part detection, and the final section of this chapter.

2.1 Physical therapy

Physical therapy or physiotherapy is a branch of rehabilitative health that uses specially designed exercises and equipment to help patients regain or improve their physical abilities. Physical therapy helps a patient to treat, prevent, correct, rehabilitate dysfunction, disability of the body or mind with physical therapy which are bending, pulling, compressing, massage, exercise, or any part of bodies of the patient which needs to receive these healing according to scientific way. Physical therapy can divide into the following main systems [4].

2.1.1 Musculoskeletal physical therapy, such as patients with impaired mobility problems pain caused by musculoskeletal disorders, inappropriate exercise, or injury from works (Office syndrome), bone fracture patients, or having surgery including those with dismemberment disabilities [5].

Figure 2.01 Musculoskeletal pain [6]

2.1.2 Neurological physical therapy is for patients with mobility problems or patients who have difficulty in helping themselves in daily life. This situation is caused by disorders of the nervous system, such as cerebrovascular patients, Parkinson's patients, patients who have problems with their movement such as congenital cerebral palsy including patients who have had an accident that results in brain injuries or spinal cord.

Figure 2.02 Neurological [7]

2.1.3 Physical therapy on the respiratory and circulatory system (lungs and heart). Patients who got breathing problems or heart function, such as lung disease patients with residual sputum or infection, Heart disease patients Moreover, patients before and after surgery

Figure 2.03 Respiratory and circulatory system [8]

2.1.4 Sports physical therapy, for example, the maintenance and rehabilitation of athletes before and after the competition, or injuries caused by sports practice.

Figure 2.04 Sports physical [9]

2.1.5 Physical therapy in the community. It is a physical therapy work that focuses on working proactively, to thoroughly care for the people Whether it is an elderly person or the disabled person who cannot go to the hospital or clinic to receive treatment. Suggesting people in promoting exercise in the community.

Figure 2.05 Physical therapy in the community [10]

2.1.6 Other physical therapy work such as exercise for pregnant women both before and after childbirth, diabetes care, breast ultrasound for nursing mothers, spa and physical therapy, health care, and Holistic health care.

Figure 2.06 Other physical therapy [11]

2.2 Frozen Shoulder

Frozen shoulder is a condition in which there is less movement of the shoulder joint. It usually starts with very mild symptoms, such as being unable to fully lift the shoulder or across the back completely. If not treated, the symptoms will worsen until little move the shoulder or cannot move [12], which is the most common cause of inflammation and the thickening of the shoulder membrane make the movement less. It is often caused by hard work and may be caused by everyday activities. Repeated use for a long period of time, such as sitting for a long period of time or posture that repeats the movement of the shoulder joint causing friction and inflammation of the tendons and the muscles of the shoulder blades in the elderly, is more likely to suffer from overuse [13]. In which the shoulder joint is stuck, causing pain and dull pain where pain increases with movement. The most obvious symptom is the inability to move the shoulder joint. There is pain when lying down or at night.

There are three phases of symptoms of a frozen shoulder. The first phase is the freezing or painful stage. Pain increases gradually, making shoulder motion harder and harder. Pain tends to be worse at night. This stage can last from 6 weeks to 9 months. The angle of shoulder movement is reduced. The second phase is the frozen stage. Pain does not worsen, and it may decrease at this stage. The shoulder remains stiff. It can last from 4 to 6 months, and movement may be restricted. The third phase is the thawing stage. Movement gets easier and may eventually return to normal. Pain may fade but occasionally recur. This phase takes between 6 months and 2 years [14].

The principles of treatment for frozen shoulder

- Give pain relievers, either oral or injectable drugs.
- Physical therapy: Patients have to do physical therapy regularly from the initial stage of symptoms to get good results.
- Surgery for some patients who did not succeed in drug therapy and physical therapy.
- Exercise [15]

2.3 Medical record

All types of medical documents that are recorded and stored gather patient history stories including personal history, family history, drug allergy, medical consent documents, past, and current illnesses, indications [16]. Individual medical treatment the medical expenses laboratory results of autopsy wounds or tipping over the results of saving the values of numbers, letters, images, or any other instrument from the instrument. A public health service facility or all types of medical equipment or documentation of recording any act directed to treatment consultation nursing referring patients to treatment elsewhere adopting patient treatment to follow the order of authority in the medical treatment as specified by the health service establishment, other documents used to support for medical decisions for coordination in the medical treatment of patients, and any other documents which the World Health Organization (WHO) or public health service establishes as a document in the medical record refers to the name of the agency that serves to organize making such documents collection, search, recording, editing, coding of disease. Preparation of medical reports bringing the patient statistics to be used for study or research any other activities required by the health service facility. This also includes the medical documentation in the digital or electronic media format (Electronic Medical Record (EMR)), which is a form of the medical record that is developed today.

2.4 Questionnaires

Question format in a series that has been compiled in a formal and systematic manner [17]. For measuring what the doctors want to know from the sample or target population to get past facts. Present and future event predictions the questionnaire consists of a neatly generated list of questions. To gather information about opinions or facts by sending to the sample group voluntarily the use of questionnaires as a tool for collecting that information. Questioning is an important task for the researcher because investigators may not have the opportunity to meet with respondents to explain the meaning of the questions they wish to collect.

2.5 ICD -10

ICD - 10 is the 10^{th} revision of the International Statistical Classification of Diseases and Related Health Problems (ICD) [18], a medical classification list by the World Health Organization (WHO). It contains the codes of diseases, signs, and symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases [19]. In the base classification, the code set allows for more than 14,000 different codes and permits the tracking of many new diagnoses compared to the preceding ICD - 9.

With optional sub-classifications, ICD - 10 allows for specificity regarding the cause, manifestation, location, severity, and type of injury or disease. The adapted versions may differ in several ways, and some national editions have expanded the code set even further; with some going so far as to add procedure codes. ICD – 10 - CM, for example, has over 70,000 codes. The WHO provides detailed information regarding the ICD via its website – including an ICD - 10 online browser and ICD training materials [20].

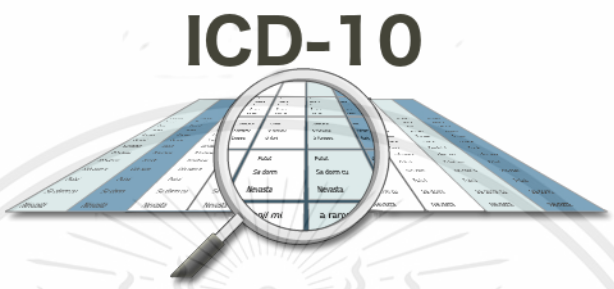


Figure 2.07 ICD – 10 [21]

2.6 Deep Learning

Deep learning is an artificial intelligence (AI) function that mimics the workings of the human brain in processing data for use in detecting objects, recognizing speech, translating languages, and making decisions.

Deep learning or AI can learn without human supervision, drawing from data that is both unstructured and unlabeled [22].

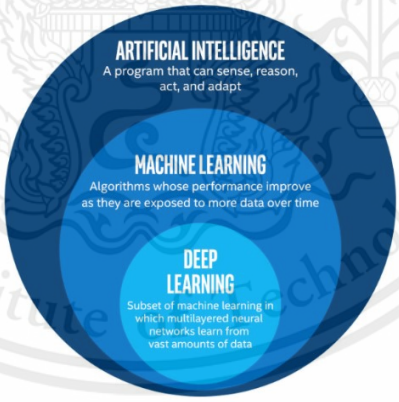


Figure 2.08 Example of deep learning [23]

For OpenPose from Carnegie Mellon University is one of the most accurate methods for human pose estimation. This convolutional neural network-based approach attacks the problem using a multi-stage classifier where each stage improves the results of the previous one.

The first stage takes the input image and predicts the possible locations of each key point in the image with a confidence score (called the confidence map). There are three steps, first step is key points localization: One branch of the network is responsible for

predicting all the key points with a confidence score. This is called a confidence Map. The second step is Part Affinity Fields: Another branch of the network predicts a 2D vector field that predicts the key points association data. The last step is Greedy Inference: Now, we connect all the key points using greedy inference [24].

For example, run the single person pose estimation using OpenCV. Confidence maps show the key points. To keep this post simple, showing how to connect multiple person key points using Pose affinity maps. There is a way that would be using the pretrained model trained by the OpenPose team using Caffe on the MPI dataset. This dataset has 15 key points to identify various points in the human body.

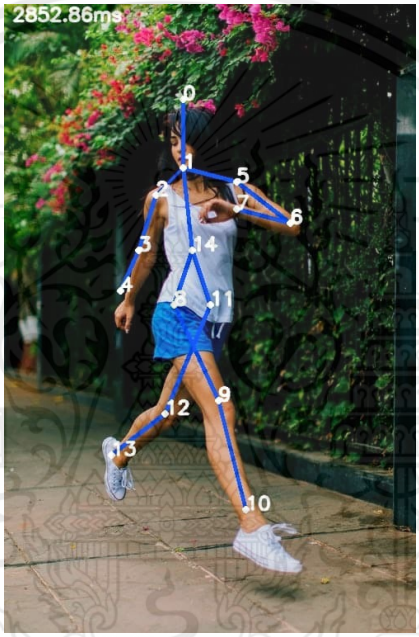


Figure 2.09 Key points of body's parts [25]

2.7 Image Processing

Image processing is a method to perform some operations on an image, to get an enhanced that image, or to extract some useful information from it. It is a type of signal processing in which input is an image, and output may be an image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms a core research area within engineering and computer science disciplines too [26].

The related theory that we use for image processing is Haar - Cascades for object detection by using the OpenCV library in the python program. The OpenCV for python comes with some advanced tools in an easy–to–use package, object detection using Haar - the Cascades is one of them. We are going to use Haar Feature-based Cascade Classifiers to detect faces and hands. In short, it is a machine learning method where a so-called cascade function is trained on a large. Amount of positive and negative images (positive meaning it includes the desired object and negative images lack it), which in turn can be used for object detection [27].

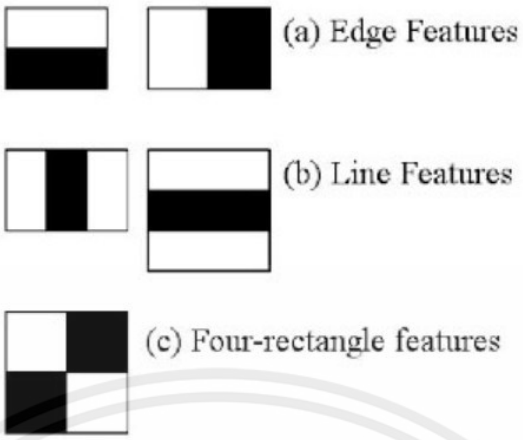


Figure 2.10 Haar - Cascades for object detection [28]

2.8 Background subtraction

Background subtraction (BS) is a common and widely used technique for generating a foreground mask (namely, a binary image containing the pixels belonging to moving objects in the scene) by using static cameras. The background subtraction calculates the foreground mask performing a subtraction between the current frame and a background model, containing the static part of the scene or, more in general, everything that can be considered as background given the characteristics of the observed scene [29].

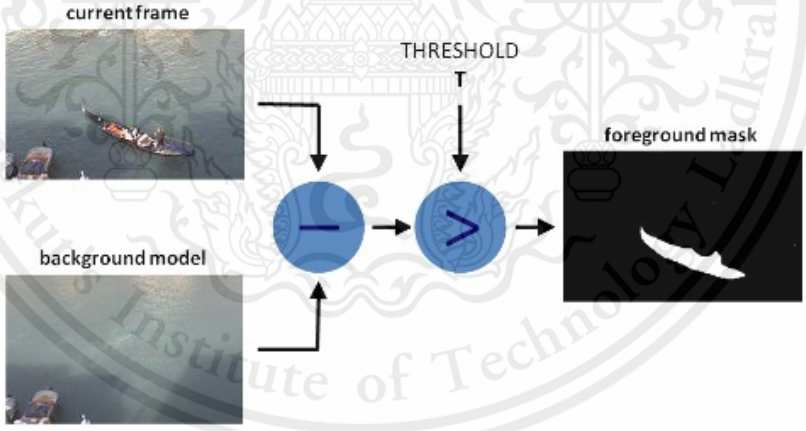


Figure 2.11 Background subtraction [30]

2.9 HSV Threshold

Hue, Saturation, and Value (HSV) is a color model that is often used in place of the RGB color model in graphics and paint programs. In using this color model, a color is specified then white or black is added to easily make color adjustments. The HSV may also be called HSB (short for hue, saturation, and brightness). The HSV can be imagined like a three-dimensional cylinder [31].

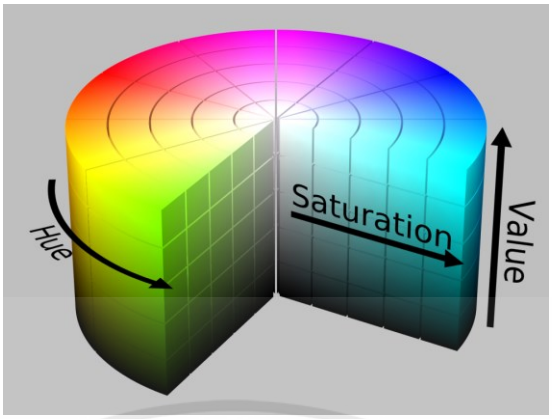


Figure 2.12 Hue, Saturation, and Value [32]

- Hue: the color type (such as red, blue, or yellow)
- Saturation: the intensity of the color. A saturation of 0 is white, and saturation of 255 is maximum intensity
- Value: the brightness of the color

2.10 Law of cosines

The trigonometry, the law of cosines (also known as the cosine formula, or cosine rule) relates the lengths of the sides of a triangle to the cosine of one of its angles [33].

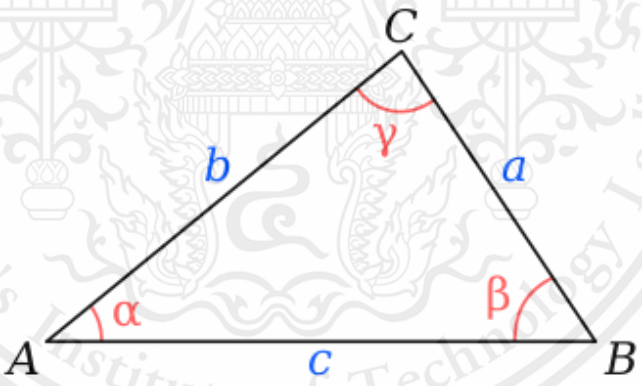


Figure 2.13 Triangle [34]

$$c^2 = a^2 + b^2 - 2ab\cos\gamma,$$
$$a^2 = b^2 + c^2 - 2bc\cos\alpha,$$
$$b^2 = a^2 + c^2 - 2ac\cos\beta.$$

Figure 2.14 Formula [35]

$$c = \sqrt{a^2 + b^2 - 2ab\cos\gamma};$$

$$\gamma = \arccos\left(\frac{a^2 + b^2 - c^2}{2ab}\right);$$

Figure 2.15 Calculate angle [36]

2.11 Android Studio

Android Studio is the official integrated development environment (IDE) for android application development. It is based on the IntelliJ IDEA [37], a Java integrated development environment for software, and incorporates its code editing and developer tools [38]. For supporting application development within the android operating system, Android Studio uses a Gradle - based build system, emulator, code templates, and GitHub integration. Every project in the Android Studio program has one or more modalities with source code and resource files. These modalities include the android app modules, library modules, and Google App Engine modules as an example [39].

Figure 2.16 Android Studio Logo [40]

The basic unit of the android application is the activity. A user interface is defined in an XML file. During compilation, each element in the XML is compiled into an equivalent android GUI class with attributes represented by methods [41].

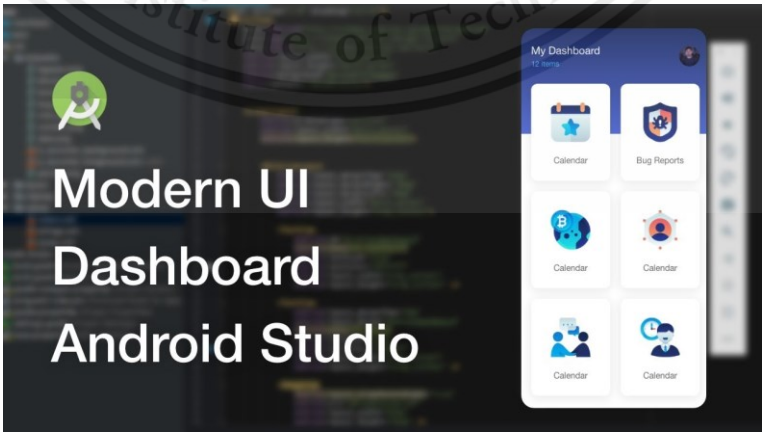


Figure 2.17 User Interface [42]

2.12 Microsoft SQL Server Management Studio

SQL Server Management Studio (SSMS) is an integrated environment for managing any SQL infrastructure. Use SSMS to access, configure, manage, administer, and develop all components of SQL Server, Azure SQL Database, and Azure Synapse Analytics. SSMS provides a single comprehensive utility that combines a broad group of graphical tools with several rich script editors to provide access to SQL Server for developers and database administrators of all skill levels [43]. The SQL Server Management Studio will connect with Android Studio for collecting the database [44].

Figure 2.18 Microsoft SQL Server Management Studio Logo [45]

2.13 PyCharm

PyCharm is an integrated development environment (IDE) used in computer programming, specifically for the Python language. It is developed by the Czech company JetBrains [46]. The PyCharm program provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems (VCSes), and supports web development with Django as well as data science with Anaconda.

PyCharm is cross-platform, with Windows, macOS, and Linux versions. The Community Edition is released under the Apache License, and there is also Professional Edition with extra features – released under a proprietary license [47].

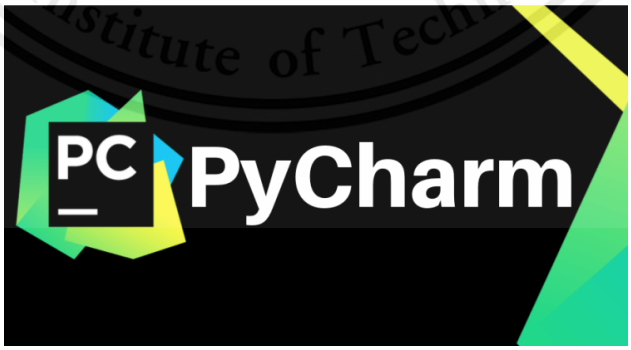


Figure 2.19 PyCharm program [48]

2.13.1 Components

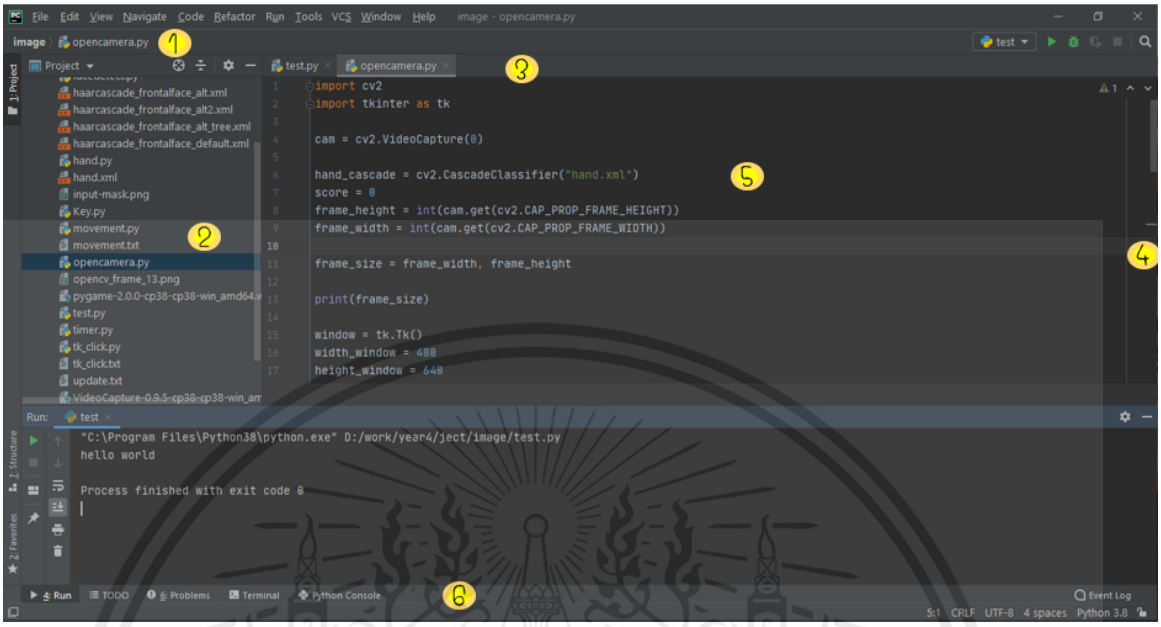


Figure 2.20 Component of PyCharm program [49]

Number	Meaning
1. Navigation bar	Above the editor additionally allows you to quickly run and debug your application as well as do the basic VCS actions.
2. Project view	The left side displays your project files.
3. Filename	Python file
4. Right gutter	On the right side of the editor. shows the results of its code analysis in the right gutter: errors, warnings, etc. The indicator in the top right-hand corner shows the overall status of code analysis for the entire file.
5. Editor	On the right side, where you write your code. It has tabs for easy navigation between open files.
6. Status bar	Show various warnings and information messages like file encoding, line separator, inspection profile, etc. Refer to the section Status Bar for details.

Table 2.01 Component of PyCharm program [50]

2.13.2 Syntax

Write the sample code such as hello world and go running, after that the output will show on the run console. The code and result after running an example are shown in figure 2.21 and figure 2.22.

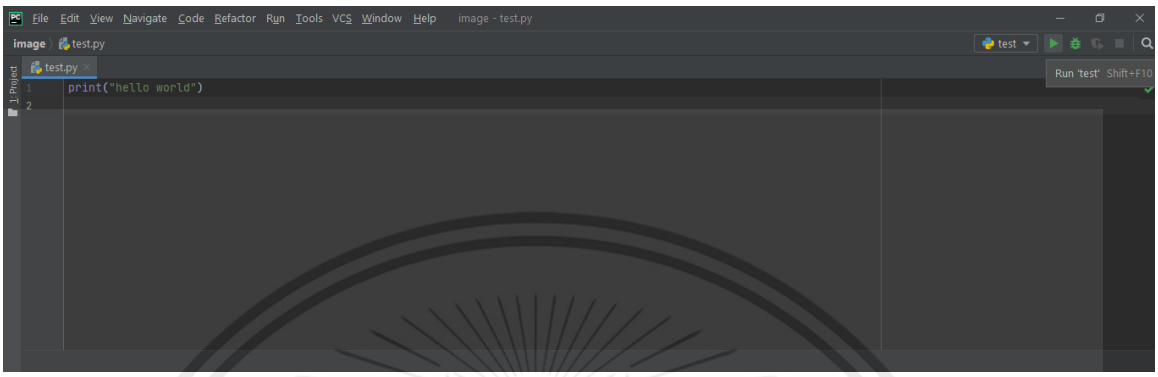


Figure 2.21 PyCharm program

Figure 2.22 Print ("hello world")

2.14 Python

Python is an open-source programming language that was developed without being attached to the platform. Python can be run on Unix, Linux, Windows, or even FreeBSD systems. Python is an Open-Source language that like PHP, allowing everyone to use Python to develop programs for free without cost. As an Open - there are experts to help develop the python language have higher abilities, and applicable to all types of work [51].

Figure 2.23 Python Logo [52]

Programming Python uses a development tool called an Integrated Development Environment (IDE) that includes a source code editor, a debugger, and a run tool. In general, the Python IDE can execute commands in two modes:

1. Immediate mode is a mode in which the user will type one command in a section called shell or console, and the translator will interpret the commands. If there is no error, the command will be executed.

2. Script mode in this mode, the programmer has to type several commands together and save them as a file. To instruct the translator to execute the commands from the first command Until the last order If you want to verify the validity, it can be used for testing in media mode [53].

2.14.1 OpenCV

The OpenCV was started at Intel in 1999 by Gary Bradsky, and the first release came out in 2000. Vadim Pisarevsky joined Gary Bradsky to manage Intel's Russian software OpenCV team. In 2005, OpenCV was used on Stanley, the vehicle that won the 2005 DARPA Grand Challenge. Later, its active development continued under the support of Willow Garage with Gary Bradsky and Vadim Pisarevsky leading the project. OpenCV now supports a multitude of algorithms related to Computer Vision and Machine Learning and is expanding day by day [54].

OpenCV is an open-source library of Python that was developed by Intel in the year 2000. It is mostly used in computer vision tasks such as object detection, face detection, face recognition, image segmentation, but also contains a lot of useful functions that you may need in ML [55].

OpenCV supports a wide variety of programming languages like Python, C++, Java, etc. It can process images and videos to identify objects, faces, or even the handwriting of a human. When it is integrated with various libraries, such as NumPy which is a highly optimized library for numerical operations, then the number of weapons increases in your Arsenal [56].

2.14.2 Math

The Math Library provides us access to some common math functions and constants in Python, which can use throughout our code for more complex mathematical computations. The library is a built-in Python module; therefore, you do not have to do any installation to use it [57].

The math module contains various functions for calculating trigonometric ratios for a given angle. The functions (sin, cos, tan, etc.) need the angle in radians as an argument. The math module presents two angle conversion functions: degrees( ), and radians( ), to convert the angle from degrees to radians and vice versa. For example, the following statements convert the angle of 30 degrees to radians and back [58].

Example: Math Radians and Degrees Copy

```
>>> import math
>>> math.radians(30)
0.5235987755982988
>>> math.degrees(math.pi/6)
29.999999999999996
```

Figure 2.24 Example of math library [59]

2.14.3 NumPy

The NumPy library is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms basic linear algebra, basic statistical operations, random simulation and much more [60].

```
>>> import numpy as np
>>> x = np.array([1, 2, 3])
>>> x
array([1, 2, 3])
>>> y = np.arange(10)  # Like Python's list(range(10)), but returns an array
>>> y
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

Figure 2.25 Array creation using NumPy library [61]

2.14.4 Argparse

The argparse module makes it easy to write user-friendly command-line interfaces. It parses the defined arguments from the sys.argv. The argparse module also automatically generates help and usage messages, and issues errors when users give the program invalid arguments. A parser is created with ArgumentParser and a new parameter is added with add_argument(). Arguments can be optional, required, or positional [62].

2.14.5 Collections

The Collections in Python are containers that are used to store collections of data, for example, list, dict, set, tuple, etc. These are built-in collections. Several modules have been developed that provide additional data structures to store collections of data. One such module is the Python collections module. Python collections module was introduced to improve the functionalities of the built-in collection containers. Python collections module was first introduced in its 2.4 release. This tutorial is based on its latest stable release [63].

2.14.6 imutils

A series of convenience functions to make basic image processing functions such as translation, rotation, resizing, skeletonization, displaying Matplotlib images, sorting contours, detecting edges, and much easier with OpenCV and both Python 2.7 and Python 3 [64].

2.15 Chapter Summary

In Chapter 1, we proposed to introduce the statement and significance of the problems of this study, as well as initial planning.

In this chapter, we present the related theory and knowledge involved in this study.

The next chapter presents the methodology of study which is a system for the tele – therapy system project.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives an outline of research methods that were followed in the study. We separate the method into 3 sections. Section1 describes the project's designing methodology and system requirements. Section2 is the creation of database parts. The training of physical therapy is represented in section3. A proposed solution is the discussion, followed by a summarize**.**

3.2 Design Methodology

3.2.1 Create the user interface of the mobile phone application

The Settings app on Android includes a screen called Developer options that configure the system behaviors that help profile and debug mobile app performance

3.2.1.1 Setting the mobile phone

- Go to setting, scroll down to the bottom of the setting, and find the System management as shown in figure 3.01.

- Go to the About phone page to tap the Software version field seven times to enable Developer Options. Tap a few times and you will see a toast notification with a countdown that reads "No need, you are already a developer" you can see in figure 3.02.

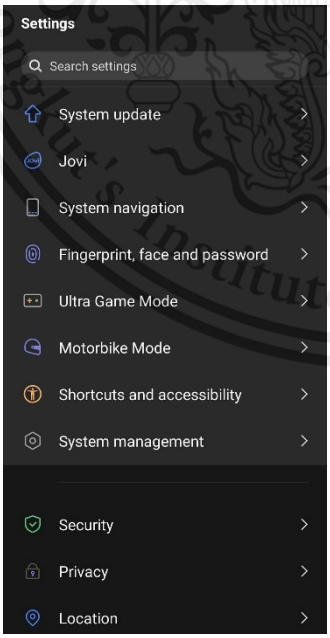
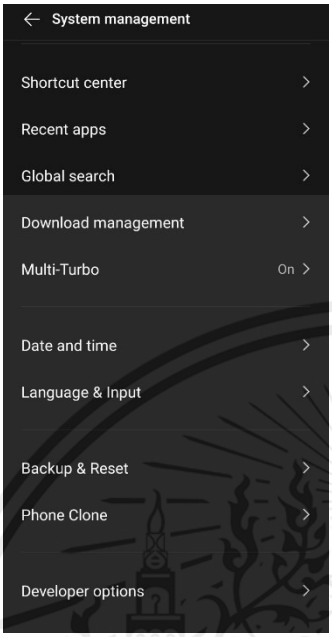


Figure 3.01 Setting page (Left)
Figure 3.02 About phone page (Right)

- Go back to the System management then click on Developer Options bottom to enable the “USB Debugging” slider as shown in figure 3.04.



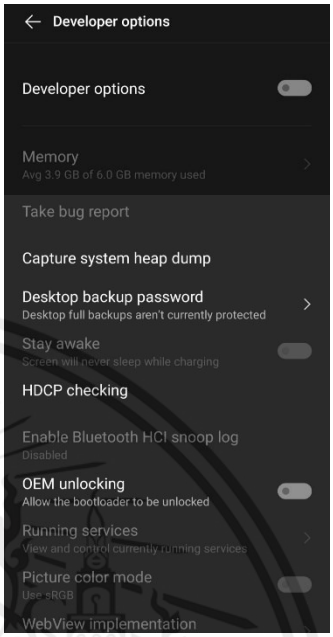
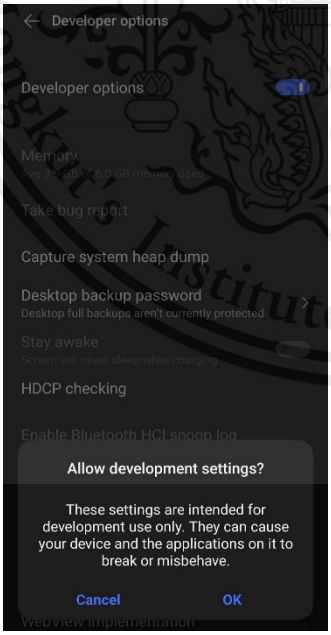


Figure 3.03 Inside the System management (Left)
Figure 3.04 Developer Options (Right)

- After enabling the Developer Options, pop up will occur then click OK to enable it as shown in figure 3.05.



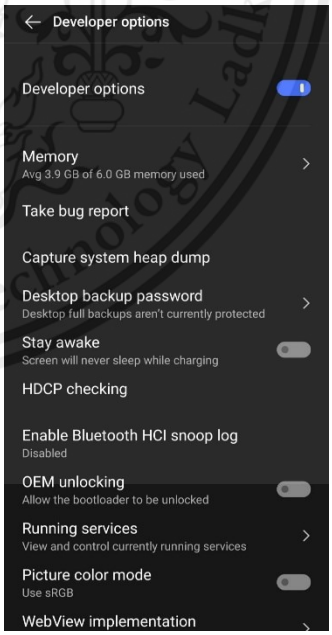
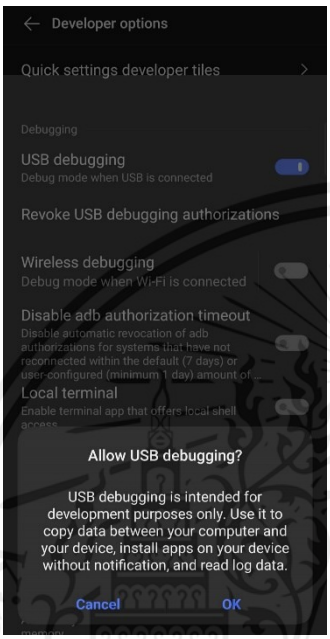


Figure 3.05 Allow development settings (Left)
Figure 3.06 Enable Developer Options (Right)

- USB Debugging was thought to be a security risk if left on all the time. Google has done a few things that make that less of an issue now because debugging requests have to be granted on the phone—when you plug the device into an unfamiliar PC, it will prompt you to allow USB debugging as shown in figure 3.07 and figure 3.08 is USB debugging is opened.



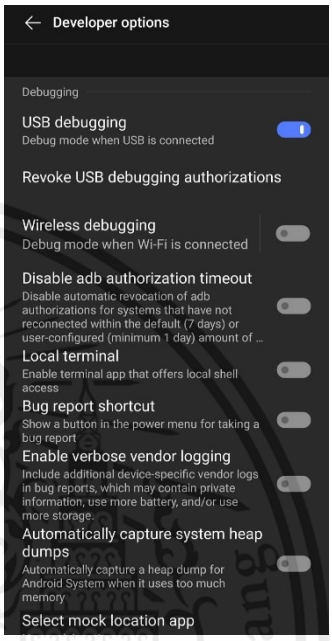


Figure 3.07 Allow USB debugging (Left)
Figure 3.08 Turn on USB debugging (Right)

3.2.1.2 Create a project in Android Studio program (New > New project)
Create a new project for design the user interface of an application

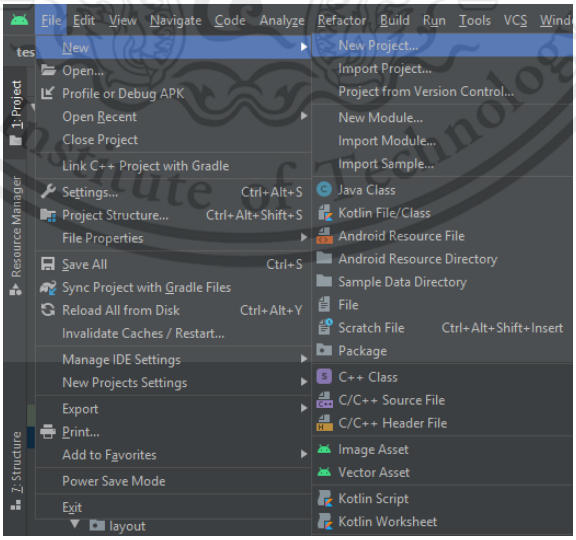
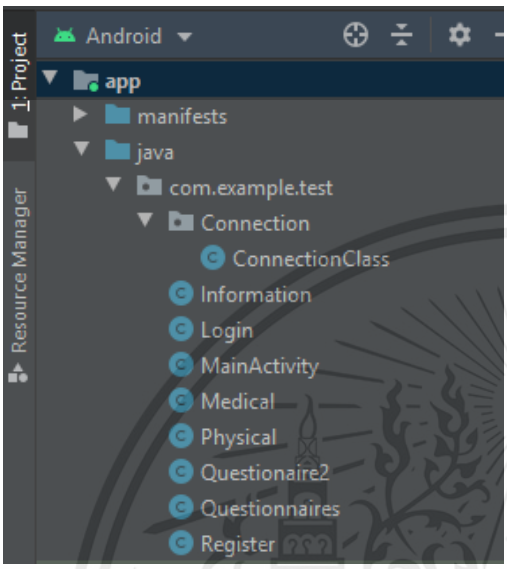


Figure 3.09 Create a new project in android studio

3.2.1.3 Create java class in the project

- Create the java class consist of Information, Login, Mainactivity, Register, Medical, Physical, and Questionaire1 and 2 as shown in figure 3.10.
- XML as the layout of java class above as shown in figure 3.11.



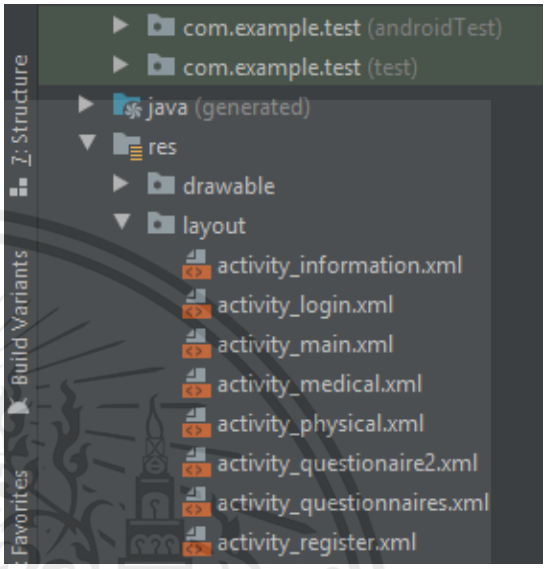


Figure 3.10 Java class (Left)
Figure 3.11 XML class (Right)

3.2.1.4 Design the user interface

- The register page is designed in the activity_register.xml as shown in figure 3.12.

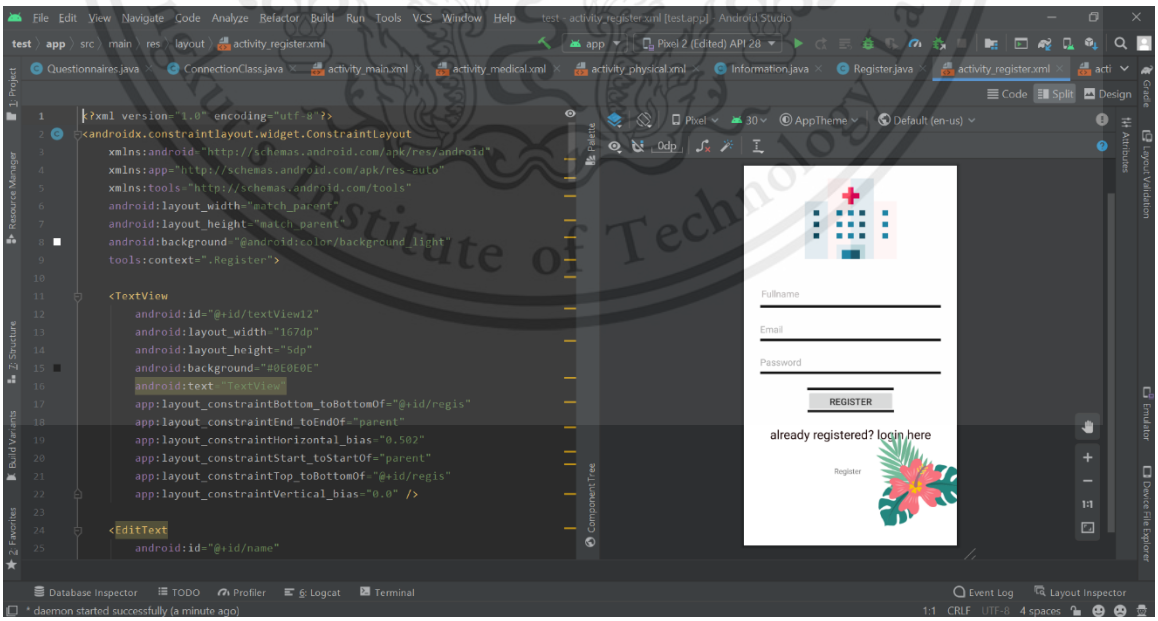


Figure 3.12 Register page

- The login page is designed in the activity_login.xml as shown in figure 3.13.

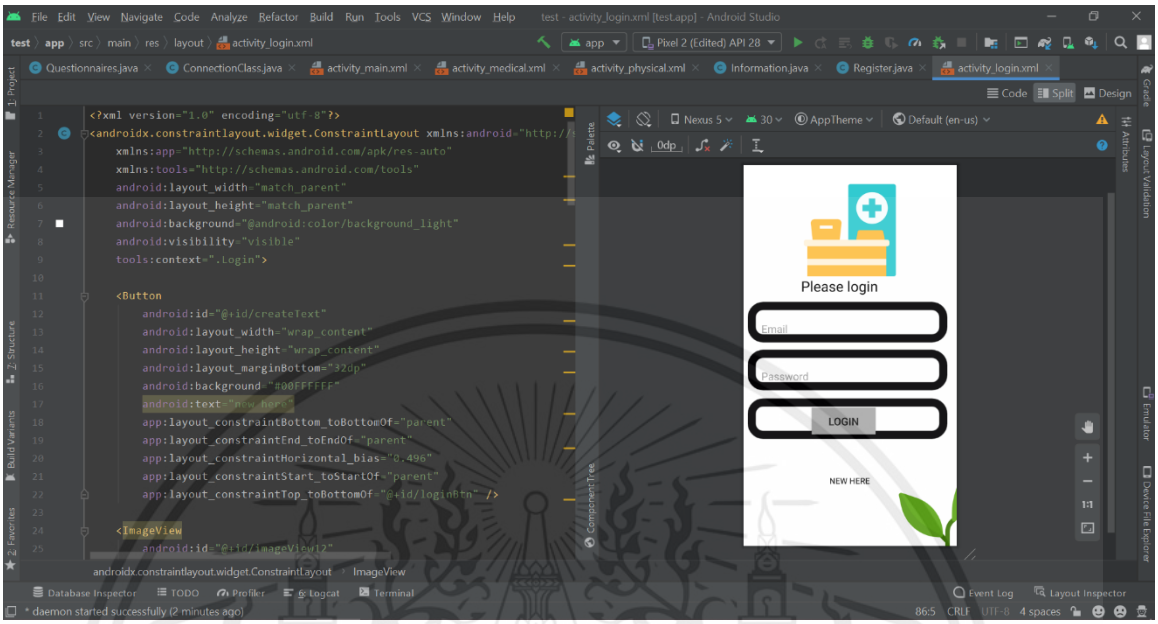


Figure 3.13 Login page

- The homepage is designed in the activity_main.xml for the homepage of mobile application as shown in figure 3.14.

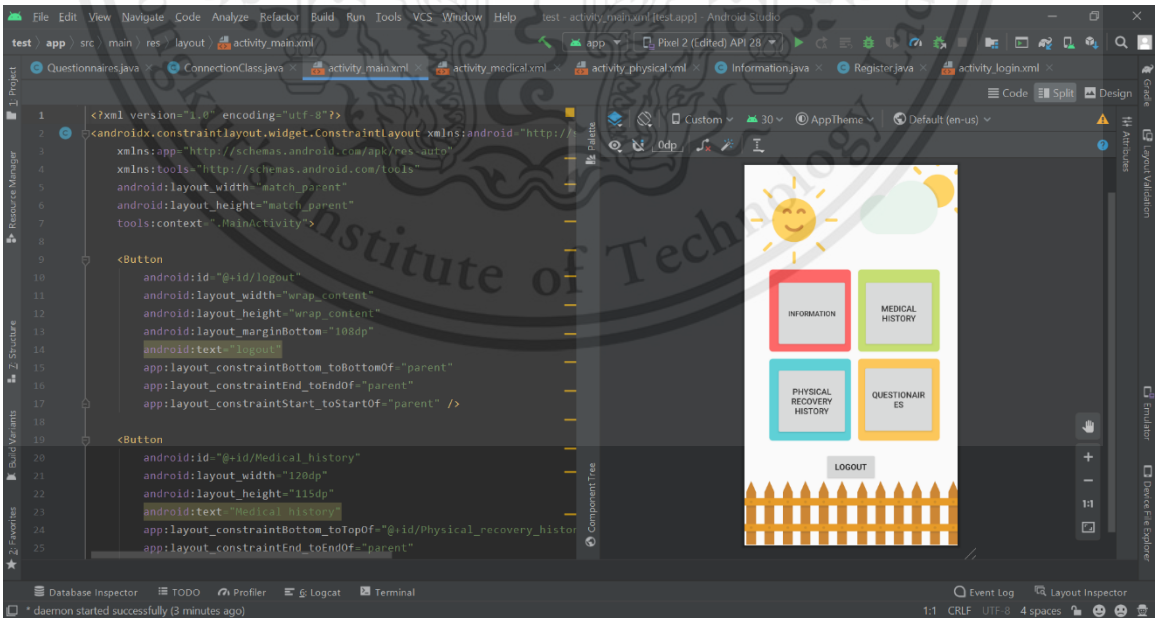


Figure 3.14 Main page

- The information page is designed in the activity_information.xml for filling in the personal information of the patient as shown in figure 3.15.

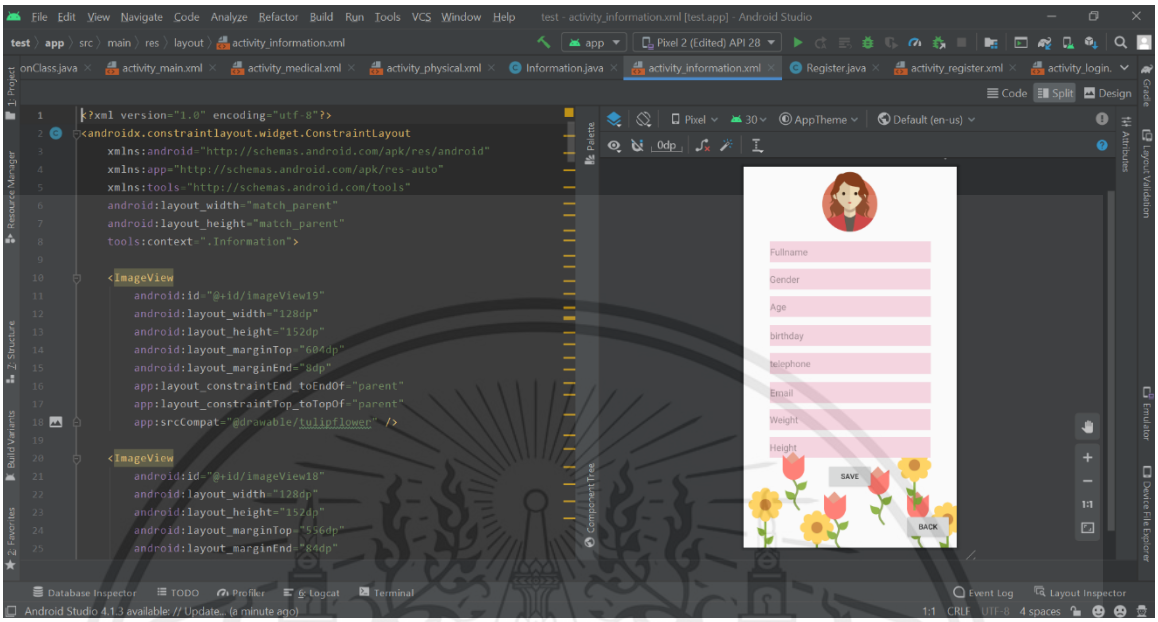


Figure 3.15 Information page

- The medical page is designed in the activity_medical.xml for the medical history that staff will fill in as shown in figure 3.16.

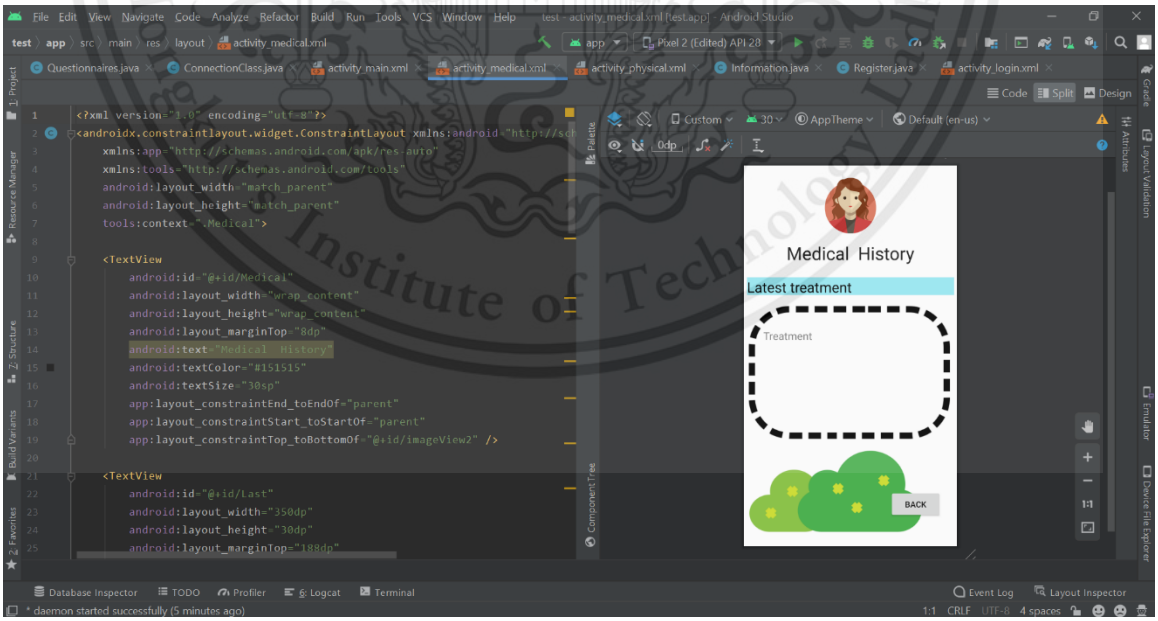


Figure 3.16 Medical history page

- The physical recovery history page is designed in the activity_ physical.xml for the treatment history of the patient as shown in figure 3.17.

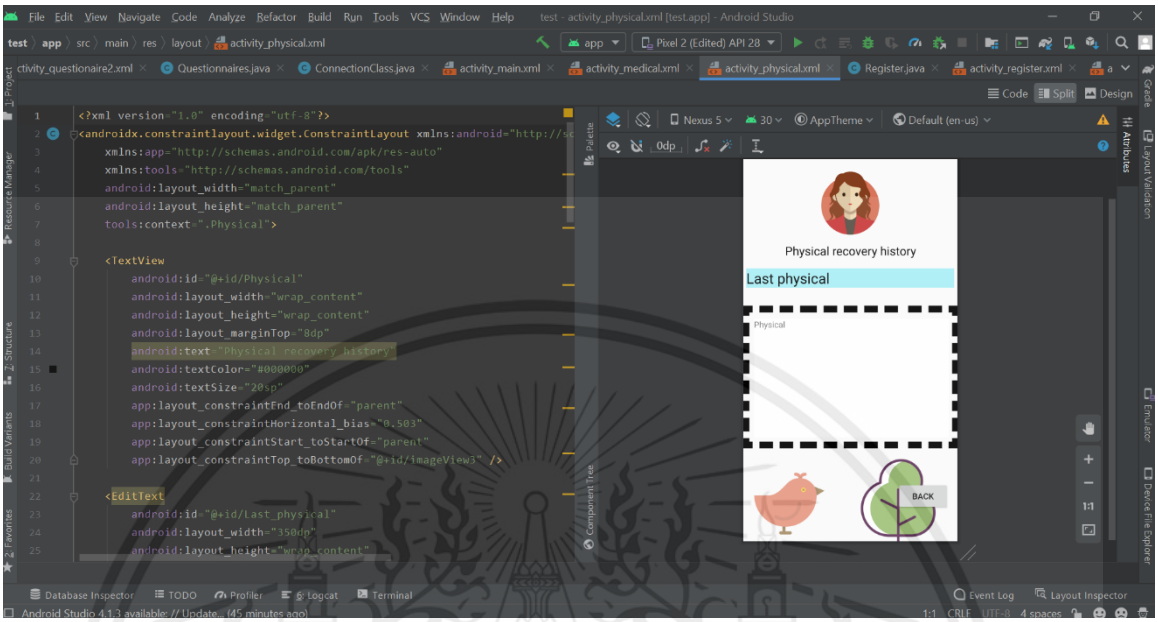


Figure 3.17 Physical recovery history page

- The questionnaire page is designed in the activity_ Questionnaire.xml for the examination of the patient as shown in figure 3.18.

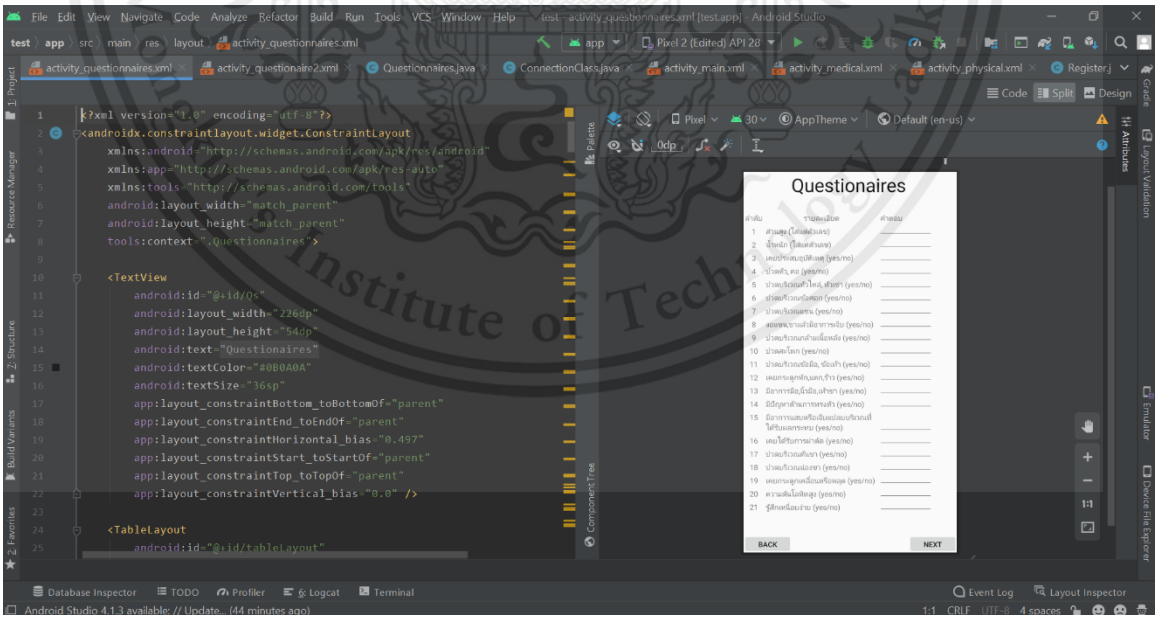


Figure 3.18 Questionnaires form

3.2.1.5 Run on device

- In the toolbar, select the app from the run configurations drop-down menu. From the target device drop-down menu, select the device that wants to run the app on. The name of the device that connected with the android studio program is vivo vivo 1915 (mobile phone) as shown in figure 3.19.

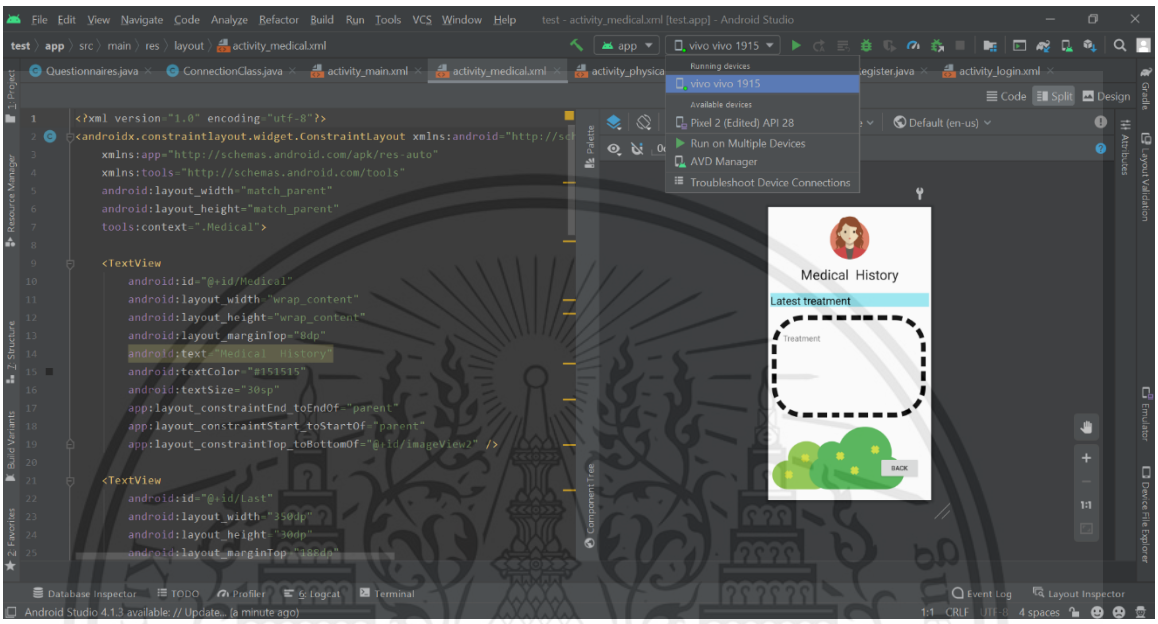


Figure 3.19 Run on device

- Figure 3.20 is displayed on the mobile phone that USB debugging is connected. It means that the mobile phone is connected with the Android Studio program. The testing running on the mobile phone screen is displayed as shown in figure 3.21 start with the register page.

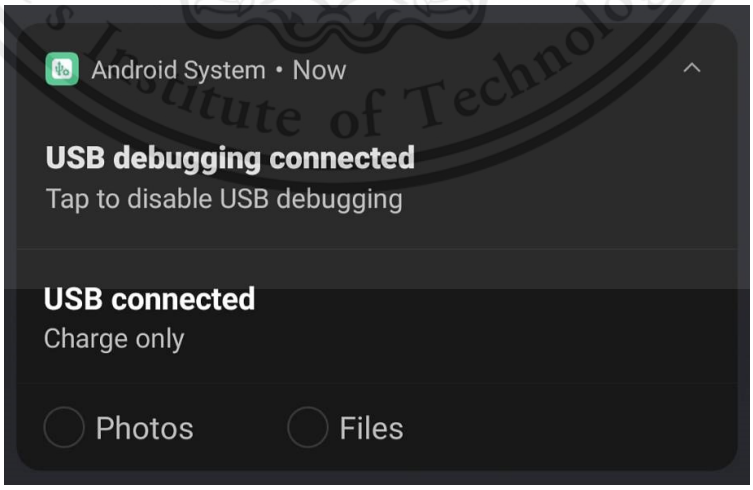


Figure 3.20 Android System display

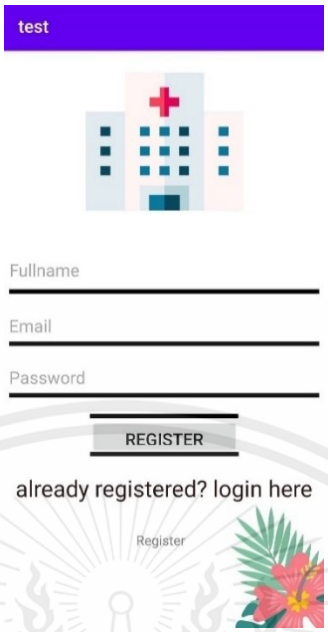


Figure 3.21 Test running

3.2.2 Database part

- Create a table in Microsoft SQL Server Management Studio that using SQL language for writing the code. Set the userid to the primary key of the register and information table. The coding of the register and information table is shown in figure 3.22 and 3.23

```
CREATE TABLE register (
userid      decimal(18, 0)    PRIMARY KEY,
name        VARCHAR(50)       NOT NULL,
email       VARCHAR(50)       NOT NULL,
password    VARCHAR(50)       NOT NULL,
);
```

Figure 3.22 Register table

```
CREATE TABLE information (
userid      decimal(18, 0)    PRIMARY KEY,
name        VARCHAR(255)      NOT NULL,
gender      VARCHAR(50)       NOT NULL,
birthday    VARCHAR(50)       NOT NULL,
email       VARCHAR(50)       NOT NULL,
age         INTEGER           NOT NULL,
phone       VARCHAR(50)       NOT NULL,
weight      VARCHAR(50)       NOT NULL,
height      VARCHAR(50)       NOT NULL,
);
```

Figure 3.23 Information table

- Right-click at the table created after that click the design button to set the properties as shown in figure 3.24.

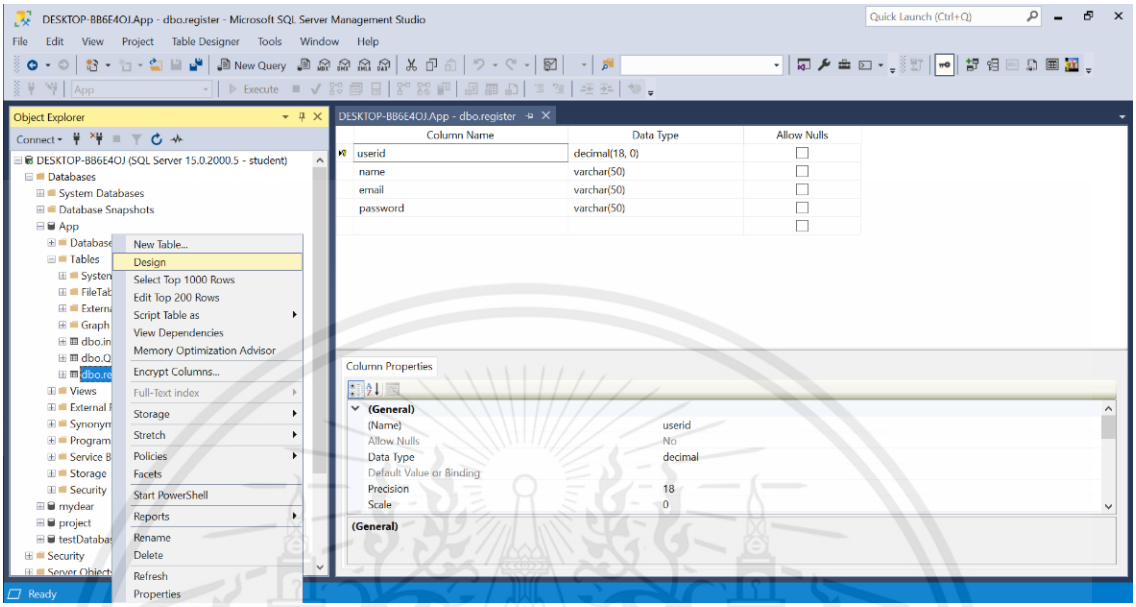


Figure 3.24 Design of register page

- Setting the identity Specification to yes for allowing of a new row of the table as shown in figure3.25.

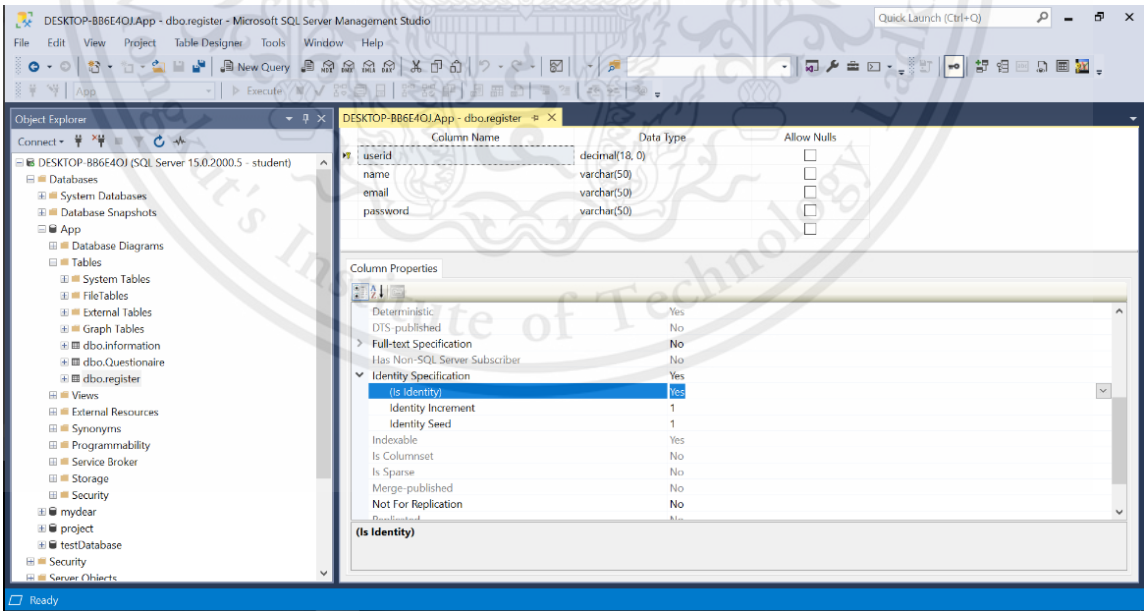


Figure 3.25 Setting the table

3.2.3 Connect Android Studio and Microsoft SQL Server Management Studio

- Figure 3.26 is shown the diagram for connecting the Android Studio and Microsoft SQL Server Management Studio.

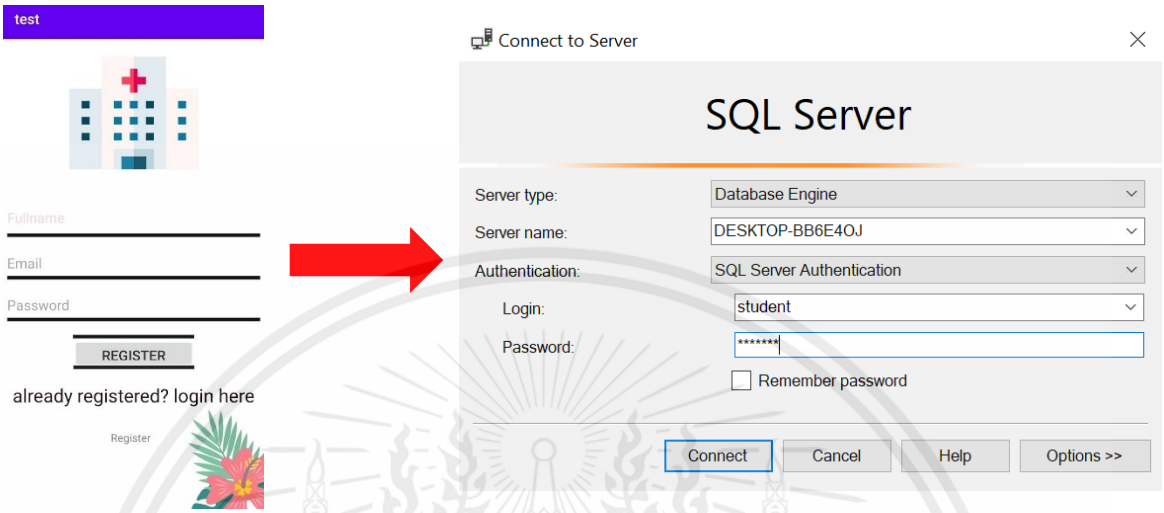


Figure 3.26 Connect Android Studio and Microsoft SQL Server Management Studio

- We use the JTDS.jar library that can download from the internet for connecting with the database.

- Copy the downloaded library in the android project's library folder and add it as a library to project inside the libs as shown in figure 3.27.

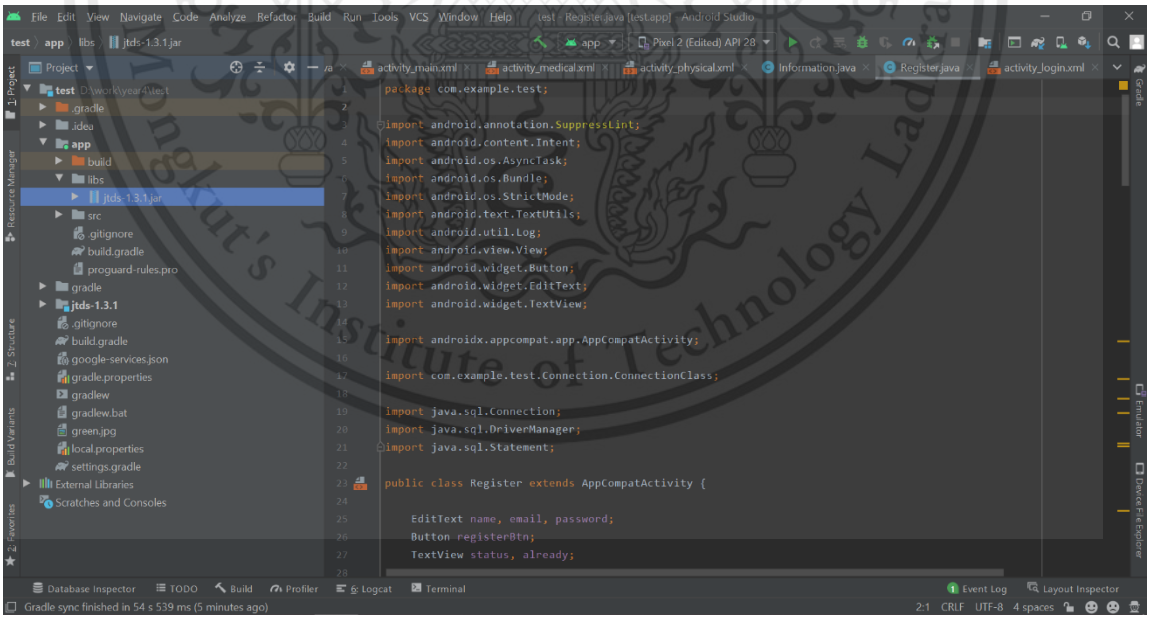


Figure 3.27 Add as Library JTDS library

- Create a java file in android's project with the name ConnectionClass.java. This class will return a database connection object which can be used to connect with our database. We define the username, password, and database name as a student, student, and App of Microsoft SQL as shown in figure 3.28.

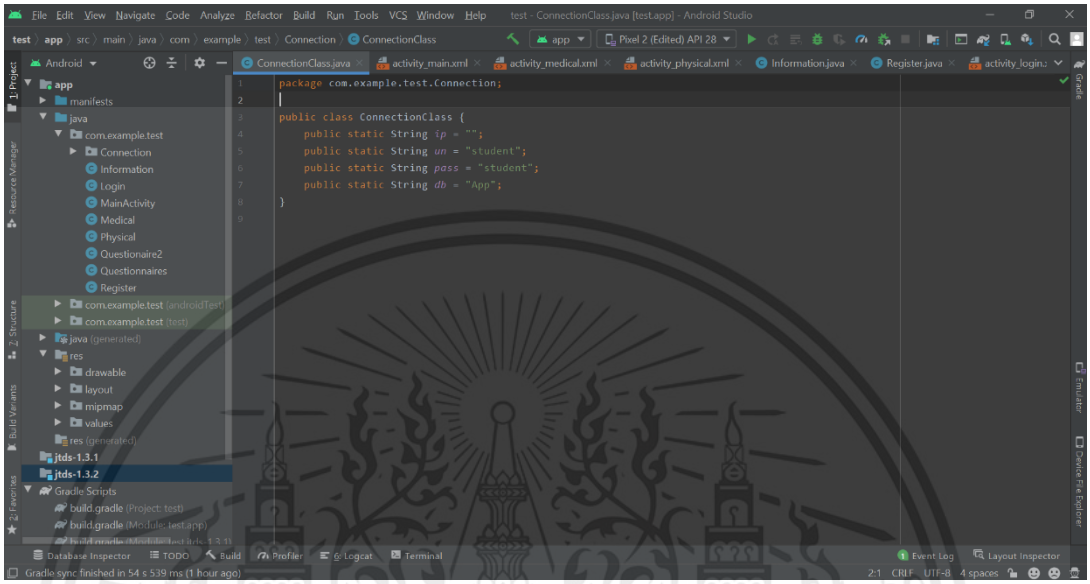


Figure 3.28 Create ConnectionClass.java

- Line 33 in figure 3.29 is very important in adding information. We will add information into the register table, so we define a URL with IP is equal to 192.168.43.210, which is the number of IP Address Location or IP Private Network coming from the hotspot internet on the mobile phone.

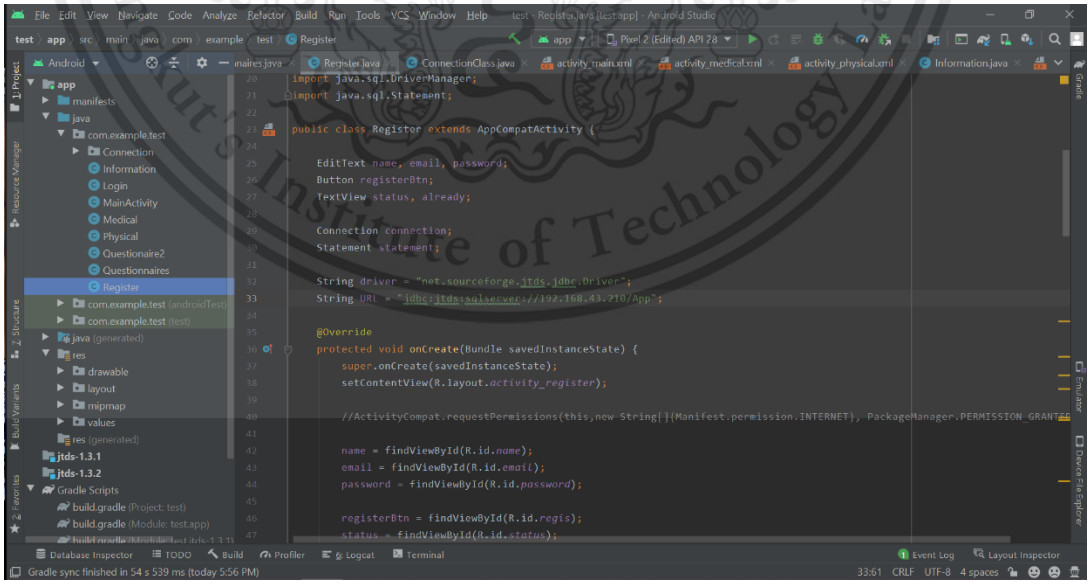


Figure 3.29 Register.java

3.2.4 open webcam camera in PyCharm program

For test the PyCharm program, we firstly import cv2 from OpenCV as a library for all sorts of image and video analysis, like facial recognition and detection.

```python
import cv2
cam = cv2.VideoCapture(0)
frame_height = int(cam.get(cv2.CAP_PROP_FRAME_HEIGHT))
frame_width = int(cam.get(cv2.CAP_PROP_FRAME_WIDTH))
frame_size = frame_width, frame_height


def show_webcam(mirror=False):
    while True:
        ret_val, img = cam.read()
        if mirror:
            img = cv2.flip(img, 1)
        cv2.imshow('my webcam', img)
        if cv2.waitKey(1) == 27:
            break  # esc to quit
    cv2.destroyAllWindows()

def main():
    show_webcam(mirror=True)

if __name__ == '__main__':
    main()
```

Figure 3.30 Code for open camera

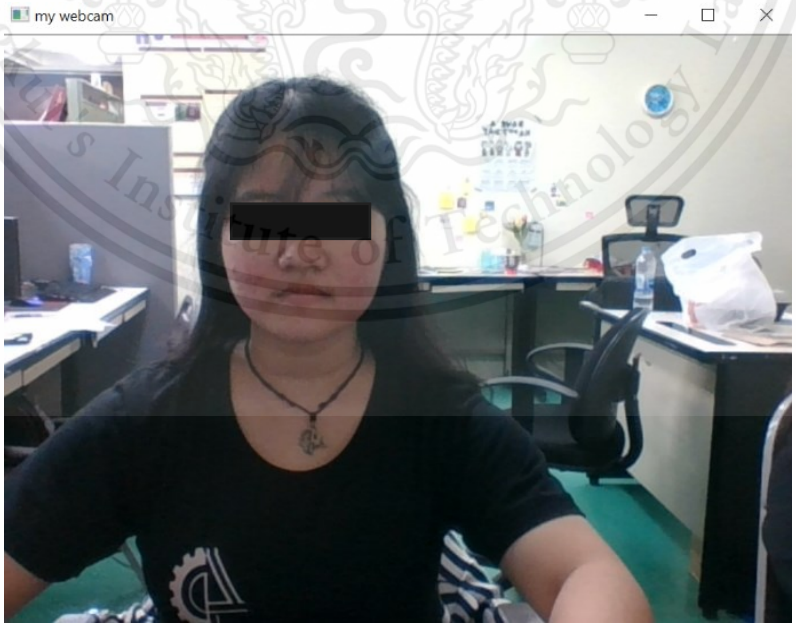


Figure 3.31 Output of open camera

3.2.5 Parameters part

3.2.5.1 Detect part of body.

- We use deep learning library in python to define the parts of body consist of 18 points as shown in figure 3.32.

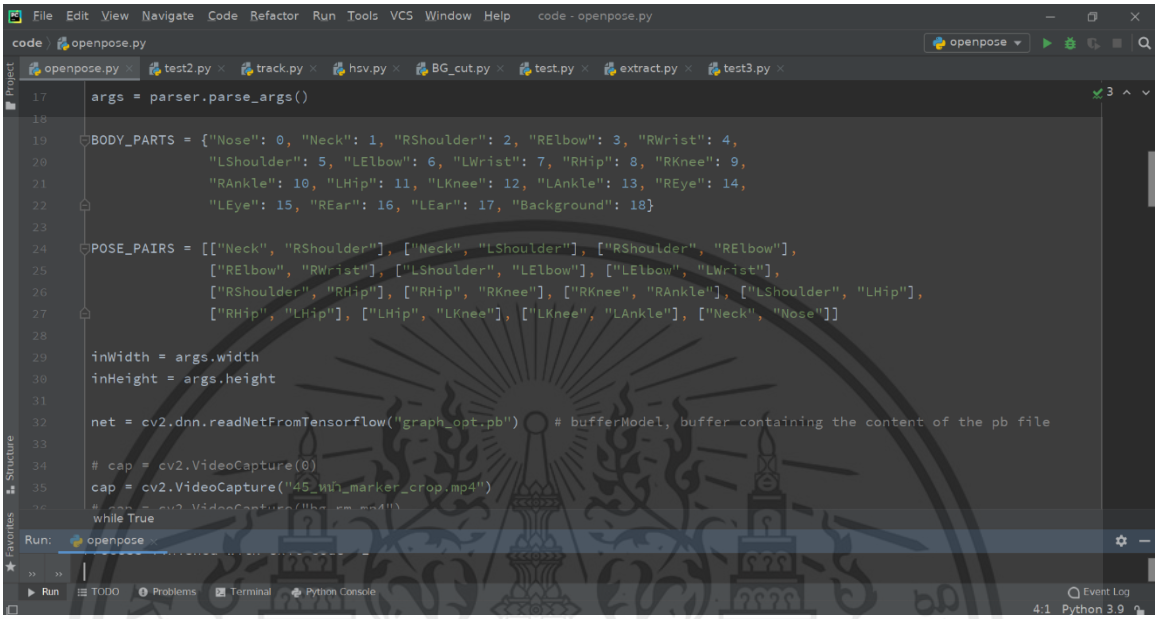


Figure 3.32 Define part of the body

- Use the background subtraction method to remove the background out after that replace it with a white background. The code for background subtraction is shown in figure 3.33.

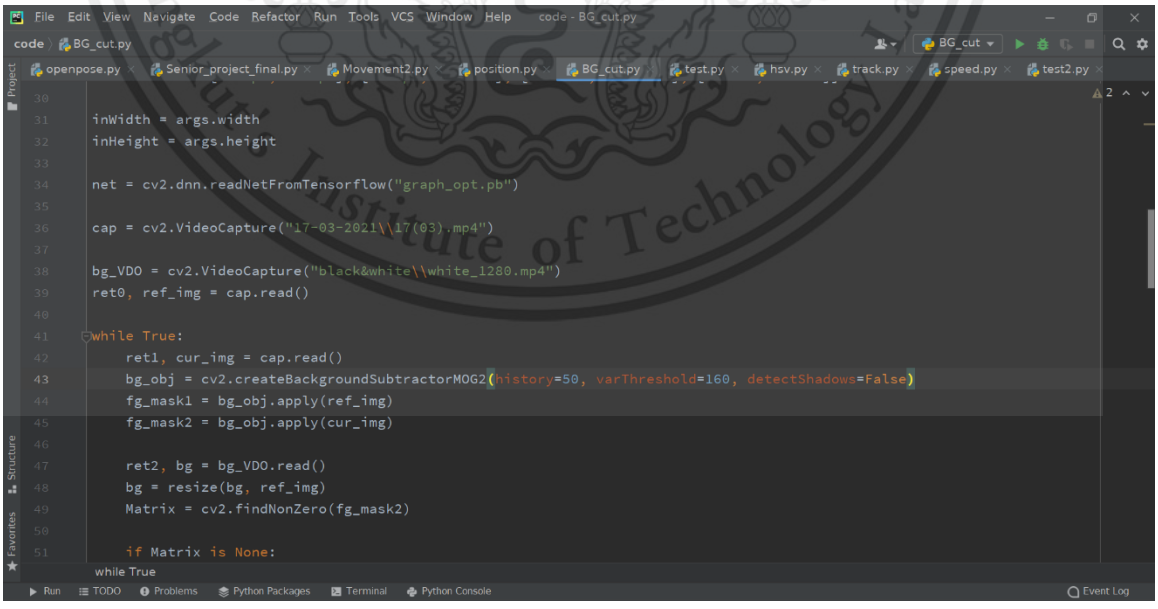


Figure 3.33 Cut the background

- We use python language in the PyCharm program to model people by creating yellow lines along the body lines. The blue and red lines are shown the line between shoulder - elbow, and shoulder - hip. The black dots on 2 sides of the wrists as shown in figure 3.34.

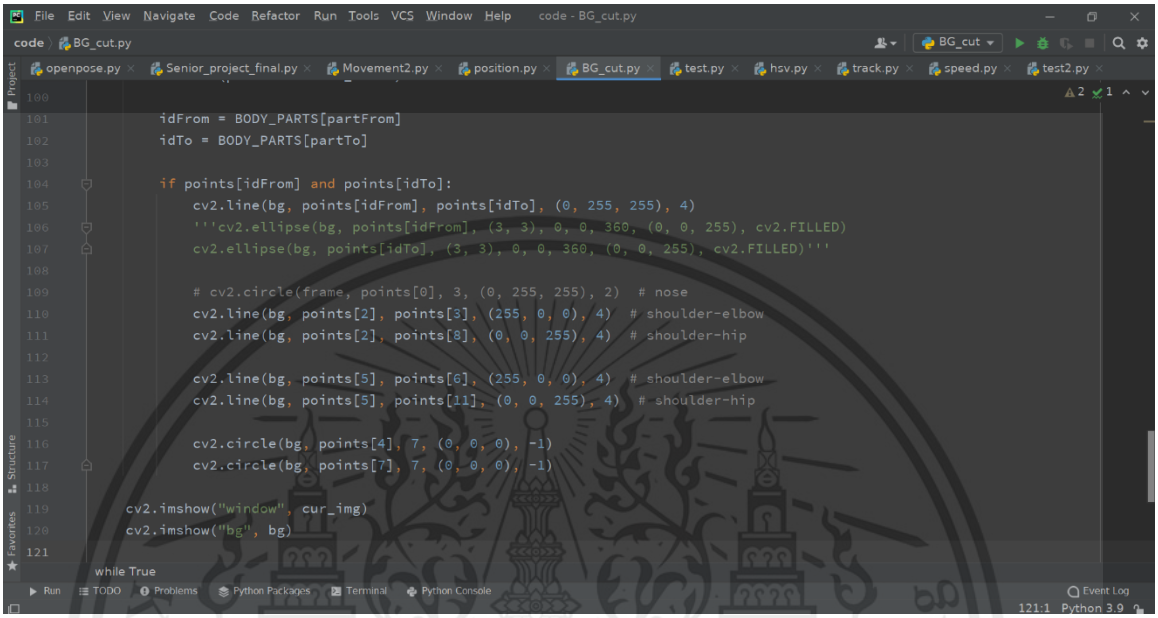


Figure 3.34 Create the line

3.2.5.2 Calculate an angle

- For calculating an angle between elbow - shoulder - hip (shoulder angle), we use the law of cosine theory which given three sides of a triangle. Figure 3.35 is shown the calculation of the length of the triangle.

Figure 3.35 Formula of length

- We use the math library in python for calculating an angle and focus on gamma or shoulder angle. We define gamma 1 and 2 as a left and right side of the shoulder as shown in figure 3.36.

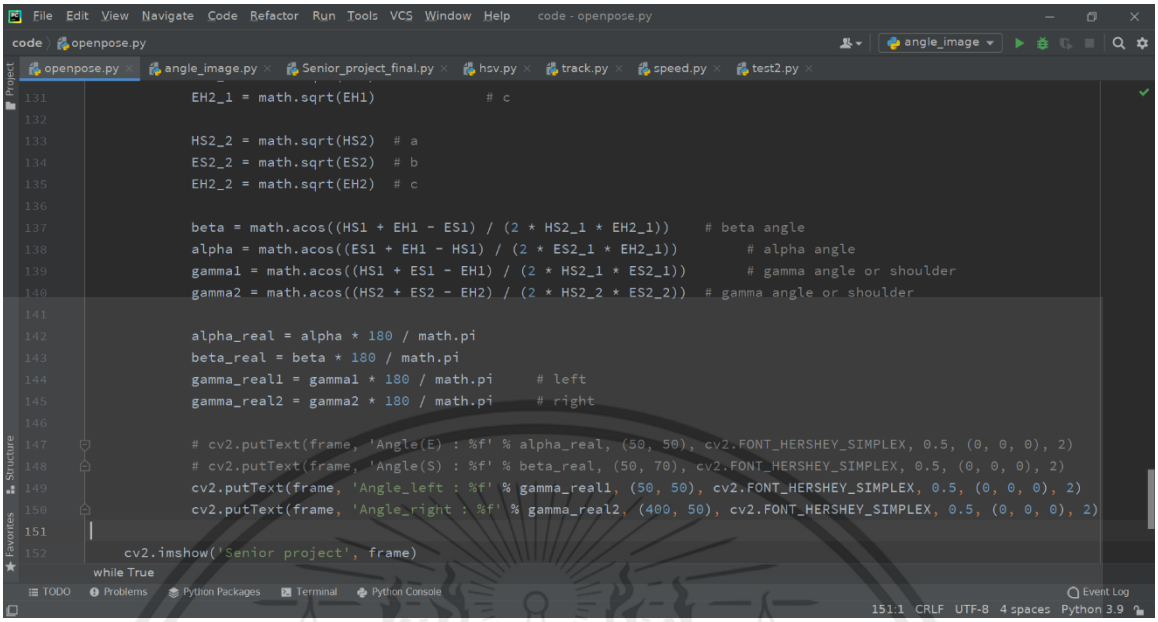


Figure 3.36 Calculate the angle

3.2.5.3 Track path

- First we decide to use HSV threshold theory to get the track path by input the recorded video into the PyCharm program after that do the coding to get the HSV value that consists of the upper and lower bound. We focus on the green mark on the patient's wrist. Slide the scrollbar for finding the interesting value, then the upper bound value of green color is (113, 255, 138) and the lower bound value of green color is (68, 111, 21) as figure 3.37. The code is shown in figure 3.38.

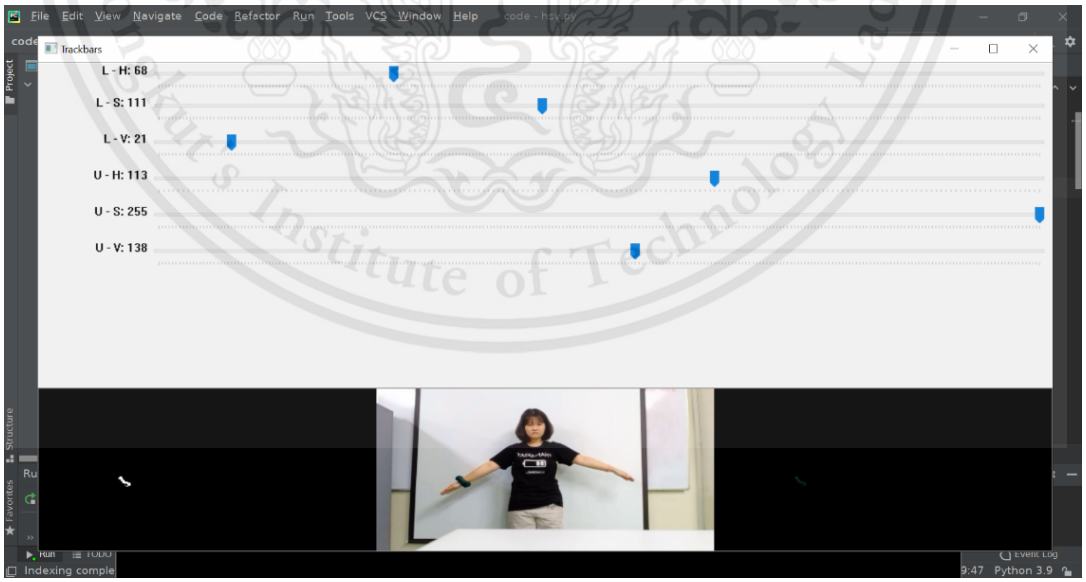


Figure 3.37 HSV threshold of green mask

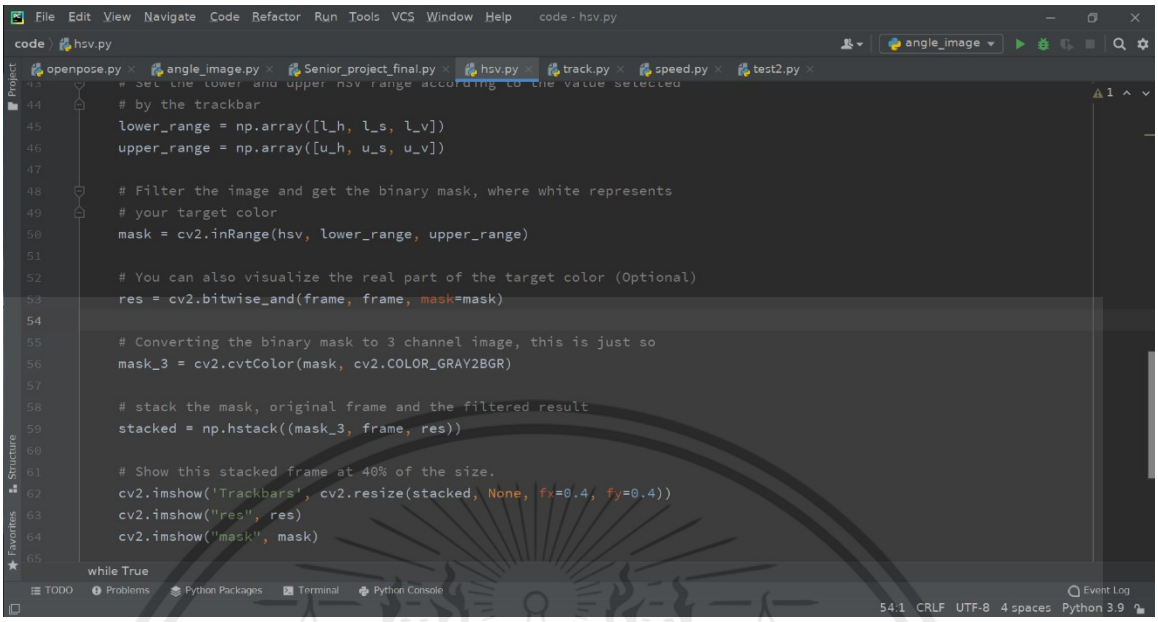


Figure 3.38 Code for HSV threshold

- We create a mask, which uses an "inRange" statement, for our specific range. This is true or false, black, or white, so the mask of green color is in the yellow circle of figure 3.39.

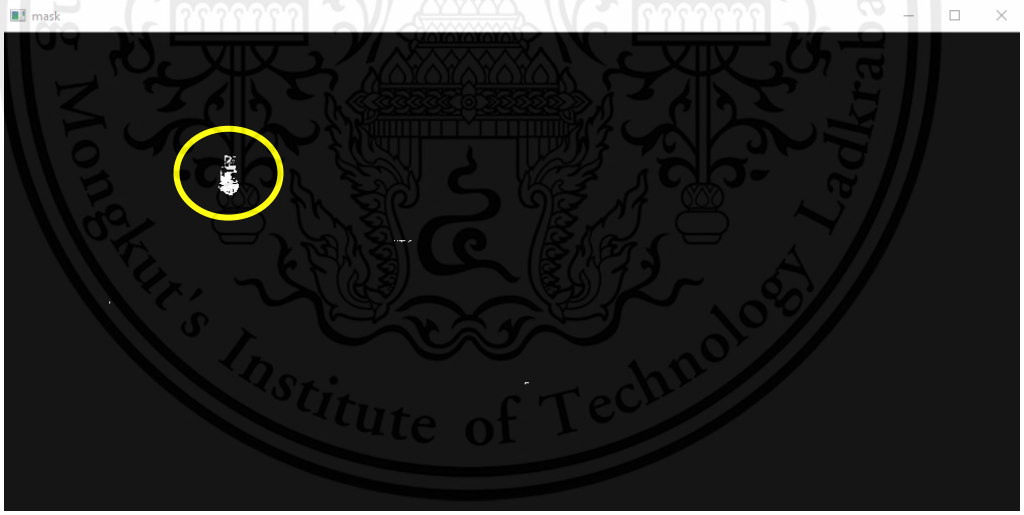


Figure 3.39 Mask

- Next step is we "restore" our interesting object or green marker by running a bitwise operation. Basically, we show color where there is the frame and the mask. The white part of the mask will be green range, which was converted to pure white, while everything else became black. Finally, we show it all. We chose to show the original frame, the mask, and the final result or green color as shown in figure 3.40.

Figure 3.40 Green color residue

- Find the center of an interesting object or green marker, the next step is creating the yellow circle then build the red line as a track path. Figure 3.41 is the code for finding the center of the green marker and creating the red line.

Figure 3.41 Create track path

3.2.6 Practice physical therapy part

Using a long cane or a PVC pipe to practice the physical therapy was an accepted posture in a patient's practice of physiotherapy, so we write code using our computer's camera. The correct posture of holding the PVC pipe, the hand in which the frozen shoulder is placed on top. The hand on the shoulder that normal is placed underneath so that it will be the side that exerts for physical therapy. Demonstrate the correct posture, patient holds the PVC pipe as shown in figure 3.42. Put a tennis ball at the tip of the PVC pipe for easy detection.

Figure 3.42 Demonstrate holding the PVC pipe

- In this part, we will separate the method into 3 main steps. The first step is the process of getting the HSV value of the tennis ball. The following step is the condition when patients do the physical therapy practice by themselves. Giving the score and feedback is the last step of this part.

- Find the HSV value of the tennis ball by sliding the scrollbar until got the correct value or at the left figure is remain only tennis ball as shown in figure 3.43.

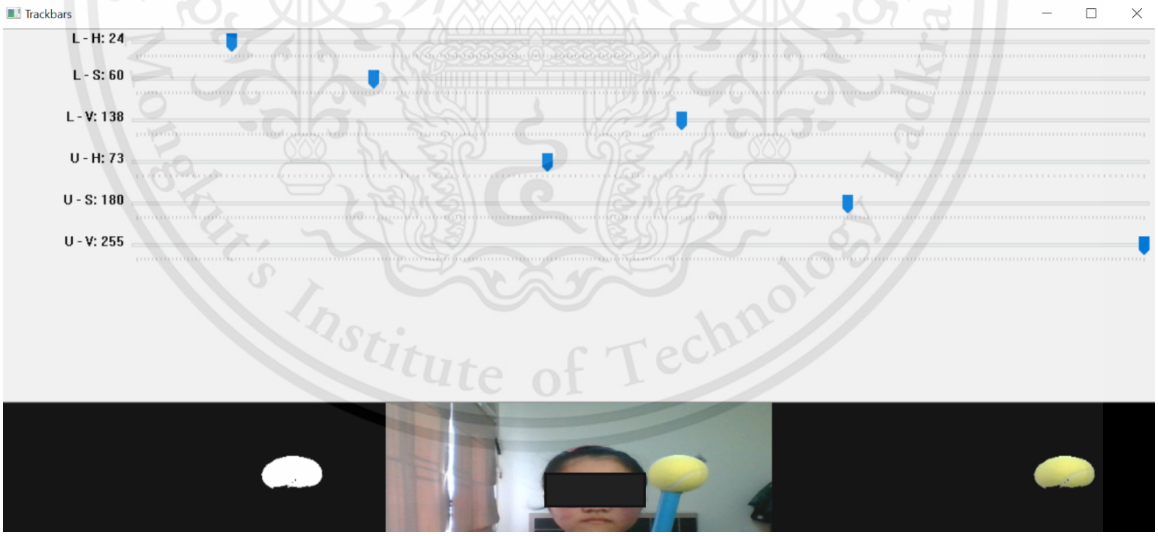


Figure 3.43 Find the HSV value of tennis ball

- Flowchart is the most important thing before coding because it makes it easier to plan the work. The first step of the second process is setting the x, y coordinate as a (310, 430) for adding an image on the frame. Afterwards, create the condition of tennis ball hitting the virtual ball, so the condition is (x - 30) < last_point_x < (x + 30) and (y - 30) < last_point_y < (y + 30). If the resulting value is followed in the condition, the score

increases 1 point. The x, y coordinate will update to x = x – 40 and y = y – 65 then 5 second countdown timer. We create the loop for easy coding. If the score is equal to 6, finish the code. The flowchart shown in figure 3.44 is demonstrating the process of raise the arms.

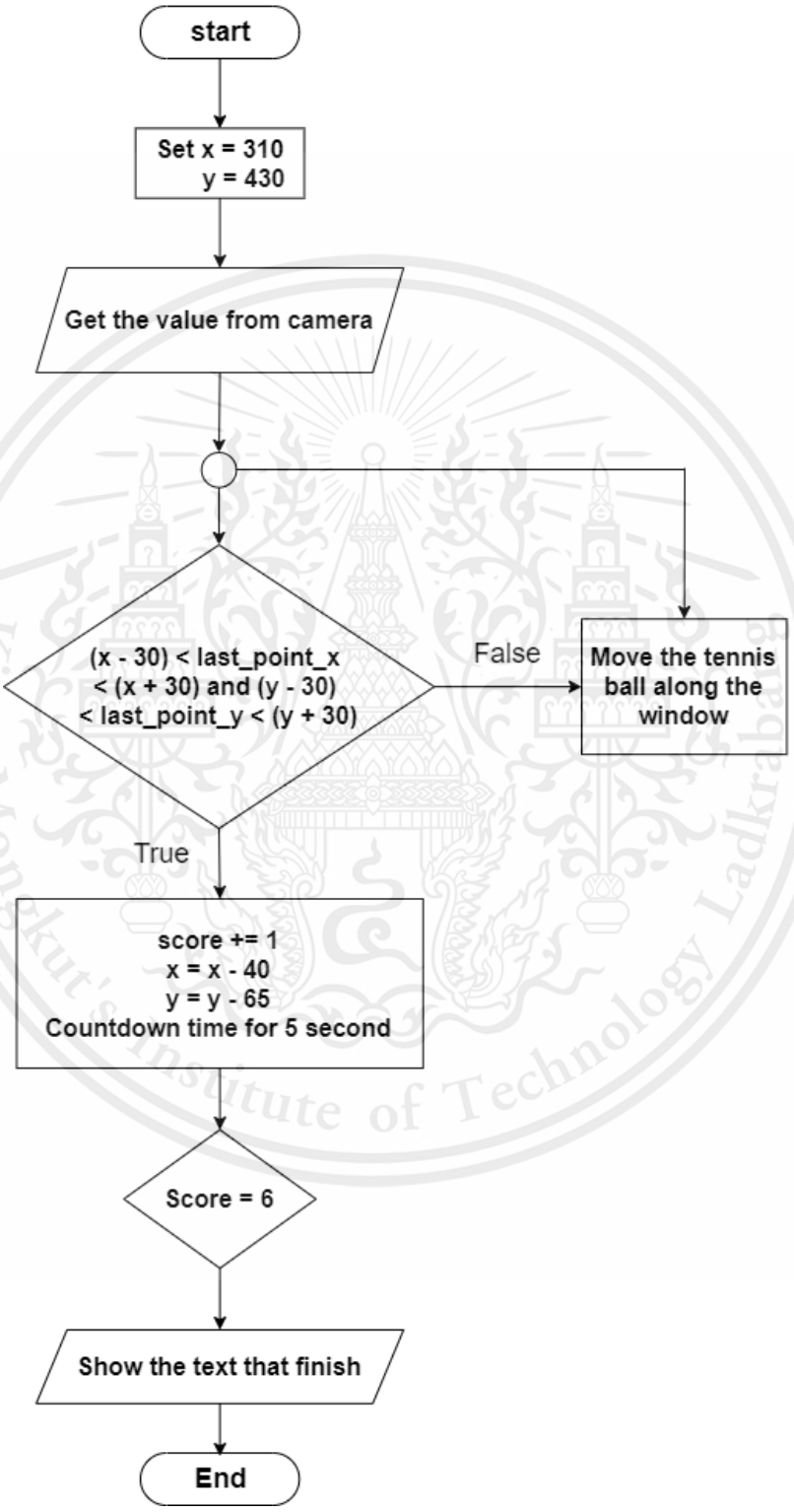


Figure 3.44 Flowchart for Arms raised

- The process of put down the arms is shown in figure 3.45. The process is quite similar to figure 3.44 but x, y coordinates start with 70 and 40. The x, y coordinate will update to x = x + 40 and y = y + 65 when the tennis ball hits the virtual ball.

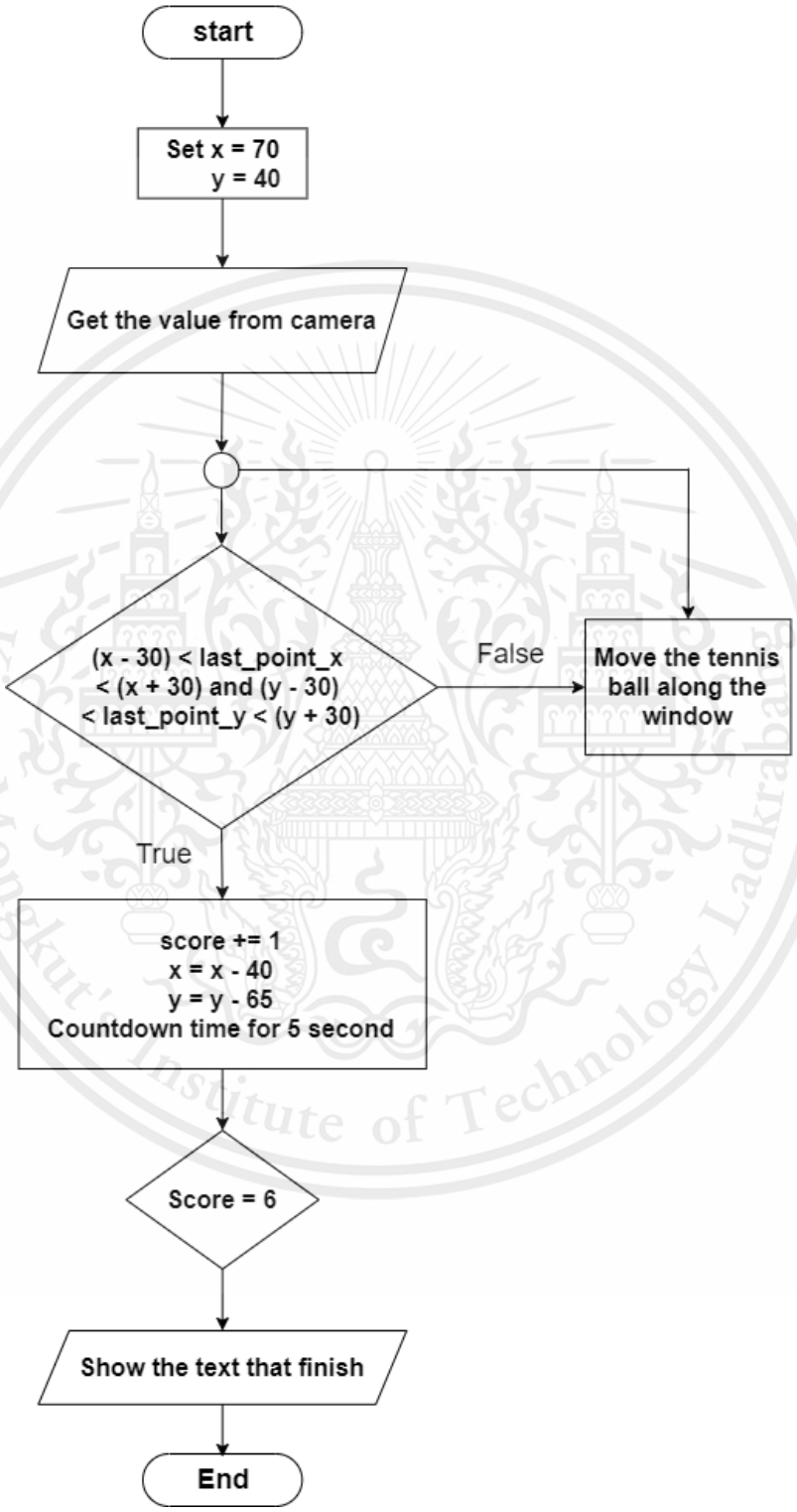


Figure 3.45 Flowchart for put arms down

- For the coding, we use the while loop to be the condition of the patient in the practicing of physical therapy as shown in figure 3.46.

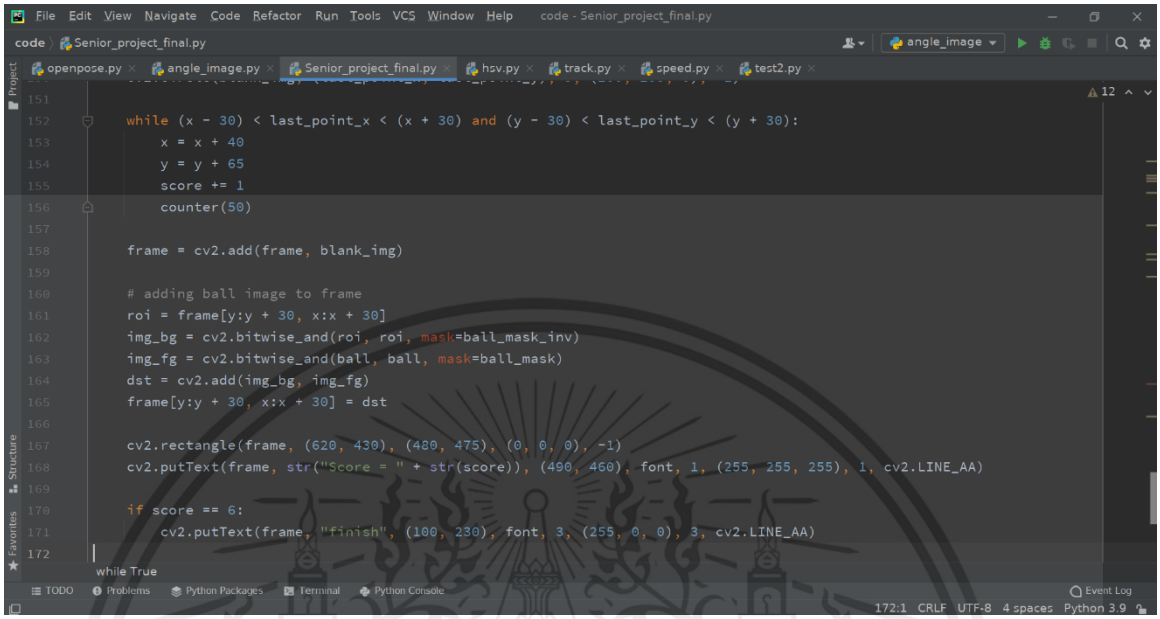


Figure 3.46 Coding of condition

3.3 Interesting Problems

The problem that we encountered is connecting the database at the beginning, which is the initial problem of the project. First, we use the firebase as a database collecting. The second problem is tracking the motion of the patient's activity that will be used in the rehabilitation process or physical practice for patients. The third problem is background and light are the obstacles. The most important problem is the process of physical practice for patients.

3.4 Proposed Solution

From the problem of connecting the database at the beginning, solving the problem by changing the database storage server to suit the project. That server is Microsoft SQL Server Management Studio. This program can connect to the designed UI (User Interface) and store data. In the part of the second problem, we solve it by using python language to detect the motion of a patient and create the virtual object for physiotherapy practice of patients by themselves.

3.5 Summary

This chapter described the designing of Tele - therapy system that helps patients in physical therapy. This chapter started by describing mobile phone settings, project design, or user interface design in the android studio program, the table as a collected table in medical record designed from Microsoft SQL Server Management Studio, connecting the android studio program with Microsoft SQL Server Management Studio together. The last step, the system which assists in the training of the patient's physical therapy by using the knowledge of python. The proposed solution will discuss in the section proposed solution as mentioned above, there will be covered in further detail in Chapter 4 which describes the implementation of solutions to apply in future work.

CHAPTER 4
EXPERIMENT RESULT

4.1 Introduction

In this chapter the results of the study are presented regarding the aim of the study about the Tele - Therapy system in three sections and a summary of the results. This chapter is organized as follows: Section 1 is the user interface of the mobile phone application. Section 2 presents part of the collecting database. The results of the study are present in section 3 about analyzing data such as detect the patient's body, find the parameter related to physical therapy and give feedback about a physical problem or frozen shoulder. These aspects were described in the previous chapter that presented the methodology used in the study.

4.2 User interface of the mobile phone application

This section is covering the design of the user interface that consists of the register page, login page, main page, information page, medical page, physical recovery history page, and questionnaires form as shown in 4.01, 4.02, 4.03, 4.04, 4.05, 4.06, and 4.07.

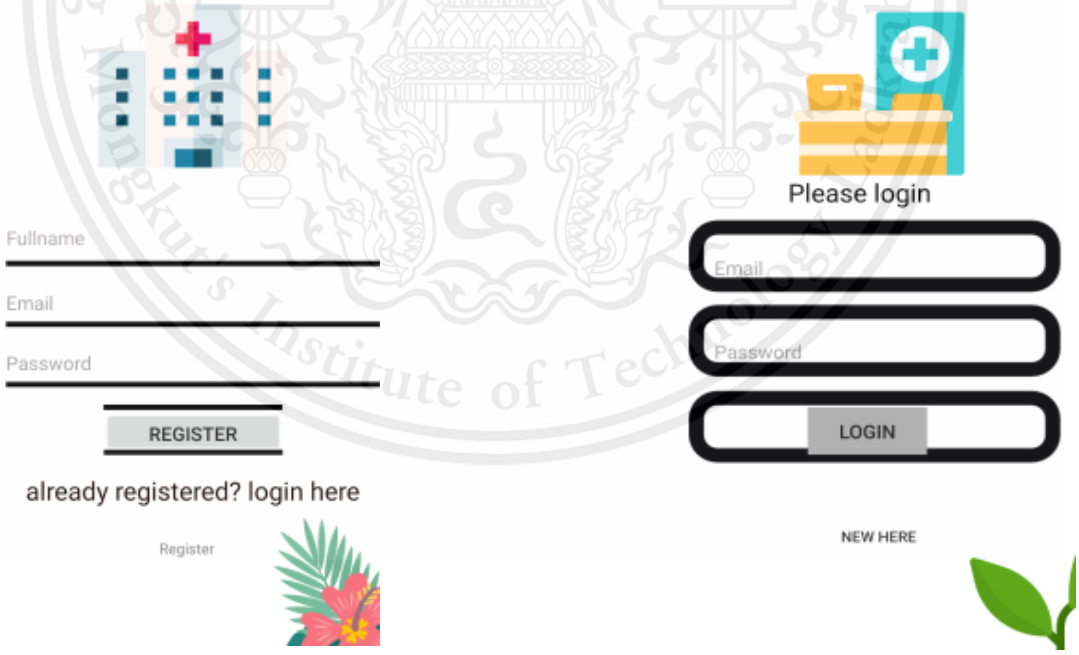


Figure 4.01 Register page (Left)
Figure 4.02 Login page (Right)

Figure 4.03 Main page (Left)
Figure 4.04 Information page (Right)

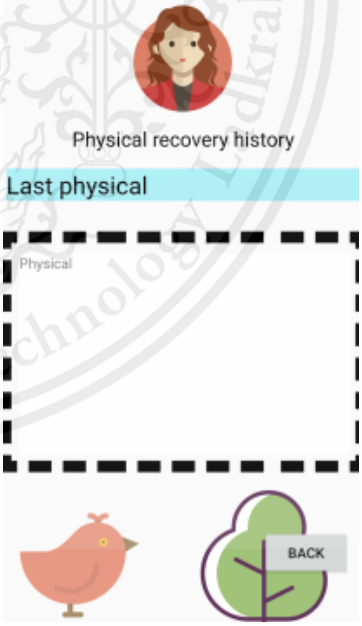


Figure 4.05 Medical page (Left)
Figure 4.06 Physical recovery history page (Right)

Figure 4.07 Questionnaires form

From the figure mentioned above, there are a total of 7 images that consist of the first page is the register page. If the patients do not have information or data in the database of the hospital or clinic, they are required to complete the registration information such as full name, e-mail, and password. After the registration is complete, patients can log in by filling an e-mail and password as shown in figure 4.02. When the patients have successfully logged in to the system, the application will show the main page as shown in figure 4.03 which can go to 4 different windows. The first subpage is the Information page. There are 8 blocks inside this page for the patients to fill in their personal information. After that, the patient's information will be stored in the hospital or clinic database for the patient's medical record. Other information of the patient such as medical history, drug history, appointments, the staff will fill in for update the patient's information into the application so that patients can see their information. The last page is the questionnaire form. The patient can fill out the answers on the examination.

4.3 Collecting database

The data is collected in Microsoft SQL Server Management Studio as a server.

userid	name	email	password
1	N	n	r
2	S	6	f
3	Tl	6	1
4	K	6	1
5	K	6	1
6	N	h	r
7	Ta	n	1
8	w	ss	v

Figure 4.08 Information of register table

userid	name	gender	birthday	email	age	phone	weight	height
1	N	Female		nannaph...	22	0	48	150
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 4.09 Information of information table

From the 2 of the figures illustrated above, there are 2 tables. Figure 4.08 is shown a table of patient information that is filled in. This information comes from the register page in the application which we collect on the Microsoft SQL Server Management Studio program. Figure 4.09 is a table of patient information that comes from the information page.

4.4 Analyze data

This topic introduced the results of image processing such as detect the body's parts, calculate an angle, and find the track path including the practice of physical therapy.

4.4.1 Parameter part

4.4.1.1 Detect body

To make it easier to detect, if the background that patient record the video sent to the physiotherapist for analyzing the data is not the uncleared background, it may be difficult to detect part of body, so we have another way to solve the conflict. This is removing out the background image by cutting the background out and replacing it with a white background. Set the connecting line between the points using the yellow line. The blue lines represent the lines that connect the point between the shoulder and the elbow, and the red lines shown in figure 4.10 is the lines that connect the point between the shoulder and the hip.

Figure 4.10 Detection body

4.4.1.2 Angle

We use python language as a command to find the degree of arm elevation of the patient using the shoulder as the center. We get an angle of the left and right side are approximately 77.57 and 69.07 degrees (angle between the blue and green lines) as shown in figure 4.11.

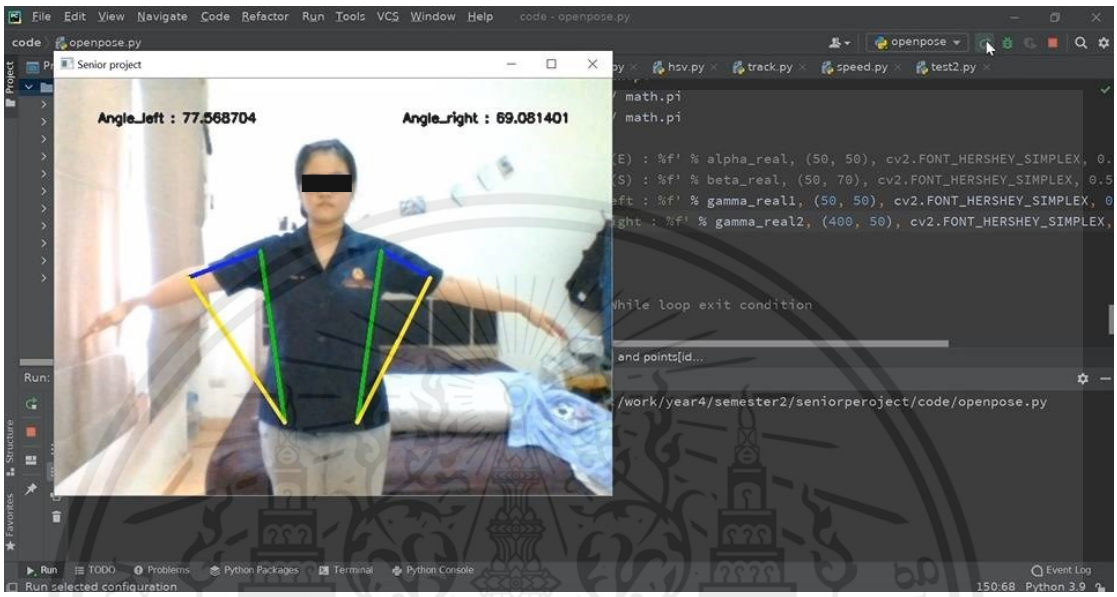


Figure 4.11 Angle

- To be sure, we take a photo screenshot and take it to check an angle again from the code that we write ourselves by clicking on the manual three points, which is the light green dots, so we got an angle that is equal to 77 and 68 as shown as light green text on figure 4.12. Calculated as the error value are equal to 0.74% and 1.59%.

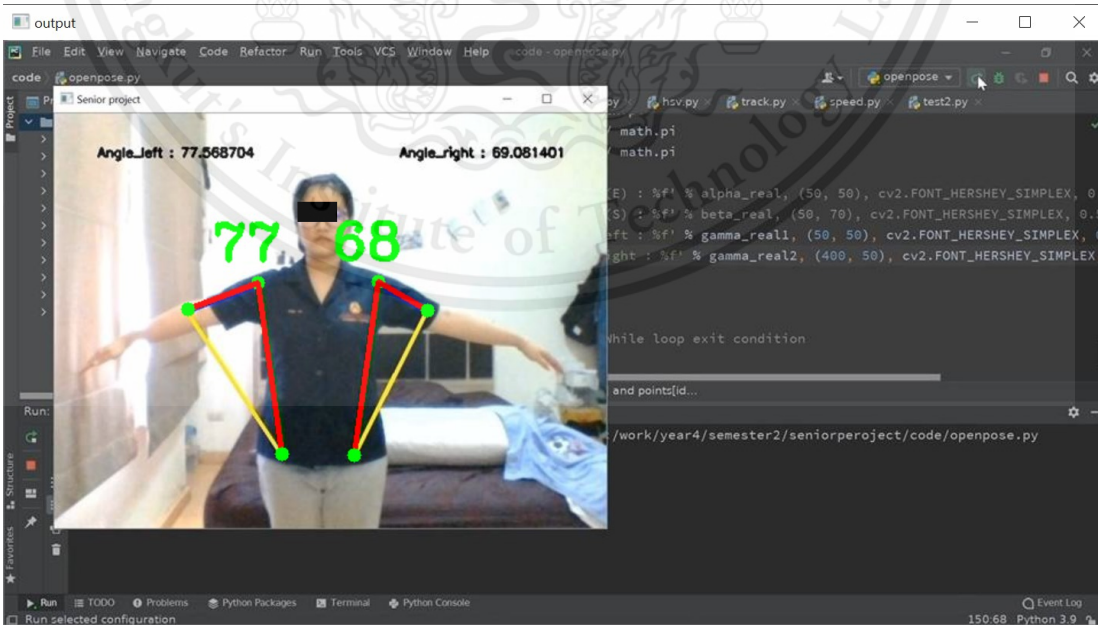


Figure 4.12 Check an angle

4.4.1.3 Find track path

From figure 4.13 is the tracking path where the yellow circle represents the center of the green cloth that is attached to the patient's wrist. The red line represents the path along with the patient's wrist movement.

Figure 4.13 Find track path

4.4.2 Practice physical therapy part

- The first step is finding the HSV value of tennis ball. We got the 2 of value to consist of upper bound (73, 180, 255) and lower bound (24, 60, 138) as shown in figure 4.14.

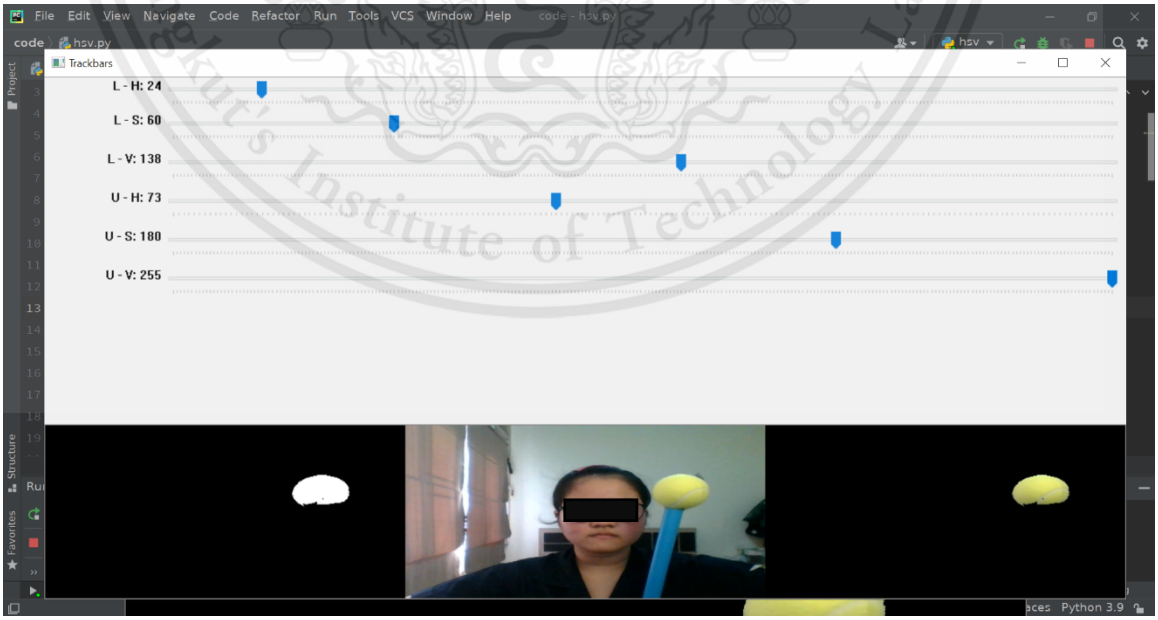


Figure 4.14 HSV value of tennis ball

- Patients raise the arm along with the frontal plane starting from bottom to top of the screen. If the tennis ball is hitting the red virtual ball, the score is increased by 1 point as shown in figure 4.15.

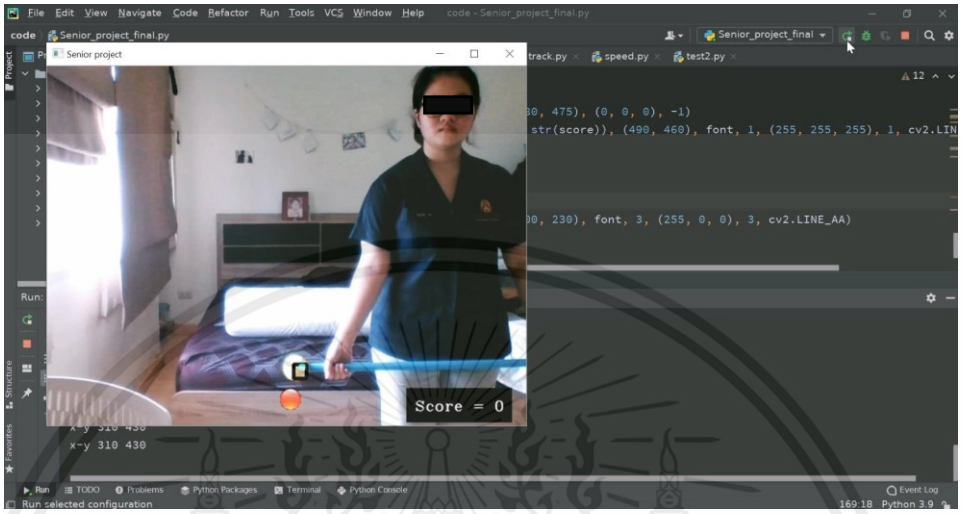


Figure 4.15 Start training physical therapy

- The position of the ball will gradually move up accordingly. When the score is equal to 6, it means that patient has completed 1 round of training the physical therapy. The screen will show the text as finish as shown in figure 4.16.

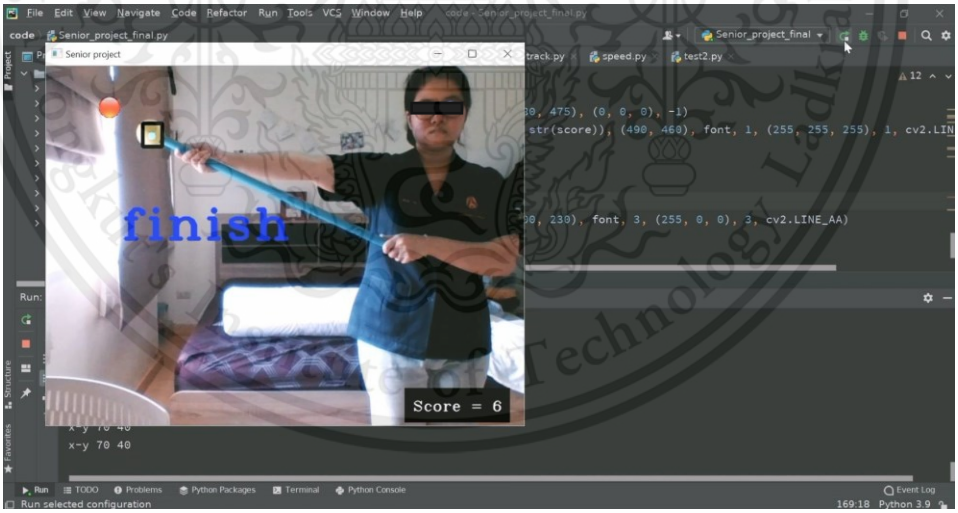


Figure 4.16 score = 6

4.5 Summary

This chapter has presented the results. This system that we create can monitor the patient to do the physical therapy by themselves. In addition, in the form of the game can increase the motivation of the patient. The following chapter shall discuss on the conclusion for the whole research study.

CHAPTER 5
DISCUSSION AND CONCLUSION

This chapter contains four major sections. Section 5.1 Introduction that shortly explain about the summary; section 5.2 discussion; section 5.3 conclusion; section 5.4 Recommendation.

5.1 Introduction

In this chapter, we first summarize, and a discussion derived from the finding of the study on the mobile application involved in the practice of physical therapy are described. The conclusions were based on the purpose which is to be an intermediary between patient and hospital.

5.2 Discussion

The results of our experiments were consistent with the assumptions we had set. This is because the objectives mentioned in Chapter 1 are to reduce the time and cost of patients coming to the hospital or clinic by using image processing. We have made a system that might be able to save time for treatment or physical therapy of the patient. It also can lighten the workload of the staff and reducing the percentage of errors may be able to help make the work more efficient. Then analyzing the patient's data is accurate, reducing the discrepancies. As for the method of treatment and rehabilitation by physical therapy. The patient can practice by themselves. This resulted in a decrease in the time or number of people who wanted to come to the hospital.

5.3 Conclusion

The aim of this senior project is to create the applications or systems for accessing treatment or physical therapy that minimize the patient’s time and expense, moreover the most beneficial to the patient. It is also possible to provide information about tests and initial physical therapy using image processing to the patient and physiotherapist. This is beneficial in reducing the number of visits to the hospital or clinic of the patient and reduce the density of the number of patients in the hospital as well, which application or system that makes use of good use for patients and physiotherapists?

The results of our studies have shown that the application or the system has a positive effect on patients and physical therapists. Patients are more comfortable in receiving treatment or practicing physical therapy by themselves, reducing the number of procedures that may take time-consuming. The application or system is easily accessible to patients. No matter where you are, it can be used. As for physical therapists, medical personnel, or staff also reduce the workload and be able to work in other areas to be more efficient, which is good for their work and productivity.

5.4 Recommendation

Due to this project, the testing of the application or the system may not be perfect because it requires some profound data and a high level of privacy of patients that is difficult to implement for doing the project. However, preliminary data was collected which makes the application or the system work. In terms of treatment, therapy, and rehabilitation, we only tested one disease that is Frozen Shoulder syndrome. It may have limitations on posture in camera management. We have inquired of an expert that the preliminary moves that are handled can be used, which can be developed into a game or a test. However, an application or system has taken many expert advice, fixes, and developments to solve problems and can be used more efficiently.

The future of project study is to develop the application or system to be more effective, for example in the accessibility of treatments that are easily accessible and comfortable to the patient. Learning or testing the patient's symptoms which may lead to an early diagnosis of the disease. To reduce the screening process, reduce the burden of screening staff, the treatment, and rehabilitation of physical therapists to be able to do physical therapy by themselves as the physiotherapist instructs. Physiotherapists can see patients that they are doing the right procedure which is good for patients who cannot come to the hospital and can also develop other cognitive treatments. Whether it is a game or other activity to increase patients' interests and able to treat more diseases.

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