T.R.

GEBZE TECHNICAL UNIVERSITY

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DEPARTMENT OF COMPUTER ENGINEERING

REAL TIME FINGER MOVEMENT SIMULATION FOR OSTEOARTHRITIS

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SUPERVISOR
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GEBZE TECHNICAL UNIVERSITY	GRADUATION PROJECT JURY APPROVAL FORM

This study has been accepted as an Undergraduate Graduation Project in the Department of Computer Engineering on 31/08/2021 by the following jury.

JURY

Member
(Supervisor) : Doç. Dr. Habil KALKAN

Member : Prof. Dr. Yusuf Sinan Akgül

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Alp Emir BİLEK

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ABSTRACT

The people having osteoarthritis lives difficulties on moving their fingers and this may cause neuropathic ache. In this project, a real time simulation system that that will detect the patients finger under a camera and move the increase the length of fingers more than actual will be created. OpenCV library will be used in Python.

Figure 1: General scheme of the project.

Keywords: Image Processing;Real Time;Simulaiton;OpenCV;

INTRODUCTION

Osteoarthritis is the most common form of arthritis, affecting millions of people worldwide. It occurs when the protective cartilage that cushions the ends of the bones wears down over time.Although osteoarthritis can damage any joint, the disorder most commonly affects joints in your hands, knees, hips and spine.Osteoarthritis symptoms can usually be managed, although the damage to joints can't be reversed. Staying active, maintaining a healthy weight and receiving certain treatments might slow progression of the disease and help improve pain and joint function.

Osteoarthritis patients may experience severe pain while moving their joints. In this project, it was desired to develop a simulation to assist Osteoarthritis patients while they are being treated.In this simulation, patients with osteoarthritis disease in their fingers were aimed.

The general purpose of the simulation is to give the feeling that the fingers of the patients who have serious difficulties in moving their fingers are being extended with the help of simulation.

Simulation was developed through a machine to be used under the supervision of a doctor.he machine is in the form of a rectangular prism and has a black background, camera and light inside.The machine has two hand-held ports.From one of these entrances, the patient will insert her/his hand from the other, and the extension operations will be performed.The doctor will choose one of the patient's fingers and ask the patient to try to extend the chosen finger as much as possible.After this request, the doctor will withdraw her/his hand to start the simulation and the operation to extend the selected finger will begin.

LITERATUR REVIEW

First of all, opencv library was examined to develop the simulation.Along with the examinations, how to detect the finger, how to extract the joint points and what kind of algorithms to use for extension processes were investigated.

As a result of the research, it was determined that Opencv's Mediapipe library will be used. SkinMask will be used to cut out the selected finger. Python's Trinker library will be used for the User Interface.

PROJECT GENERAL SCHEME AND ROUTE

The first step as the general route of the project is finger detection.Then it is to find joint points. Then it is to do finger extension with calculations.

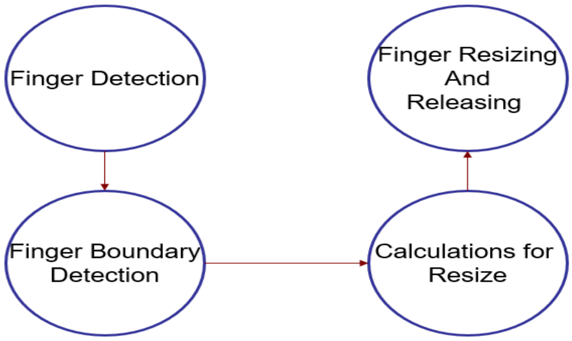

Figure 2: General Route.

REQUIREMENTS

Briefly, if we list the things that need to be done to achieve the result in the project;

Hardware Requirements

- Camera
- Appropriate Light

Software Requirements

- OpenCV
- MediaPipe
- SkinMask
- Trinker

1. FINGER DETECTION

OpenCV is a library used for computer vision applications. With help of OpenCV, we can build an enormous number of applications that work better in real-time. Mainly it is used for image and video processing.Along with OpenCV, we are going to use the MediaPipe library.

1.1. MediaPipe

MediaPipe is a framework mainly used for building audio, video, or any time series data. With the help of the MediaPipe framework, we can build very impressive pipelines for different media processing functions.

Figure 1.1: MediaPipe's Hand Landmark Model.

Basically, the MediaPipe uses a single-shot palm detection model and once that is done it performs precise key point localization of 21 3D palm coordinates in the detected hand region.The MediaPipe pipeline utilizes multiple models like, a palm detection model that returns an oriented hand bounding box from the full image. The cropped image region is fed to a hand landmark model defined by the palm detector and returns high-fidelity 3D hand key points.

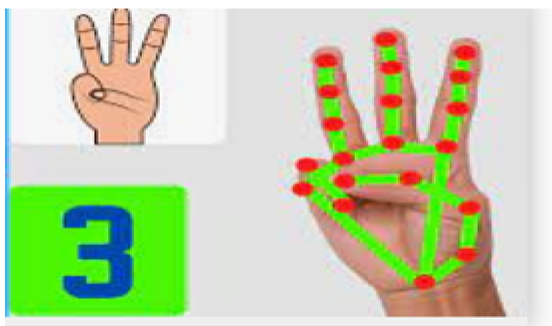

Figure 1.2: An example for hand detection.

1.2. Joint Points

We also extracted the joint points with the help of the MediaPipe.There are 4 joint points in a finger and these points are in the middle of the finger.Since they are in the middle, points covering the entire finger should be obtained with certain calculations.

Proceeding from the extreme joint point of the finger, literally the tip point of the finger is found.Then, the coordinates of the edges of the finger were found by moving from the joint point to the right and left.Finally, the corners of the finger's starting points were determined, and as a result, 4 points were found that completely covered the finger.

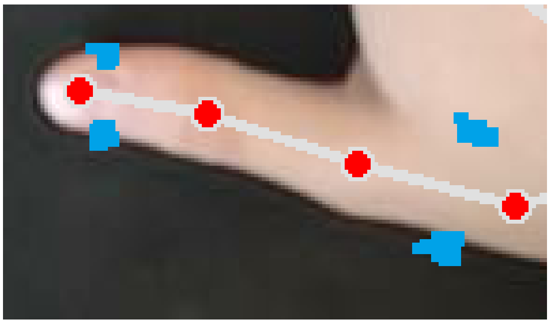

Figure 1.3: Finger's coverage list.

2. FINGER RESIZING

2 different methods were tried for finger resizing.

2.1. First Solution Approach

In the first method, using the coverage list of the finger, the finger was masked and cut out with the help of a skinmask.

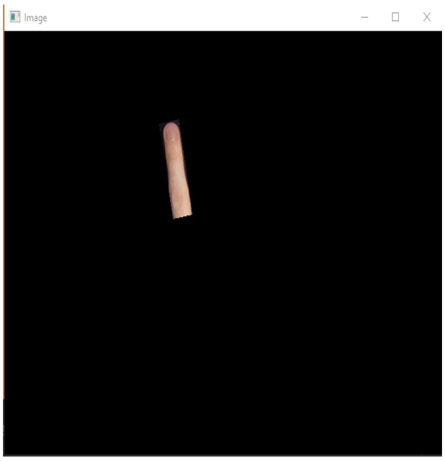

Figure 2.1: Cut out Finger

After the finger was cut out, the finger was resized as a normal picture was resized.In this method, accurate results were obtained when the finger was operated at a perpendicular and linear angle to the camera.

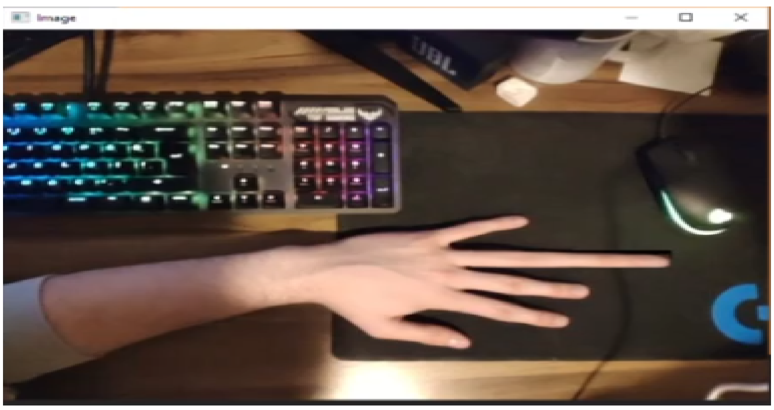

Figure 2.2: Result for First Approach

2.2. Second Solution Approach

In this method, general mathematical operations are resized without any cutting out.

First of all, it was determined how far the finger would resize in the picture according to the resizing rate of the finger.Then, according to the angle of the finger, the empty pixels between the finger and the real one started to be filled.Pixels of real image copied while empty pixels are filled.

First, an equation of each line according to the angle was obtained, and then the pixels were copied according to the result obtained from these equations while copying.

Figure 2.3: Finger Resizing with Second Approach

3. DOCTOR TOUCH

In this part of the project, it was focused on having the patient on one side of the simulation and the doctor on the other.

MediaPipe's hand detection model allows a maximum of 2 hand detects.One of these 2 hands will be the patient's hand and the other will be the doctor's hand. While 21 joint points are detected in the Hand Landmark Model of MediaPipe shared above, this number increases to 42 when the doctor inserts his hand.The patient's joint points are between 0-20 and the doctor's joint points are between 21-41.

Whichever finger the doctor touches, that finger resizing procedures will be started.As mentioned before, the operation is performed by finding the real tips of the fingers, this is also valid for the doctor's fingers.When the doctor's finger literally touches the tip of the patient's finger, the finger is selected and the operations begin.

Figure 3.1: Doctor Touch

Figure 3.2: Resizing after Doctor Touch

4. CONCLUSION

In this simulation, two different methods were tried by using the python and opencv libraries. It was observed that the line-by-line finger extension method worked better than these methods.

Finger resizing operations were performed with the help of this simulation prepared for Osteoarthritis patients suffering from severe pain. As a result of this project, experiments were performed on Osteoarthritis patients in a physical therapy clinic, and 80 percent of the patients were told that they actually felt the finger extending.

RESOURCES

- https://learnopencv.com/image-resizing-with-opencv/
- https://www.researchgate.net/publication/282956557_Real_time_finger_tracking_andcontour_
- https://medium.com/analytics-vidhya/hand-detection-and-finger-counting-using-opencv-python-5b594704eb08
- https://www.analyticsvidhya.com/blog/2021/07/building-a-hand-tracking-system-using-opencv/