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Development of Gesture Detection Application for the Exercise System and Accumulation of Reward Points

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ABSTRACT

The COVID-19 pandemic has affected the daily lives of global citizens. Currently, it was reported that COVID-19 would last longer. Therefore, living with the COVID-19 outbreak will be the new normal. The restriction of physical contact leads to less exercise, especially outdoor activity, but more activities online. Although it will reduce the spread of the disease, but it has a negative effect on people's physical and mental health, so our team has come up with an exercise system to collect points and redeem rewards by detecting gestures by using applications to increase the practice of physical activity and enhance the health of personnel in various organizations, even people in residence can have physical activity. There were two types of exercise postures to choose from: squat and bicep curl (arm muscle exercises), which can be divided into two levels: easy and difficult. We concluded that the application could calculate points correctly and was very accurate in counting reps, especially with the bicep curl, but there was still a slight discrepancy in the count of squat reps, which can be further developed to increase accuracy.

Introduction

The COVID-19 pandemic which began in December 2019 in Wuhan, China, made the World Health Organization (WHO) announce this as an international public health emergency on January 30th, 2022. For Thailand, the outbreak of the COVID-19 virus began with the first infected person, a tourist from China on 12 January 2020, and the first Thai patient found on 31 January 2020, whose history of driving a taxi for Chinese tourists. After that, the number of infected people continued to increase, causing the Ministry of Public Health to announce in the Government Gazette on March 1, 2020, and declare COVID-19 to be a serious contagious disease. According to the Communicable Disease Act B.E. 2558. In the past 2 years, the COVID-19 virus has spread all over the world. As a result, people have to change their daily lives, working, studying, and doing more online activities to reduce the spread of the COVID-19 virus. However, when there are more online activities, people have less physical activity. Physical inactivity affects many ways. Being restricted from lifestyle activities due to things beyond your control affects people with chronic illnesses. As a result, the elderly, children, and adolescents who did more activities online and did not go to school, had reduced self-care, lack of social skills, insomnia, burnout, etc. A study of exercise behavior during the COVID situation of personnel in Khlong Thom Hospital, Khlong Thom District, Krabi Province found that there was 73.91% less physical activity and 89.13% felt bored. As exercising is very necessary for building immunization, so how to motivate people to exercise physically in this situation would be a very challenging issue. One example of a successful project for motivating people to exercise was in Moscow, Russia. An exercise campaign has been set up in exchange for subway tickets by requiring the user to perform the squad position 30 times in 2 minutes.

Therefore, our study aimed to develop gesture detection applications for an exercise system and accumulation of reward points, to increase physical activity and health-enhancing practices among employees in various organizations, even at home.

Methods

Equipment:

1. Visual Studio Code

Visual Studio Code is a free source-code editor program developed by Microsoft. With effective code editing, insightful suggestions, and integrated terminal functions.

2. Media pipe Holistic

Media pipe Holistic uses interchangeability between all three detection points. When all three detections are combined, there will be a topology that works together as one, which can capture up to 540+ key points of the animation (33 points of gestures, 21 points on each hand, and 468 points of the face) and can be processed in time. Detail in Figure 1.

3. Streamlit Python Library

Streamlit is a free, open-source framework for quickly creating and sharing web apps for data science and machine learning. For engineers and data scientists, it is a Python-based library. to aid in the development of a certain web application.

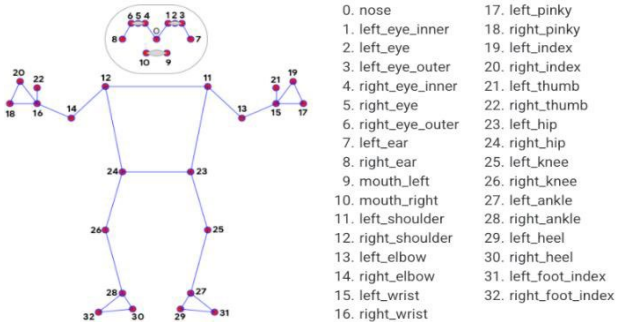

Figure 1. Different Key Points on the Human Body

Working steps

1. Collect posture information while performing a variety of exercises, squat and bicep curl, for the media pipe.
2. Use Media pipe to define different angles used for a particular exercise in Visual Studio Code so that the application can detect the poses while exercising. The angle value is a criterion for counting the number of exercise times.
3. Proceed to write the code for the exercise system that will earn points and interface with Visual Studio Code.
4. Test the accuracy of the AI's gesture detection.
5. Create a fitness system to collect reward points by detecting gestures with the Scratch programming web, which has the system's working process as follows.

   - Let the user choose a posture to exercise. The system will indicate the benefits and the number of points obtained from the exercise in that position. (The number of points earned will vary according to the amount of energy burned in each move for the same amount of time. According to the website www.burned-calories.com)
   - The system will start, which will allow the user to move in a position where the camera can see the whole body and capture the movement of the user whether it is correct or not.
   - When the exercise is completed, the system will add points to the user (Figure 2.). The user can redeem the said points for the rewards specified by the system, such as drinking water, healthy food, etc.

6. Test the fitness system's performance accuracy to collect reward points by detecting gestures. Use a manual count of corrected gestures by an expert as reference.

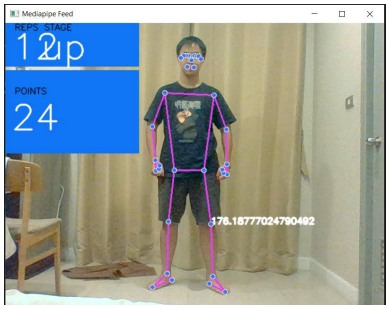

Figure 2. Key Points overlayed on the Human Body

Results

The performance of the fitness system to collect reward points by detecting gestures through the application was tested by PSU Wittayanusorn School students and staff. The accuracy of fitness system's performance is shown in Table 1 and Table 2.

Table 1. Compare the number of correct gestures counted for "bicep curl" by fitness system and manual count.

No.	Sex	Age	System count		Manual count		Count difference (%)		Accuracy (%)	
			Hard	Easy	Hard	Easy	Hard	Easy	Hard	Easy
1	M	17	88	44	88	44	0.00	0.00	100	100
2	M	18	66	33	66	33	0.00	0.00	100	100
3	M	16	64	32	64	32	0.00	0.00	100	100
4	M	17	48	24	48	24	0.00	0.00	100	100
5	M	16	70	35	70	35	0.00	0.00	100	100
6	M	45	98	49	98	49	0.00	0.00	100	100
7	M	17	66	33	66	33	0.00	0.00	100	100
8	M	16	64	30	64	30	0.00	0.00	100	100
9	M	17	51	25	51	25	0.00	0.00	100	100
10	M	12	52	26	52	26	0.00	0.00	100	100
11	M	17	56	28	56	28	0.00	0.00	100	100
12	F	17	61	30	61	30	0.00	0.00	100	100
13	F	17	66	32	66	32	0.00	0.00	100	100
14	M	17	55	27	55	27	0.00	0.00	100	100
15	M	17	33	16	33	16	0.00	0.00	100	100
16	F	17	46	22	46	22	0.00	0.00	100	100
17	F	17	39	18	39	18	0.00	0.00	100	100
18	M	17	57	28	57	28	0.00	0.00	100	100

No.	Sex	Age	System count		Manual count		Count difference (%)		Accuracy (%)	
			Hard	Easy	Hard	Easy	Hard	Easy	Hard	Easy
19	F	17	57	28	57	28	0.00	0.00	100	100
20	M	17	61	30	61	30	0.00	0.00	100	100
21	F	17	31	15	31	15	0.00	0.00	100	100
22	M	16	34	17	34	17	0.00	0.00	100	100
23	F	17	46	22	46	22	0.00	0.00	100	100
24	M	17	33	16	33	16	0.00	0.00	100	100
25	M	16	21	10	21	10	0.00	0.00	100	100
26	F	17	30	14	30	14	0.00	0.00	100	100
27	F	17	36	18	36	18	0.00	0.00	100	100
28	M	26	38	19	38	19	0.00	0.00	100	100
29	M	17	20	10	20	10	0.00	0.00	100	100
30	F	17	26	15	26	15	0.00	0.00	100	100

Table 2. Compare the number of correct gestures counted for "Squat" by fitness system and manual count.

No.	Sex	Age	System count		Manual count		Count difference (%)		Accuracy (%)	
			Hard	Easy	Hard	Easy	Hard	Easy	Hard	Easy
1	M	17	51	26	54	27	5.56	3.70	94.44	96.30
2	M	18	63	31	66	33	4.55	6.06	95.45	93.94
3	M	16	56	28	57	32	1.75	12.50	98.25	87.50
4	M	17	56	28	58	30	3.45	6.67	96.55	93.33
5	M	16	38	19	42	20	9.52	5.00	90.48	95.00
6	M	45	15	7	19	10	21.05	30.00	78.95	70.00
7	M	17	38	19	40	20	5.00	5.00	95.00	95.00
8	M	16	38	19	41	22	7.32	13.64	92.68	86.36
9	M	17	46	23	47	25	2.13	8.00	97.87	92.00
10	M	12	44	22	47	22	6.38	0.00	93.62	100.00
11	M	17	39	19	40	22	2.50	13.64	97.50	86.36
12	F	17	37	15	37	16	0.00	6.25	100.00	93.75
13	F	17	23	12	23	12	0.00	0.00	100.00	100.00
14	M	17	31	16	31	17	0.00	5.88	100.00	94.12
15	M	17	46	23	47	25	2.13	8.00	97.87	92.00
16	F	17	36	18	36	18	0.00	0.00	100.00	100.00
17	F	17	40	20	42	20	4.76	0.00	95.24	100.00
18	M	17	25	11	26	13	3.85	15.38	96.15	84.62
19	F	17	20	10	22	10	9.09	0.00	90.91	100.00

No.	Sex	Age	System count		Manual count		Count difference (%)		Accuracy (%)	
			Hard	Easy	Hard	Easy	Hard	Easy	Hard	Easy
20	M	17	16	8	17	11	5.88	27.27	94.12	72.73
21	F	17	35	15	37	16	5.41	6.25	94.59	93.75
22	M	16	29	13	30	13	3.33	0.00	96.67	100.00
23	F	17	18	9	18	9	0.00	0.00	100.00	100.00
24	M	17	27	14	27	14	0.00	0.00	100.00	100.00
25	M	16	37	17	38	19	2.63	10.53	97.37	89.47
26	F	17	29	14	30	17	3.33	17.65	96.67	82.35
27	F	17	17	8	18	10	5.56	20.00	94.44	80.00
28	M	26	12	6	14	7	14.29	14.29	85.71	85.71
29	M	17	20	10	20	12	0.00	16.67	100.00	83.33
30	F	17	13	6	13	6	0.00	0.00	100.00	100.00

Following the exercise, the algorithm determined points based on the number of correct motions, shown in Table 3.

Table 3. The number of correct gestures counted, and points earned by fitness system (Top 10 highest scorers).

No.	Sex	Age	Bicep Curl	Points	Squat	Points	Total points
1	M	17	88	132	151	102	234
2	M	18	66	99	63	126	225
3	M	16	64	96	56	112	208
4	M	17	48	72	56	112	184
5	M	16	70	105	38	76	181
6	M	45	98	147	15	30	177
7	M	17	66	99	38	76	175
8	M	16	64	96	38	76	172
9	M	17	51	76.5	46	92	168.5
10	M	12	52	78	44	88	166

Discussion and Conclusions

The system does a very good job of correctly detecting posture, particularly the “bicep curl”, which it does with 100% accuracy. For "Squat", the two users with the highest counting errors were numbers 6 and 20, according to Table 2. Following analysis, it was discovered that incorrect dressing might be the cause of the failure of the angle detection. When the information that may have errors has been eliminated. The system was found to be highly accurate. The system can be further developed to increase the accuracy of gesture detection. It can also be added more exercise posture or designed to work with facial detection to collect points to redeem bonuses. This may be in the form of a QR code that can be used to exchange products or services from stores participating in the program. The application has a relatively high accuracy for gesture detection and can be developed to be more diverse to meet the needs of a wide range of people. Only a group of volunteers from academic institutions were used to test the system in this study.

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