

FACULTAD DE INGENIERÍA

Escuela Académico Profesional de Ingeniería de Sistemas e Informática

Tesis

**Patients rehabilitation with musculoskeletal
sequel from covid-19 using vision artificial in the
city of Huancayo**

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Para optar el Título Profesional de
Ingeniero de Sistemas e Informática

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Declaramos que hemos participado en la ideación del problema, recolección de datos, elaboración y aprobación final del artículo científico.



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Patients rehabilitation with musculoskeletal sequel from covid-19 using vision artificial in the city of Huancayo

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Patients rehabilitation with musculoskeletal sequel from covid-19 using vision artificial in the city of Huancayo

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Abstract—Technology and its applications are here to improve our lives, it is used ever more these days with the pandemic Covid-19. This article is aimed to reduce the attendance to Hospitals and clinics where you would be treated with musculoskeletal muscular treatments in the city of Huancayo. With the help of modern technology it is offered an alternative software with artificial vision in order to monitor most patients in real time. The development of this investigation is set in 5 stages, the first stage talks about a posture recognition with artificial vision with framework mediapipe. The second stage explains the design interface and the mathematics formula which controls a patient development, the third stage describes the integration from the first and the second stage with a treat method. The fourth stage describes de development of a webpage using services to develop and monitor in real time. The last stage describes the process of the software validation having the last usuary with a chart of questions. Finally, the results of validations show the patient acceptance, as so 63.6% of patients who had no difficulties doing the software exercises. As Such a monitoring from the initial stage from the patien is hey factor before starting the therapy.

Keywords— *Musculoskeletal Rehabilitation, Machine Vision, Web Service.*

I. INTRODUCTION

The most common Neurological symptom SNP(Peripheral nervous system) affects to an average 38 cases(3.4%) in habitants between 55 years-old and an average of 10 deaths (26%) [1]. The most common part of the body damaged was found in the dorsolumbar between two and four months (30%), followed sequels on the neck around seven and thirty days (27.27%) and very notorious on the elbow and arm with (12.73%). [2]

As it is mentioned, the main goal of this investigation is to supply with a most needed rehabilitation in patients with muscular musculoskeletal alterations due to Covid19 sequels using “Visual artificial digital tracking” software. The digital rehabilitation helps patients in different areas in the health department using the latest software development. [3]

The machine learning is important for this software due to the fact that it helps to predict the movement of the human body with highly accuracy to the pixel, this is part of artificial

intelligence [4, 5], Google has a framework multiplatform named MediaPipe, this to process information from the images to use compatible with Android, Python, iOS and JavaScript. This framework offers a variety of solutions ML(Machine Learning). What in Python can be done; face detection, facial grip, hands, body postures (continuous human movements), selfies segment and objetron. [6]

The solution POSE from framework MediaPipe in Python offers the possibility of detect body movements which generated 32 anchor point where we can select specific dots to analyze the range of movements on the dots when a body human makes movements and flexions, such as: shoulders, elbows, knees and more body parts, in this case the main focus are on rehabilitation muscle therapy and skeletal.[7]

In this project, This physical therapy is aimed to patients who are in a post Covid recovery as it treats the movement sequels caused by this not forgiven virus. Most patients are in hospitals unable to move for long time as others are in intensive care, whereas others are at home, never the less the effects are on the muscular skeletal, muscular streams, lack of strength and inefficient muscular movements. [3, 8, 9]

In this article we describe how the development of this application works, there are five stages included with materials and steps based on the results and experiment done to rehabilitate post covid patients. Stage of recognition for rehabilitating musculoskeletal, stage of interface and desktop software, stage of web monitoring from a hosting [10] showing developments in graphics for the patient and last stage of investigation with patients having muscular skeletal alterations.

II. MATERIALS AND METHODOLOGY

We show the description of the methodology in how the desktop application is develop using artificial intelligence and web monitoring as shown in Fig. 1.

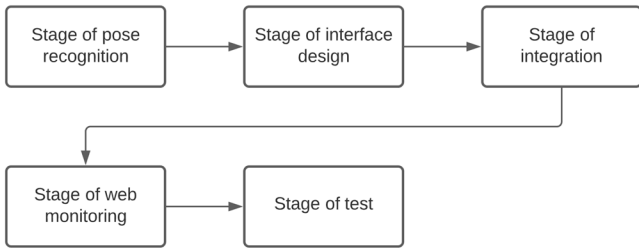


Fig. 1. Phases of the methodology

In this method we see the five stages in a sequel: stage of pose recognition, stage of interface design, stage of integration, stage of web monitoring and stage of test.

A. Stage of pose recognition

To develop a stage of movement recognition we use libraries as follow: MediaPipe, numpy and math and these are applied in Pycharm. Mediapipe is a library designed to recognize human postures and their movements through dots, this enable to detects parts of the body moving in real time. The chart below shows body parts dots in a human body, as seen in Fig. 2.

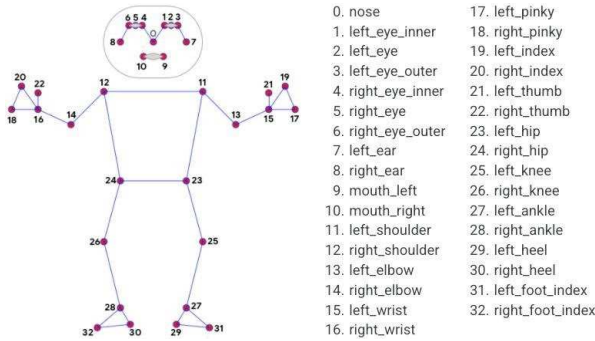


Fig. 2. The location of 33 pose landmarks

The dots on this library are very relevant to follow a therapy in body parts recognition as shown on Fig. 3.

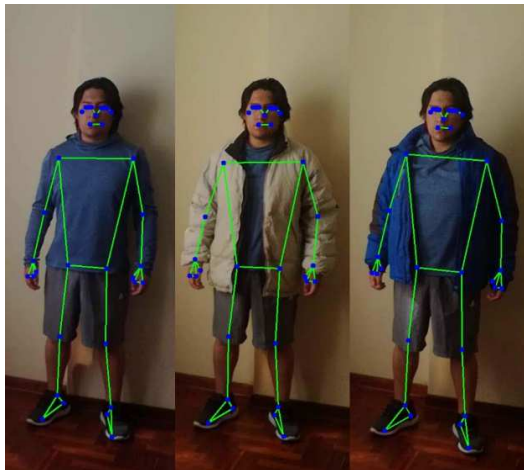


Fig. 3. Software obtaining human body data with different clothes.

To determine its accuracy of the body moments health professionals in physiotherapy were consulted, as their professional experience are a big contributions analyzing several videos showing the Body movements to further studies in the patients recovery, also selecting a proper therapy related with muscular skeletal recoveries.

The first exercise is done in lower limbs and the second in upper limbs. After determining the possible flexion angles and were up to requirements and tested to have a minor error when recognizing movements as show on fig. 4.



Fig. 4. Arm detection showing the movement in angles.

B. Stage of design and interface

In this stage we made initial interface, therapy and recommendations, we did used a program called QT DESIGNER in order to design the desktop application. It was first designed using two buttons to access to two more following interfaces, this interface was designed to show a sample Musculoskeletal rehabilitation video from arms and legs, as well as its recognitions and movements from arms and legs.

The percentage of a patient development is determinate with a equation (1) where “x” is the percentage of development on patients, “a” is the lower among of legs movements, “b” is the lower amount of arms movements, “c” are the correct movements of the arms, “d” is the correct movements of the legs.

$$x = (a + b) * 100\% / (c + d) \quad (1)$$

The minimal movements of legs and arms are required from the type of therapy to follow, as it is a professional the one who assign the amount of minimal movements, as well as the recommended interface before and after the therapy, this is a must follow by the patient.

C. Integration stage

The integration stage requires interfaces and pose recognitions, for this stage we use a language programing as Python, as well as PyQt5 MediaPipe library, this library works in compatibility with files designed in Python platform.

For the integration we codified a treat so see artificial vision Othead on library Pyqt5 and it is inserted a sequel ‘run’ on the codecs which recognize the stage of pose. To show sample videos of the therapy exercises we use threads called Qthead so it could execute many processes at the same time.

D. Web monitoring stage

The monitoring stage. For this part we used Freeware hosting called Awardspace, also an installation of WordPress on the hosting to create a webpage, it gives you a free domain as well, The hosting works with MySQL database.

When it is created a WordPress ask for a free domain, in this project we used the domain, scienceontheweb.net, After that we installed InteriorWP, it is possible to edit, delete or create widgets, menus, headings and background. We used the following plugin for designing the webpage: Arile Extra, Elementor, Ninja Charts, Ninja tables, Page Layer, Ultimate Member and WP Super Cache.

The plugin Arile Extra is to create Themes in WordPress, in this investigation we used InteriorWp and there is where we Added a monitoring menu and graphic of the development in each patient. For this graphic wit is used a plugin called Ninja Tables to create a monitoring chart on the monitoring hosting base. The variables of the tables are the correct movements, name, patient and their full names, city and Id monitoring. The plugin Page Layer is to edit the webpage with functions in mind required. The plugin Ultimate member is to create information forms registration, login and profile. And for last the plugin WP Super Cache to improve the performance of our webpage.

The data obtained when using the software is saved in a local Database, for this investigation we used SQLite in order to save the correct human body movements, percentage development, date, days and sessions attended.

To send data from the local software we used SQLite and at the same time to save and send data we have the web showing in graphics, the codification is done with Python in a module "self" every time the program is opened automatically sends information to the web page, for this a protocol must be followed on the (Web service). A php file is created to connect with mysql in the hosting where is saved WordPress. After making the code in the hosting we did a connection in the software with a local attachment JSON to send data to "Update movements" through a POST petition with the link php.

E. Testing stage

The testing stages. In this stage we did a validation of the software, for that we did a survey to every patient, as for this many questions are formulated as show in Table I. The patient have to use he software, first of all the interface of recommendations and then the therapy interphase which will be done. At the end of the interaction with the software, the patient fills up the survey.

In the stage of pose recognition, in the development of the code to recognize a human body, it was tested in different environments to test its precision in a well light on dark environment, the type of clothes to use, large, slim fit, dark colors, bright colors, distance from the camera and the test subject, camera resolution and position of this.

The integration of movement recognition from upper and lower limbs must separated, so in each exercise the software would recognize a certain part of the body, as it is believe these are the first therapy exercises from the legs but should not detect other parts. When the legs exercises are done we should follow

by doing the arms exercises. The software should only detect the arms. To be able to reach this it is necessary to separate each movement codec from the legs and arms, as the program will recognize each body movement through individual interface.

The angles are indeed important to be able to add up every correct movement made by the patient, such as: when the legs are moved up and down following the right angle so that the program can take count every right movement, in case the movements are not made in the right way, the software will not count that certain movement.

TABLE I. TABLE DE PREGUNTAS

Question	Scale
During the session with the movement recognition. How complicated was to make the exercises?	Many options. Very complicated, regular, minimal, not at all complicated
What price are you willing to pay for the software?	Many options. s/1,000.00 + Less than s/100.00
Would you recommend to use this application for recovering therapy	Scale it from 1 to 5. Would you recommend it or not?

III. RESULTS

Once the last stage is terminated being tested by 11 patients residents in the city of Huancayo who used the software, it was determinate the complete satisfaction upon using this software. In the moment of movement recognition the software determines the correct movements of the inferior and superior limbs. When we have a low resolution camera there are lest accuracy tracking on the software so that the counters was not that precise.

The interface design resulted to be compressible by the patients as shown in the fig. 5. But the therapy interface was recommended to be show in video and not the threads of the lines detections as it may confuse at the moment the therapy is done.

The detection of the movements from the exercises from arms as well as legs are detected correctly as well as having a precise counter for each correct movement one by one until to finish the first therapy as shown on fig. 6.

The eleven patients who did the muscular skeletal therapy were standing at least 2 meters and a half away from the webcams, a well-lit room and different clothes were used.

After practicing the rehabilitation exercises with different cameras, the angles used to count each correct movement was observed to be more precise on a Logitech HD 720p, with standard VGA with 0.307 megapixel and HD with 0.922 megapixel, but when we are using the cameras on the test subjects, the movement recognition on the legs had more error at the time the correct movements were shown, as it is necessary to change the angles of the cameras, however when using on the arms the angles are stable and it is not necessary to change it.

The survey done on the patients showed that 63.6% said that it is not complicated to make those rehabilitation exercises using the software shown in fig. 7.

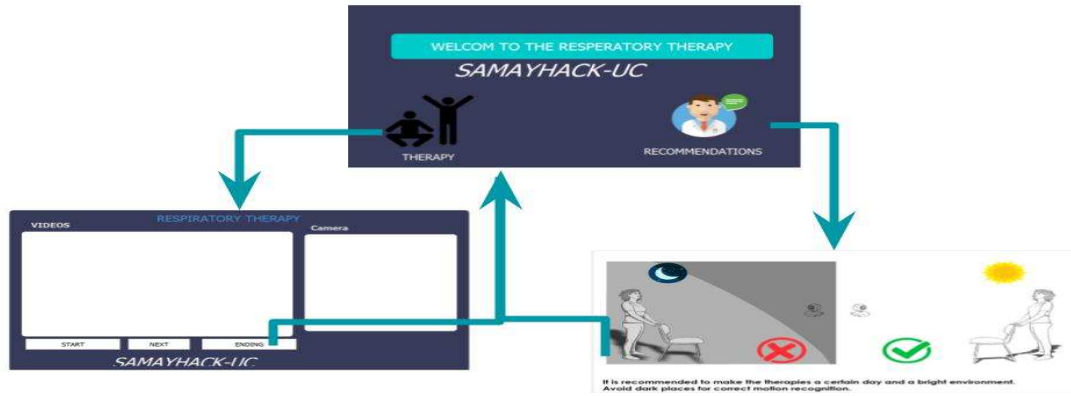


Fig. 5. Sequence of interface of the therapy software

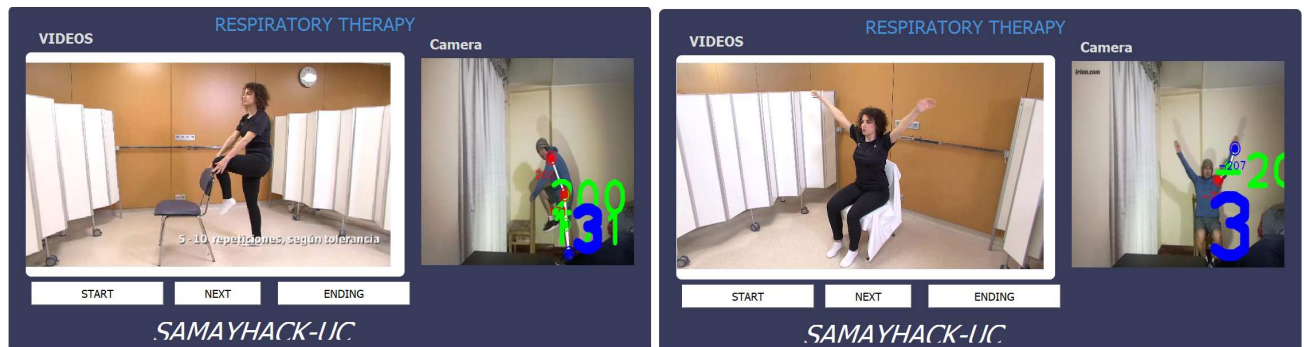


Fig. 6. Rehabilitation exercises upper an lower limbs.

The 54.5% of the patients said that they would pay between s/200 and s/500 for the software as shown in fig. 8. And for last 6 of out 11 patient recommended to use the software in this kind of therapy giving a score 4 out of 5 as shown in fig. 9.

During the movement recognition session , How complicate was to execute the exercises?

11 answres

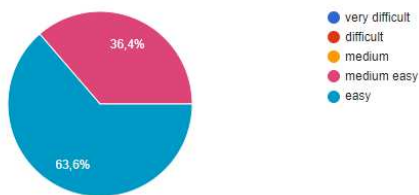


Fig. 7. Usage complex

And finally, the software was shown to a therapist from Huancayo, who said that this solution can be more helpfull on public hospitals because there are more patients due to the ease of monitoring as shown in Fig. 10. So, on public hospitals usually happens that a therapist ought to treat several patients at the same time and cannot ensure that all patients are performing the suggested exercises properly. On the other hand, private clinics have personalized and individual attention.

How much would you pay for the program?

11 answres

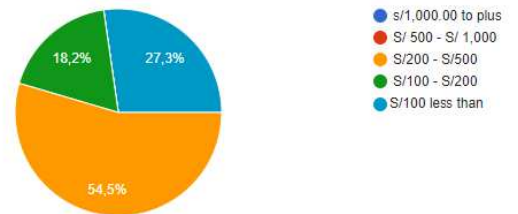


Fig. 8. May pay for the software

would you recommend to use this application for your therapy sessions?

11 answres

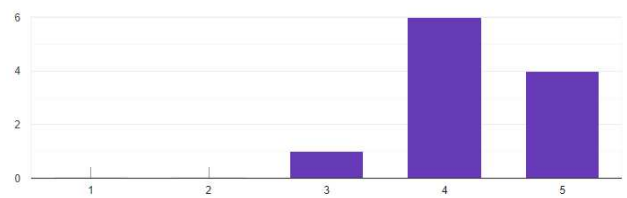


Fig. 9. Software recommendation

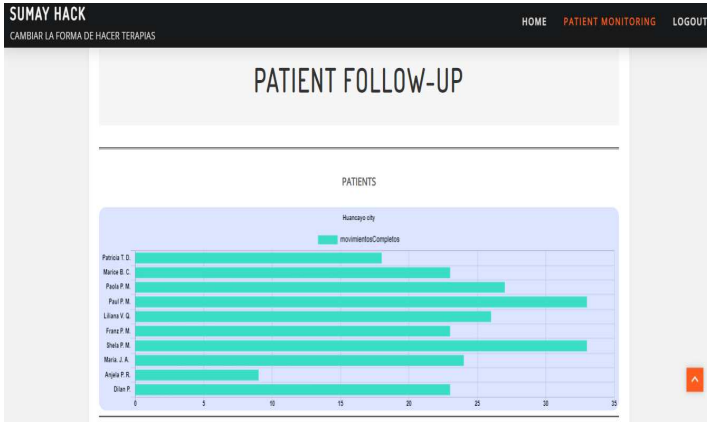


Fig. 10. Correct movements from the patients

IV. CONCLUSION

In this article it is propose a new development of treatment doing musculoskeletal rehabilitations from a remote place in real time, a patient monitoring using an artificial intelligence during this pandemic Covid 19, as it is a need to decrease the number of people infected. In this investigation, we use techniques of learning machine based on Framework such as Mediapipe, as well as combined detecting the number of exercise movements. Before using the software, the patient should monitor the position of the initial position angle of the legs and arms, this is made to detect an accurate measure of the patient state.

The patients monitoring is based in Web services with the purpose to send data to the webpage in real time, it is effective and easy use in the therapy. The given equation (1) raised to determinate the process of the patient it is going to make easy future development studies; it is much easier the monitoring from the patients themselves and the therapist. A 54.5% from the patient are willing to pay between s/200 to s/500 for using this software.

In the future, the rehabilitations will be done remotely around the world, using artificial vision and other technologies, as technology is developing on big steps and a rapid pace due to the Covid-19.

REFERENCES

- [1] E. Mariños Sánchez, P. Espino Alvarado, L. Rodriguez, and E. Barreto Acevedo, "Manifestaciones neurológicas asociadas a COVID-19 en el Hospital Edgardo Rebagliati Martins, Perú," *Revista de Neuro-Psiquiatría*, vol. 83, no. 4, pp. 243–256, Feb. 2021, doi: 10.20453/mp.v83i4.3890.
- [2] E. E. García-Salirrosas, R. A. Sánchez-Poma, E. E. García-Salirrosas, and R. A. Sánchez-Poma, "Prevalencia de trastornos musculoesqueléticos en docentes universitarios que realizan teletrabajo en tiempos de COVID-19," *Anales de la Facultad de Medicina*, vol. 81, no. 3, pp. 301–307, 2020, doi: 10.15381/anales.v81i3.18841.
- [3] A. Alarcon-Aldana, M. Callejas-Cuervo, and A. P. L. Bo, "Telerehabilitation based on serious video games as support in the recovery of the musculoskeletal system," 2020 15th Iberian Conference on Information Systems and Technologies (CISTI), Jun. 2020, doi: 10.23919/cisti49556.2020.9141048.
- [4] L. M. Garcés-Socarrás et al., "Implementación de un detector de movimiento para cámaras inteligentes sobre sistemas embebidos," *Ingeniería Electrónica, Automática y Comunicaciones*, vol. 41, no. 3, pp. 53–65, 2020, Accessed: Nov. 09, 2021. [Online]. Available: http://scielo.sld.cu/scielo.php?pid=S1815-59282020000300053&script=sci_arttext&lng=pt.
- [5] A. Alarcon-Aldana, M. Callejas-Cuervo, and A. P. L. Bo, "Prevalencia de trastornos musculoesqueléticos en docentes universitarios que realizan teletrabajo en tiempos de COVID-19," 2020 15th Iberian Conference on Information Systems and Technologies (CISTI), Jun. 2020, doi: 10.23919/cisti49556.2020.9141048.
- [6] N. Ale Ale and J. Fabián, "Detección del estado fisiológico de los ojos en Conductores mediante técnicas de visión artificial," *Ingeniare. Revista chilena de ingeniería*, vol. 27, no. 4, pp. 564–572, Dec. 2019, doi: 10.4067/s0718-33052019000400564.
- [7] Duy Khuat, B., Thai Phung, D., Thi Thu Pham, H., Ngoc Bui, A., & Tung Ngo, S. "Vietnamese sign language detection using Mediapipe," 2021 10th International Conference on Software and Computer Applications, 2021, doi:10.1145/3457784.3457810.
- [8] C. A. Quinayás Burgos, D. F. Quintero Benavidez, E. Ruíz Omen, and J. L. Narváez Semanate, "Sistema de detección de caídas en personas utilizando video vigilancia," *Ingeniare. Revista chilena de ingeniería*, vol. 28, no. 4, pp. 684–693, Dec. 2020, doi: 10.4067/s0718-33052020000400684.
- [9] E. E. García-Salirrosas, R. A. Sánchez-Poma, E. E. García-Salirrosas, and R. A. Sánchez-Poma, "Prevalencia de trastornos musculoesqueléticos en docentes universitarios que realizan teletrabajo en tiempos de COVID-19," *Anales de la Facultad de Medicina*, vol. 81, no. 3, pp. 301–307, 2020, doi: 10.15381/anales.v81i3.18841.
- [10] A. Haider Hadi, O. Suha Sahib, A. Haider Rasheed. "Designing and configuring context-aware semantic web applications," *Telkomnika*, vol. 18, no 5, pp. 2549-2559, 2020.