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UNIVERSIDAD DE CASTILLA-LA MANCHA

TRABAJO FIN DE GRADO

Diagnostico de patologias mediante el analisis de movimiento via inteligencia artificial

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Departamento tutor académico

Tecnología Específica

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Mes , Año

*D*edicado a mi familia y a todos
aquellos que me apoyaron durante el camino

Yo, Carlos Rincón González con DNI 04235371J, declaro que soy el único autor del trabajo fin de grado titulado ” Diagnostico de patologias mediante el analisis de movimiento via inteligencia artificial” y que el citado trabajo no infringe las leyes en vigor sobre propiedad intelectual y que todo el material no original contenido en dicho trabajo está apropiadamente atribuido a sus legítimos autores.

Talavera de la Reina, a 19 de Diciembre de 2023

Fdo: Carlos Rincón González

Resumen

Esta plantilla puede modificarse para adaptarse a las particularidades de cada Proyecto, tanto en contenido como en formato, siempre y cuando se respete las directrices básicas indicadas en la guía de estilo y formato para la elaboración de TFG del Grado en Ingeniería Informática de la Facultad de Ciencias Sociales y Tecnologías de la Información de Talavera de la Reina.

Abstract

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HTML Lenguaje de marcas de hypertexto

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Chapter 1

Introduction

1.1 How back pain affects health

Health is a problem that never can escape us, whether we want it or not, we get sick from time to time, and illnesses are a main cause of discomfort in your day-to-day life, but for many people, it's not only a discomfort, many people have chronic ilneses that don't allow them to have a normal life, and they don't deserve it. As many experts see it two main causes of illness affect people in today's world, mental illness and back pain.

As Gordon Waddell talks about in his book "The back pain revolution", back pain is a pervasive and often debilitating condition that affects millions of people worldwide, transcending age, occupation, and lifestyle. As one of the most common reasons for seeking medical attention, back pain poses a significant challenge to the well-being and functionality of individuals across diverse demographics. This book delves into the multifaceted nature of back pain, exploring its possible causes, far-reaching implications, and the profound impact it has on the daily lives of those who grapple with this condition.

Understanding the root causes of back pain is crucial in addressing and managing this prevalent health issue. From musculoskeletal imbalances and poor posture to more complex conditions such as herniated discs and spinal deformities, the variety of factors contributing to back pain is vast. By unraveling these causes, we can better comprehend the intricate web of influences that contribute to the development and persistence of back pain, thereby paving the way for more targeted and effective interventions.

Beyond the physical discomfort it causes, back pain goes through various aspects of individuals' lives. It enters professional life, limiting work productivity and potentially limiting career advancement. Simple daily activities become annoying tasks, demolishing the quality of life for those

fighting with persistent pain. Furthermore, the emotional toll of chronic back pain can lead to anxiety, depression, and a sense of helplessness, creating a cascading effect on mental well-being.

Posture stands as a cornerstone in the intricate puzzle of back pain. Poor posture places undue stress on the spine, its supporting structures, and surrounding muscles, often leading to discomfort and pain. Sedentary lifestyles, prolonged hours spent hunched over screens, or improper ergonomics contribute to the prevalence of poor posture. This misalignment, whether subtle or pronounced, can over time lead to imbalances in muscle strength and flexibility, setting the stage for chronic back issues.

The way individuals walk, known as *gait*, is another pivotal factor influencing back health. An abnormal gait pattern can trigger misalignments in the spine, impacting the distribution of forces throughout the body. For instance, an uneven gait or excessive pronation of the feet can lead to compensatory movements in the spine, potentially causing strain and pain, this is a very well know problem for those who have plain feet and the reason those people ned to have prosthetics to help their posture.

Occupational demands and lifestyle choices significantly contribute to poor posture and walking habits. Jobs that require prolonged sitting or repetitive movements may contribute to muscular imbalances and faulty posture. Similarly, carrying heavy loads, whether at work or in daily activities, can strain the back and alter gait patterns, further increasing the risk of developing or exacerbating back pain.

This project will explore not only the physiological aspects of back pain but also its broader implications on society. By researching this condition, we aim to help the development of comprehensive strategies for prevention, management, and treatment. Through an understanding and research of back pain, we can empower individuals, healthcare professionals, and policymakers to collaborate in mitigating its impact and creating a healthier, more resilient society.

1.2 Mental issues and how they relate to posture

This project will take part in a bigger research article related also with the importance of mental ilness in society.

Mental illness poses a significant challenge to society, affecting people, families, and communities on various levels. Moreover, mental illness can disrupt social relationships and hinder effective communication, leading to social isolation and the destruction of a person's life from within itself. Depression, a common mental health disorder, affects millions of people globally, impairing their ability to function optimally in daily life. The repercussions of depression extend beyond individual

suffering, where it can lead to harder and much worse consecuences. Even if it doesn't go too far it can hinder your life in a very hard way making you not be a "proper" person even limiting you to to a bed, as you dont have the strength to leave.

Alzheimer's disease, a form of dementia, is a particularly prevalent and devastating mental health condition. As populations age worldwide, the incidence of Alzheimer's continues to rise, placing immense emotional and financial strain on families. The progressive nature of the disease not only steal the cognitive abilities on the people who suffer it but also places a burden on the families and whoever is in charge of them. Personaly this has been a big issue in my family, where i've suffered several cases of alzheimer's disease and it's been hard to us as a family to deal with.

The societal impact of mental illness also manifests in stigmatization, discrimination, and inadequate access to mental health services. Stigma surrounding mental health issues can lead to delayed or inadequate treatment, increasing the severity of conditions. Adressing mental health challenges on a societal level requires comprehensive strategies, including destigmatization, improved access to mental health resources, and increased awareness to help a supportive and inclusive environment for those affected by these conditions. Addressing mental health not only benefits individuals but also contributes to the overall well-being and productivity of society.

In the research this project takes part of, we aim to also stablish a link on posture and movement to the discovery and precention of mental health such as both we talked aboout, alzheimers and depression. There are articles that correlate mental health sympthomps to verval but also non verbal signs. Researchers have focused their attention on a visual and linguistic indications for assessing depression. This project introduces related work on facial features, audio features, body features, and Kinect-based rehabilitation training and detection methods in particular.

1.3 Improving the medical field

Technology, particularly advancements in computer science, has played a crucial role in revolutionizing the medical field, enhancing patient care, and driving improvements in the healthcare sistem. One of the most notable contributions comes from the utilization of electronic health records, which have simplified the management and accessibility of patient information. EHRs enable doctors to access detailed and up-to-date patient records instantly, facilitating more informed decision-making and coordinated care across various medical departments. This not only improves the efficiency but also reduces medical errors wich lead to a better health care sistem overall.

Moreover, artificial intelligence (AI) and machine learning (ML) applications have significantly impacted medical diagnostics and treatment planning. Advanced algorithms can analyze vast

amounts of medical data, such as imaging studies, genetic information, and patient histories, to identify patterns and provide decisions that may escape the human eye. In fields like radiology, AI algorithms have demonstrated remarkable accuracy in detecting abnormalities, expediting diagnoses, and contributing to earlier interventions. Additionally, personalized medicine has gained momentum through genomic research, leveraging computational methods to analyze individual genetic profiles and create treatment plans to the specific genetic makeup of each patient.

Telemedicine, another technological advancement fueled by computer science, has transformed healthcare accessibility. Using video consultations, remote monitoring, and digital communication, patients can receive medical advice and monitoring without the need for physical visits to hospitals. This has proven particularly important as of late, folowing the events of the global pandemic that hit us a couple of years ago, even tho other parts of the world had been using it prior to that.

This project aims to tackle the previous points and merge them into one, alowing us the benefits of telemedicine and artificial intelligence in the aims of creating a new diagnostic method for the biggest health issues of today's world. This is the goal, helping society to overcome what we see as the problems of the future and the present, that make life worse for so many people on this world.

Chapter 2

Objectives

2.1 O1: Data obenction via RGB camera

We are going to consider the different types of cameras to be used to process the data, these cameras have different capabilities and characteristics. We are going to analyze the differences between them and we are going to see the way in which we can make use of their data.

In our case we are going to use RGB cameras, which do not have depth perception by themselves, so we have to investigate how to transcribe depth to them.

Not only is the camera we use relevant, but the software used to process what is seen by the camera is also relevant. Therefore we are going to investigate the different ways of data capture and processing.

2.2 O2: Validation of the data acquisition system for motion analysis in a clinical setting

In contrast to other types of cameras our choice, the RGB camera, is not a camera with previous scientific validation. This is why we have to investigate how the validation process of the camera and the data we obtain from it can be done.

The data need to be validated not only scientifically, but also in terms of what parameters are going to be useful for the data model.

2.3 O3: Definition of the data to be used and their generalization for AI model training.

The data that we aquire from the cameras must be processed before being used for the data model and training. Also this will help us determine what data is useful for future deployment of aplications so the load on the devices is not as hard.

2.4 O4: Comparison of different methods for training AI models for the diagnosis of the pathology of the initial case study

AI models are not that new anymore, that means that there are a lot of methods and services that help you train data models, we are going to dive on the diferent aspects of ones and others that have diferent caracteristics between them. Ones may be more useful than others for our task.

That also includes diferent methods of hosting these AI models and the research of diferent diseases to best choose the one that fits us the most and can be most of an improvement.

2.5 O5: Development of a tool for training AI models for the initial case study

We not only aim to research everything in this field, we are going to develop a data model that fits our needs and gives us our desired outcome.

2.6 O6: Validation of the diagnostic system for the pathology of the initial case study.

Chapter 3

State of the art

To know what can be done regarding our interests, we must look at what has already been done so far, so we don't waste our time doing something already done by someone else and also so we can use that research as a base to further improve our understanding and our work. Because of this we are going to be looking at the state of the art on camera tecnologies, methods of stracting the data and different models of artificial intelligence.

3.1 Cameras

RGB cameras, short for Red, Green, and Blue cameras, are imaging devices that capture color information by utilizing three primary color chanels: red, green, and blue. These cameras mimic the way human vision percives color by combining these three channels in varying intensities to produce a wide spectrum of colors. Each pixel in the image sensor of an RGB camera contains three sub-pixels, each sensitive to one of the three primary colors. The combination of these sub-pixels allows the camera to capture and reproduce a full range of colors, making RGB cameras essential for applications where color fidelity is crucial.

The popularization of RGB cameras can be attributed to their widespread use in various fields. In consumer electronics, RGB cameras are a key component of smartphones, digital cameras, and webcams, enabling users to capture high quality and realistic images. In the field of entertainment, RGB cameras play a key role in film and television production, making accurate color representation for a more immersive viewing experience. Even more so, RGB cameras are extensively employed in computer vision applications, such as facial recognition, object detection, and augmented reality, where precise color information is vital for accurate analysis and interpretation. This is the field we are going to be using them in, but as we will see, there are more complications to be dealt with when using RGB cameras in the medical field.

RGB cameras have become necessary in modern society, finding applications in industries ranging from healthcare and automotive to agriculture and surveillance. Their ability to faithfully capture and reproduce color has made them indispensable tools in a wide array of technological advancements, contributing significantly to the way we perceive and interact with the visual world. This is the precise reason we chose to evolve on this type of tecnology, to make our outcome, the aplication that relies on the data model, the most accesible posible to all the posible public of our aplication.

****** Hacer un cuadro con estas camaras

- Infrared (IR) Cameras: Capture infrared light, which is beyond the visible spectrum. Used in night vision applications, thermal imaging, and scientific research.
- Ultraviolet (UV) Cameras: Detect ultraviolet light, which is also outside the visible spectrum. Applied in scientific research, forensics, and some industrial processes.
- Multispectral Cameras: Capture light in multiple bands across the electromagnetic spectrum. Useful in agriculture, environmental monitoring, and medical imaging.
- Thermal Infrared Cameras: Detect the heat emitted by objects. Commonly used in night vision, security, and industrial applications.
- X-ray Cameras: Utilized for medical imaging, security screening, and industrial inspection. Capture X-rays, which have shorter wavelengths than visible light.
- 3D Cameras: Capture depth information along with color. Used in computer vision, robotics, and augmented reality applications.
- Depth Cameras: Measure the distance of objects from the camera to create a depth map. Commonly used in computer vision, gesture recognition, and virtual reality.

These are just a few examples, and there are many specialized cameras designed for specific applications. Each type of camera serves a particular purpose, depending on the information required for a given task. In particular, we are going to take a look at the Depth cameras, in particular kinect, as it is a well known and stablished camera within the medical community for a variety of applications, like we have talked about before.

RGB cameras and depth cameras, such as the Kinect sensor, serve distinct purposes in imaging technology. While RGB cameras focus on capturing color information, depth cameras are designed to measure the distance of objects in a scene, providing a three-dimensional representation of the environment. The Kinect sensor, for instance, utilizes a combination of infrared sensors and a depth-sensing technology called time-of-flight to measure the time it takes for infrared light to travel to an object and back. This information is then used to create a depth map, representing the spatial layout of the scene. [6]

One significant difference between RGB and depth cameras lies in their respective capabilities. RGB cameras are great in capturing detailed color information, making them suitable for applications like photography, video recording, and image analysis where color fidelity is essential. On the other hand, depth cameras are valuable in scenarios where understanding the spatial relationships and distances between objects is critical. This makes them ideal for applications like gesture recognition, virtual reality, and robotics, where depth perception plays a vital role.

Even more so, in the medical field, depth cameras have been used for many different purposes for years now. Here are some detailed examples of how depth cameras have been utilized in healthcare: [1]

Rehabilitation and Physical Therapy: Depth cameras have been employed in rehabilitation settings to monitor and assist patients during physical therapy. Kinect-based systems can track body movements in real-time, providing quantitative data on a patient's range of motion, posture, and joint angles. Physical therapists can use this information to customize rehabilitation exercises and track the progress of patients recovering from injuries or surgeries. In some cases they can even give output on how a patient is doing a particular exercise and correct them in the case they are doing it wrongly. [5]

Surgical Planning and Navigation: Depth cameras have been integrated into surgical planning and navigation systems to enhance the precision of procedures. By capturing detailed 3D models of a patient's anatomy, surgeons can visualize internal structures with greater accuracy. This technology assists in preoperative planning, allowing surgeons to better understand the space between organs and plan the optimal approach for surgeries. This have been used in combination with x rays and in their replacement in cases where x rays are not a viable option. [3]

Prosthetics and Orthotics Design: Depth cameras have been applied in the design and fitting of prosthetics and orthotics. By capturing precise measurements of a patient's limbs in three dimensions, doctors can create customized prosthetics that offer a better fit and improved functionality. This personalized approach enhances patient comfort and overall effectiveness of prosthetic or orthopedic devices. [2]

3.2 Tracking (gracias david)

We not only need to talk about the way we are going to obtain the images for the purposes we are aming at. Tracking is also a very important aspect of the design and the decision that we have to make. Human movement tracking involves capturing and analyzing the motion of the human

body, often represented through skeletal models based on joints.

A skeletal model based on joints is a representation of the human body's underlying skeletal structure, focusing on key points or joints where bones articulate. This model is used in the context of human movement tracking and motion analysis. The skeletal model typically consists of interconnected joints, each associated with specific body parts, such as the head, shoulders, elbows, wrists, hips, knees, and ankles. These joints are crucial for capturing and understanding the intricate motions and positions of the human body during various activities. These joints are not only posible to be captured on a still image, but also on moving images of the body.

In the field of motion capture and tracking technologies, the skeletal model serves as a virtual framework that mirrors the actual movements of a person. The movement of joints is tracked and recorded using sensors or cameras, providing a three-dimensional representation of how the body is positioned and oriented in space over time. The accuracy and completeness of the skeletal model are essential for capturing natural and realistic human movements. The joints serve as key anchor points, enabling the reconstruction of the entire body's pose and facilitating a deeper understanding of biomechanics, kinematics, and human behavior. As technology advances, these skeletal models become increasingly sophisticated, contributing to the development of more immersive virtual environments, precise biomechanical assessments, and innovative applications in fields such as healthcare, sports, and entertainment.

Various technologies are employed for this purpose, each with its strengths and limitations.

- Inertial Sensors: Inertial sensors, such as accelerometers and gyroscopes, are commonly used for motion tracking. These sensors measure acceleration and angular velocity, allowing the calculation of joint angles and movements. Inertial sensors are wearable and portable, making them suitable for applications like fitness tracking and sports analysis, but in our case, also the medical field.

- 2D Cameras: 2D cameras or RGB cameras capture images in two dimensions and can be employed for human movement tracking using computer vision techniques. These cameras are cost-effective and versatile, making them widely used in applications like gesture recognition and video surveillance. However, they lack depth information, limiting their ability to capture the full three-dimensional nature of human movement. These are the ones we have been talking about before.

- 3D Cameras: 3D cameras, such as depth-sensing cameras, provide depth information along with the visual data. They use technologies like structured light or time-of-flight to measure distances, enabling more accurate skeletal modeling. 3D cameras are beneficial for applications like virtual reality, gaming, and biomechanical research, as they offer im-

proved depth perception compared to 2D cameras. These cameras are the category that fits the kinect as we have talked about before.

- Infrared Cameras: Infrared cameras capture infrared radiation, allowing them to work in low-light conditions. They are often used in conjunction with markers or reflective surfaces to track human movement accurately. Infrared cameras are employed in motion capture systems for animation, biomechanics research, and clinical applications. They offer high precision, but the setup can be complex and requires controlled environments.
- Marker-Based Motion Capture: Marker-based motion capture systems use markers placed on specific body parts. Cameras, often infrared, track the movement of these markers to create a detailed skeletal model. This method provides high accuracy but may be intrusive, as markers must be attached to the subject's body. For example, Optitrack is a comercial solution for motion tracking using markers, OptiTrack's motion capture systems are used in the film industry for creating realistic animations, in the gaming industry for creating immersive experiences, in the VR industry for creating low-latency positional tracking, in the robotics industry for 6DoF tracking, and in the movement sciences industry for human movement analysis. The cameras are placed around the area where the motion capture is taking place, and they capture the movement of reflective markers that are placed on the objects or people being tracked
- Markerless Motion Capture: Markerless motion capture relies on computer vision algorithms to track and reconstruct skeletal models without the need for physical markers. This approach offers more natural movement and is less invasive than marker-based systems, making it suitable for applications like entertainment, sports analysis, and healthcare. OpenPose, a 3D markerless motion capture technique that uses multiple synchronized video cameras to track human poses or skeletons from images. It has been shown to have an accuracy of 30 mm or less.

3.3 MediaPipe

Now that we have established a bases on motion capture through cameras and tracking systems, we arrive at a very important part of the project, MediaPipe. [4]

MediaPipe is an open-source framework developed by Google that provides a comprehensive solution for building real-time multimodal perceptual pipelines. It is designed to simplify the development of applications that involve various forms of sensor inputs, such as cameras and microphones. MediaPipe offers pre-built components and tools for tasks like hand tracking, face detection, pose estimation, and more.

MediaPipe provides a solution for human tracking through its Pose module, which is designed to estimate the poses of multiple people in real-time. This module can be used for applications such as fitness tracking, gesture recognition, and augmented reality experiences. It uses a pre-trained machine learning model for pose estimation. This model is trained on a large dataset of annotated images to learn the key points (joints) of the human body. The model predicts the positions of specific joints on the human body, typically including key points like the nose, shoulders, elbows, wrists, hips, knees, and ankles. These landmarks form a skeletal representation of the human pose.

The detected pose landmarks are then used as input data in a graph-based processing pipeline. Each joint becomes a node in the graph, and the connections between the joints define the edges. This structure enables efficient processing and tracking of human poses. It is optimized for real-time performance, allowing the pose estimation model to process video streams or camera input in real-time. This is crucial for applications where low-latency tracking is required such as ours.

3.4 Data extraction and compilation

Análisis de movimiento Lo primero que deberías entender aquí porque te va a ser muy necesario es el ciclo de la marcha humana, junto con sus fases. Una vez entendido eso verás que hay 2 tipos de parámetros: Parámetros espacio-temporales Aquí los espacio-temporales que son algunos como longitud de paso, longitud de zancada, tiempo de paso, tiempo de doble apoyo, etc. Parámetros cinemáticos Para entender estos primero debes entender que el cuerpo está dividido en 3 planos: Sagital, transversal y frontal. Con esos planos se pueden obtener los parámetros cinemáticos (ángulos) de las diferentes articulaciones. Por ejemplo: - Flexion/extension de la rodilla - Abducción/aducción de la rodilla - Rotación interna/externa de la rodilla.

Info recavada de mediapipe y el codigo de david

El dodigo de david usa dos clases, una detecta la pose y la otra dibuja el frame

pose: Utiliza 3 modelos que están en una carpeta separados (pregunter por ellos) utiliza la task de vision en media pipa para elegir los parametros basicos en el modelo. inicializa el objeto con los valores pasados en la creación para la detección de imagen usa la libreria de mp con la función image. landmarker es la función que usa para la detección de los puntos esto es lo que sale en la documentación de mediapipe y por eso lo referencian tanto en el paper. devuelve el resultado de la pose del landmarker draw: llama al objeto de la pose toma como configuracion los colores para los parametros. tiene unos condicionantes que colorean los joints dependiendo de la posición, como se ve en la imagen unos son la cara y otros son el lado izquierdo o derecho del cuerpo. (preguntar los enteros pero supongo que serán los numeros de los landmarks que

ya están definidos por mp) los dibuja usando cv2 notar que en este dibujado accede a .poselandmarks, lo cual parece ser la lista de los landmarks que hay en el frame. investigar ka función circle pero parece “simple” en su función usa line para las conexiones haciendo referencia a las coords x e y de ambos puntos

en el main solo hace un bucle infinito con las dos funciones se definen los valores para el objeto de la pose usa cv2 para la captura del video

[1] Chiu, C.-Y. et al. 2019. Comparison of depth cameras for three-dimensional reconstruction in medicine. *Proc. Inst. Mech. Eng. H*. 233, 9 (Jun. 2019), 938–947. DOI:https://doi.org/10.1177/0954411919859922.

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[5] Omelina, L. et al. 2016. Interaction Detection with Depth Sensing and Body Tracking Cameras in Physical Rehabilitation. *Methods Inf. Med.* 55, 01 (2016), 70–78. DOI:https://doi.org/10.3414/ME14-01-0120.

[6] Smisek, J. et al. 2013. 3D with Kinect. *Consumer Depth Cameras for Computer Vision*. Springer. 3–25.

A. Anexo 1 - Metodologia de trabajo Scrum

Scrum is an agile project management framework that helps teams deliver high-value products. It emphasizes iterative development, collaboration, and customer feedback. The process is organized into time-boxed iterations called sprints, typically lasting 2-4 weeks. Scrum includes roles like Scrum Master, Product Owner, and Development Team, as well as specific events like Sprint Planning, Daily Stand-ups, Sprint Review, and Sprint Retrospective.

This is an altered version of the scrum methodology due to the fact that there are only two parties involved in this project, the developer and the product owner. Carlos will be the developer and Felix and David will take part as the product owners. When adapting Scrum for a single developer and a single Product Owner, the structure can be simplified while maintaining key principles. Here's the modified version we are opting for: - Roles: - Developer: This is the individual responsible for all aspects of the product's development, from design to implementation and testing. Carlos Rincón González - Product Owner (PO): This person represents the stakeholders, defines the features, and prioritizes the work to maximize the product's value. Felix Albertos and David Carneros - Events: - Sprint Planning: At the beginning of each sprint (a development iteration), the developer and PO collaborate to plan the work for the upcoming sprint. These events will occur once evert 2 to 4 weeks during the sprint meeting. - Daily Check-in: The developer has a brief daily check-in to review progress and plan the next steps. This is an opportunity to adjust plans based on feedback or changing priorities. This is not a necesary step and it's mostly used as a method of self organization in the daily tasks for the developer - Sprint Review: At the end of each sprint, the developer presents the completed work to the PO. They discuss what was achieved and any adjustments needed for future sprints. Same as with the sprint planning, this will take part as part of the sprint meeting. - Sprint Retrospective: The developer reflects on the sprint, identifying what went well and what could be improved. This can be a brief self-assessment to enhance the development process. This will be a part of the sprint meeting as

well.

- Artifacts:
  - Backlog: The Product Owner maintains a prioritized list of features and tasks, known as the backlog. The developer pulls items from the top of the backlog into each sprint.
  - The initial product backlog will consist on all the objectives set for the project in the begining meeting. This objectives will be striped down into its crucial and more basic parts to be worked on and to develop a successfull project

By simplifying the structure, a single developer can still benefit from Scrum's iterative and feedback-driven approach. The collaboration between the developer and product owner remains crucial for delivering valuable increments of the product.

For the management and monitoring of the progect we will make use of a tool called Github

For this workflow we are going to use the tool within GitHub called Github projects. GitHub Projects is a collaborative project management tool designed to enhance the organization and tracking of software development projects on the GitHub platform. It provides a visual interface that allows teams to plan, track, and manage their work efficiently. GitHub Projects utilizes the concept of boards, where tasks are represented as cards that can be moved between customizable columns, such as "Product Backlog", "Sprint Backlog", "In Progress", and "Done". This flexibility makes it adaptable to various project management methodologies, including Agile and Kanban. Additionally, GitHub Projects integrates seamlessly with other GitHub features, such as code repositories and pull requests, providing a comprehensive ecosystem for collaborative software development, wich is precisely the reason why we chose to use it, as we hosted our project on github. - *** Explicar el porque de GitHub - **** Añadir product backlog inicial

A.1 Sprint 1 (20/09/2023 - 04/10/2023) - First Meeting

- **Sprint meeting**
  - We stablish the bases of the project and the work methodology, also we stablish a final name and theme.
- **Sprint Tasks**
  - Define the basics of the methodology and decide on a interface and a form to aply it
  - Create the github project and create the product backlog

A.2 Sprint 2 (04/10/2023 - 22/11/2023) Project definition and configuration

Sprint meeting - Defining the project objectives and bulletpoints

Sprint Tasks - Define and finalize the objectives of the project (3) - Create the constitution project document. (2) - Creation of the project based on Felix's template (1)

Sprint Retrospective - The template works properly and has been completely filed - The project objectives seem clear and well defined

A.3 Sprint 3 (22/11/2023 - 05/12/2023) - Introduction.

Sprint meeting - We start discusions about the project information itself and how to make the project´s memory. - We decide to start developing the introduction of the project so it is usefull as a steping stone for the rest of the project.

Sprint Tasks - Research on back pain related problems. (4) - How mental isues afect and relate to posture. (3) - How tecnology improves the medical field (3)

Sprint Retrospective - The Introduction has started successfuly but will need more work in the future. - Introduction may be splitted into different sections in the future as it may need more work

A.4 Sprint 4 (05/12/2023 - 19/12/2023) - State of the art.

Sprint meeting - We agreed that the introduction art needed more development and we set ourselves on the path to research more about it in the future. - At this point it was the time to start working on the state of the art. - Also we had to stablish the motivations and objectives more clearly and develop a clear explanation of them in the project memory.

Sprint Tasks - Further explanation of the introduction (1) - Research of the state of the art (9) - Types of cameras (4) - Tracking methodology (3) - Mediapipe definition (2)

Sprint Retrospective - **Aqui voy a poner lo que hablemos este sprint**

A.5 Sprint template (19/12/2023 - 16/01/2024) - Holiday Season Improvements

- **Sprint meeting**

  - The previous sprint was successful in creating a beginning of a state of the art.
  - this sprint will take part during the holiday season and therefor will be lighter
  - we will use this time to further improve the work on the last sprints by improving the introduction and the state of the art research.
- **Sprint Tasks**
  - Research on the introduction (3)
  - Research on the state of the art (3)
  - Write compelling explanations and deeper knowledge (4)
- **Sprint Retrospective**
  - **Aqui voy a poner lo que hablemos este sprint**

A.6 Sprint template (16/01/2024 -) - Titulo del sprint (resumiendo el objetivo)

- **Sprint meeting**
  - Revision del sprint anterior
  - Nuevas tareas
  - Establecer objetivo del sprint
- **Sprint Tasks**
  - Tareas al sprint backlog (Peso)
- **Sprint Retrospective**
  - Burndown Chart del sprint