WalkFit

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Abstract: *While walking is a basic exercise, falls are a serious health concern for older persons. With an emphasis on lightweight, user-friendly, and precise sensor integration, the prototype offers real-time data on tilt angles and pressure distribution. The initiative attempts to anticipate the risk of falls by working with a physiotherapist and using machine learning algorithms, providing useful information for families and medical professionals. The suggested method, which has implications in physiology and orthopaedics, shows promise for an ageing population. By adding sensors to a conventional walking stick to monitor the research offers a novel way to address the major health risk of falls among the elderly. Real-time data on tilt angles and pressure distribution are provided by the created prototype, which places a high priority on accurate sensor integration and lightweight, user-friendly design. The programme uses machine learning algorithms with physiotherapists to forecast fall risks, providing families and medical professionals with important information. The suggested method shows potential for applications in neurology, physiology, and orthopaedics in addition to fall prevention, demonstrating a comprehensive approach to improving an ageing population's general safety and well-being.The device is designed to improve walking safety for the elderly by incorporating accurate, lightweight, and user-friendly sensors into a traditional walking stick. The real-time data gathering on tilt angles and pressure distribution made possible by this connection provides insightful information about the user's motions. Through proactive fall risk prediction, the programme works with physiotherapists and uses machine learning algorithms to provide a tailored and efficient fall prevention strategy. The dedication to a user-friendly and ergonomic design encourages regular usage without posing any inconvenience. Beyond preventing falls, the prototype shows potential uses in neurology, physiology, and orthopaedics, highlighting its adaptability to many healthcare domains.*

Keywords: **Old Age, KNN, Joint Pains, FSR, Fall Detection**

1. Introduction

Fall mitigation measures are becoming more and more important as countries throughout the world experience a demographic transition towards an ageing population. Serious injuries from falls can include fractures, brain damage, and long-term issues that affect older people's day-to-day activities. Treating these injuries is not the only difficulty; creating preventative methods to lower the likelihood of falls is even more crucial. Given the complex nature of falls in the aged population, academics and medical experts are investigating cutting-edge technology and all-encompassing approaches to tackle this widespread problem. To address falls, it is necessary to explore the many variables that affect a person's stability, such as their stride, muscle strength, and the subtle interactions between their physical and neurological disorders. Furthermore, it is impossible to ignore how falls affect people psychologically. Reduced quality of life might arise from self-imposed restrictions on everyday activities caused by a fear of falling. As a result, an interdisciplinary strategy that incorporates knowledge from biomechanics, physiotherapy, and technology appears to be a viable way to help older people live active, satisfying lives while also preventing falls. Innovative ideas like predictive algorithms, customised rehabilitation programmes, and walking aids with sensors are becoming more and more popular in this environment. By offering customised solutions that tackle the particular difficulties experienced by the elderly, these initiatives hope to create the conditions for an older population that is safer and more resilient. Finding practical fall prevention techniques becomes a team effort as we traverse the intricacies of an older culture. To achieve this, we collaborate with researchers, healthcare professionals, and technological experts.

2. Literature Review

The study carried out by R. Kavita et al. [1] The Smart Electronic Stick, often known as the Smart E-Stick, is a creative gadget that combines cutting-edge technology to make navigation easier for those with vision problems. The stick features light and water sensors to warn the user of potential dangers in addition to an ultrasonic sensor for obstacle detection. A microprocessor receives the data gathered by the sensors, evaluates its closeness to the barrier, and if required, sounds a buzzer. In addition, the stick can sense if its environment is bright or dark and emit haptic sensations to alert the user to potential hazards like water and pits. The gadget has a wireless RF remote control that, in the event that the blind person misplaces the stick, may sound a buzzer on the stick to help them find it. Because of this, those who are blind or visually impaired may locate lost devices and obstacles with ease by using the stick. The "Speak for me" app on an Android phone may also produce voice messages for the user. The research carried out by Markus et al.[2] Current developments in embedded systems have shown a large field of potential innovation in low-cost assistive technologies for the blind. Many designs, ranging from the most basic white cane to the most advanced electronic walking stick, have been put out with the intention of protecting and helping those who are sight impaired. As a result, the present white stick's ability to combine identifications that are both above- and below-knee deterrents is improved. The bamboo stick only uses ultrasonic sensors to identify obstacles before coming into touch with them and a water detection sensor to identify any water present on the path. Depending on where the obstruction is, it provides the operator with vibration and various auditory feedbacks. Excellent trial results were achieved from a volunteer who was blinded and guided along an impeded path. The outcomes guarantee prompt identification, and security, and increase the user's mobility speed. The simulations that were run were precise and pertinent to the paper's main objective. For the blind or visually challenged, an electric bamboo walking stick may be utilised both indoors and outdoors. The study conducted by Mahmud et al.[3] Since the dawn of human history, humans have suffered from a variety of infirmities. Among them, blindness is a prevalent and intolerable condition. The goal of science and technology is to always simplify human existence. Therefore, the primary goal of this work is to reduce the effects of blindness by building automated hardware based on microcontrollers that can confirm a blind person's ability to instantaneously recognise impediments in front of them. The hardware is made up of a microprocessor integrated with a proximity sensor, wet detector, ping sonar sensor, micropager motor, and other devices.

The experiment conducted by Rahman et al.[4] This is the first of two papers that discuss the usage of walking sticks as mobility aids by the elderly or others with limited mobility to help them stay stable and balanced while going about their everyday lives and living independent lives. As a result of technological advancements, contemporary walking sticks are widely available on marketplaces. Selecting an appropriate walking aid, nevertheless, might not be simple. Value for money, unique features, and ease of use are a few of the key elements that impact a potential user's decision while selecting a walking aid. A Smart Walking Stick is created for this project. In the case of an emergency, the Global Positioning

System (GPS) is utilised to determine the position and subsequently send messages to individuals who are closely associated through mobile devices. It also has an auto fall alarm sensor installed. The goal of this recently created Smart Walking Stick is to provide a tool that can increase accessibility and mobility. Notably, this gadget was also created with the intention of supporting Malaysia's aspirations for IR4.0 and the Sustainable Development Goals (SDG), particularly by assisting those with physical limitations who would face obstacles to movement. This invention increases user safety by connecting them to the Internet of Things (IoT) in addition to the progress of digitalization. This paper discusses the creation of a revolutionary walking stick concept as well as the comprehensive findings from the market study. The extensive design configuration and technical analysis that were done on the prototype are covered in the second paper. The experiment carried out by Gopall et al.[5]Simplifying living has always been a priority for technical advancement. A fast-paced lifestyle has made everyone in today's world, with a few exceptions, use technology to their advantage. Among them are the visually challenged, who are dependent on others for things such as transportation. This research aims to propose one such theoretical framework that provides the blind with intelligent and useful electronic help using state-of-the-art technology. This paper depicts a blind person's walking stick that is powered by Arduino. Blind people may work and detect obstacles more easily and comfortably using this gadget. A traditional stick is not an effective way for visually impaired individuals to identify impediments. The gadget measures the distance between objects and the Blind-Aid Stick using an ultrasonic sensor. When impediments are audible to the ultrasonic sensor, they can be detected by listening to the buzzer's sound. It allows free movement by warning the user of any obstacles in his way. This suggested technology uses the infrared and ultrasonic waves emitted by the relevant sensors to locate the obstacle. To determine whether there has been a physical shock or impact, a shock sensor is used. When there is a suspicion based on impact that an accident has occurred, an alert SMS is automatically sent to the ambulance unit with the position using GPS and GSM. The main objective of this technology is to produce an intelligent Blind-Aid stick, which will be very beneficial for those with vision impairments who often need aid from others. The research conducted by Vishal Vinod Hingorania et al. [6] People who are blind or visually impaired are frequently subjected to harsh conditions in their daily lives. The necessities of the average man seem to be a barrier to their everyday existence. Even the most basic activities, such as walking, eating, taking a shower, talking, and even eating, are extremely difficult for them. Furthermore, when faced with such challenges, their only apparent escape appears to be reliance on the wealthy, which erodes their self-esteem and progressively increases their dependence. Among the traditional aids used by individuals with visual impairments are simple walking sticks, which fall short of expectations due to their inability to stabilise users adequately on uneven terrain and their tendency to lead users into undesirable situations. Without striking in front of them with the stick, there is no way for the person to know what it is, which might potentially result in mishaps. In order to address these issues, a smart walking stick is created that uses machine learning (ML) models to identify the item in front of it and provides a verbal alarm to the user, thus reducing the possibility of any and all mishaps. The walking stick is equipped with hardware that embodies the notion. This aids in phone stabilisation and improves object identification performance. Additionally, a voice message app is created using the acquired picture to notify the user.The experiment carried out by K.G.Shanthi et al.[7] People with visual impairments may identify and explore the world around them with the aid of smart vision. The World Health Organisation (WHO) estimates that 15% of people worldwide live with a handicap of some kind. People with vision impairments contribute significantly to this total. Their lifestyle is limited, and they are unable to use the possibilities that are presented to them to reflect on who they are. People should never depend on anyone else or their senses to the fullest extent possible to carry out their daily tasks. As a result, they become less confident and find it difficult to recognise the events going on around them.A stick, a guide dog, or an accompanying human were the only mobility aids available to blind people until ten years ago. The implementation of several support systems using Matlab, RFID, GPS, and ultrasonic sensor modules has been made possible by technological advancements. These innovations did, however, bring up a few drawbacks and challenges.This research presents a clever deep-learning vision to overcome these challenges. The Raspberry pi-3 CPU, pi camera, memory card, tensor flow, and audio amplifier module make up the suggested system. The visually impaired can recognise events around them much more easily thanks to this method.The research conducted by Laukkanen et al.[8] Independence is crucial for reaching aspirations, objectives, and goals in life. People with visual impairments find it difficult to venture outside many times. Throughout the world, the United Nations has hundreds of visually handicapped people who occasionally wish to serve as palm readers. Although many other devices have been used for decades, the white cane has gained widespread recognition as a useful tool for blind people to navigate. Subsequent efforts have been made to strengthen the cane by including a distinctive device. Using a white cane to navigate stairs or the road presents challenges for blind people, but it also requires acute somatosense awareness.The digital cane can help visually impaired people by providing an extra convenient means of transportation. For visually challenged travellers, there are many steering structures that enable them to manoeuvre swiftly and accurately against obstacles and diverse hazards. A white cane or guiding dog is typically carried by a blind user as a high-quality resource. As a result of recent technological advancements, a number of unique gadget types known as Electronic Travel Aids (ETAs) are available to improve blind people's quality of life. The primary purpose of ETA for the blind is to provide information about the layout of the road and, consequently, the positioning of barriers when they are in areas that are unfamiliar. With these details in hand, they must get to their destinations while avoiding unexpected borders.The main goal of this is to produce, share, and provide our knowledge and services to the people who are blind or disabled in society.The experiment carried out by et al.[9] Synopsis People who are blind or visually impaired are frequently subjected to harsh conditions in their daily lives. The necessities of the average man seem to be a barrier to their everyday existence. Even the most basic activities, such as walking, eating, taking a shower, talking, and even eating, are extremely difficult for them. Furthermore, when faced with such challenges, their only apparent escape appears to be reliance on the wealthy, which erodes their self-esteem and progressively increases their dependence. Among the traditional aids used by individuals with visual impairments are simple walking sticks, which fall short of expectations due to their inability to stabilise users adequately on uneven terrain and their tendency to lead users into undesirable situations. Without striking the thing in front of them with the stick, there is no way for the person to know what it is, which might potentially result in mishaps. In order to address these issues, a smart walking stick is created that uses machine learning (ML) models to identify the item in front of it and provides a verbal alarm to the user, so reducing the possibility of any and all mishaps. The walking stick is equipped with hardware that embodies the notion. This aids in phone stabilisation and improves object identification performance. 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3. Proposed Methodology

The process of designing a walking stick with fall detection entails a methodical integration of necessary parts, beginning with the selection and integration of a gyroscope sensor, Arduino Nano, Bluetooth module, and lithium-ion battery. The lithium-ion battery is selected because of its lightweight and portable nature, which guarantees that it can supply enough power for extended use. The HC-05 or HC-06 Bluetooth modules are integrated to enable wireless connection with a linked device. The primary processing unit, the Arduino Nano, was chosen because of its compact size and compatibility with the entire design. Next, the Arduino Nano is linked to the gyroscope sensor, with careful attention to communication protocols and power supply issues. The process of programming an Arduino entails writing code that reads and analyses gyroscope data that is then sent via Bluetooth. At this point, algorithmic implementations are critical, concentrating on the analysis of gyroscope data patterns linked to possible falls. The fall detection algorithm takes into account many factors, including tilt angles and angular velocity. Carefully configuring the communication protocol ensures dependable data delivery. To improve and optimise the fall detection algorithm for accuracy in real-world situations, extensive testing is carried out in a variety of circumstances. Furthermore, the technique encompasses the potential creation of a user interface for further functionalities, such as exhibiting past autumn statistics or expediting emergency contacts. The stick's usefulness is further improved by integration with a smartphone app. The goal of this all-encompassing approach is to develop a trustworthy and efficient fall-detection walking stick that is specifically designed to improve the safety of the elderly or people who are at risk of falling. The research significantly enhances its capacity to forecast the danger of falls based on sensor data by adding machine learning, notably the K-Nearest Neighbours (KNN) method. KNN is a key component of the device's architecture that helps classify and forecast possible fall hazards by carefully examining sensor signals. Data from a gyroscope and six Force-Sensitive Resistor (FSR) sensors are efficiently processed by the algorithm. The KNN algorithm evaluates these sensor signals and calculates the probability of a fall by comparing them with established parameters. The project uses an organized methodology, splitting the training dataset into 75% for training and 25% for testing, to guarantee the algorithm's dependability. The KNN algorithm's accuracy is enhanced by this thorough training procedure, which enables it to produce accurate predictions based on actual events. The efficacy of the system is in its capacity to categorize sensor data, offering insightful information about possible balance and gait-related hazards. By adding a predictive element, the KNN algorithm improves the project's overall effectiveness in fall monitoring and prevention applications. The device's utilization of machine learning enables it to provide prompt and precise predictions, facilitating proactive fall risk mitigation actions, especially for persons with orthopaedic conditions or age-related mobility problems. The project's potential to improve the safety and well-being of those who are at risk of falling is highlighted by this cutting-edge feature.

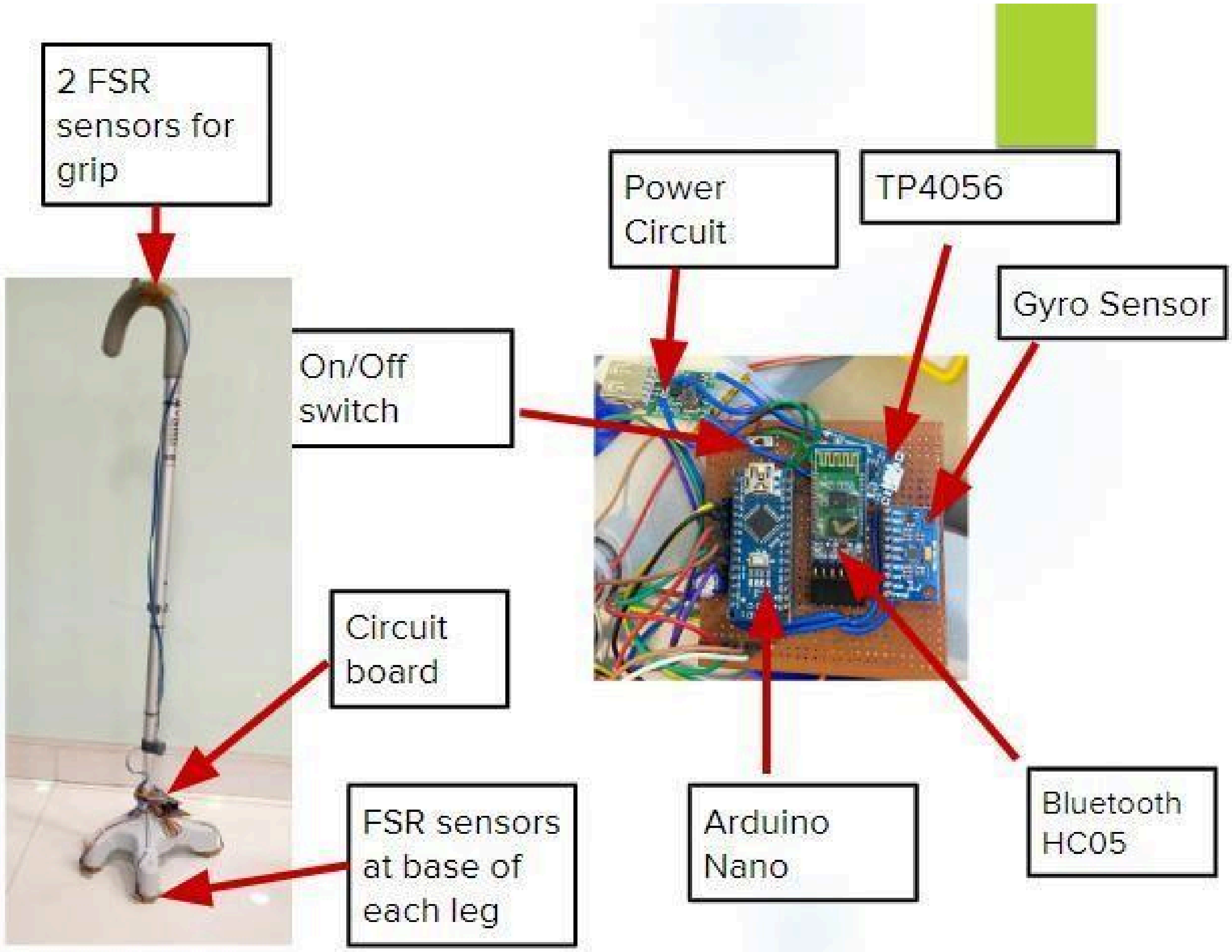

Image 1. The components and the prototype of the WalkFit

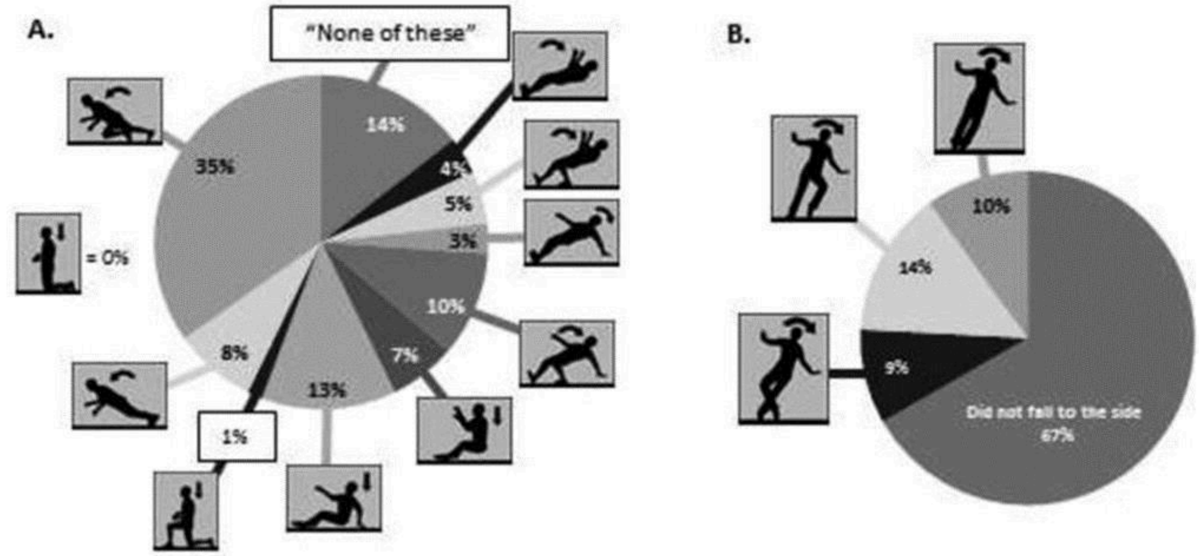

Image 2. Types of fall and body orientations

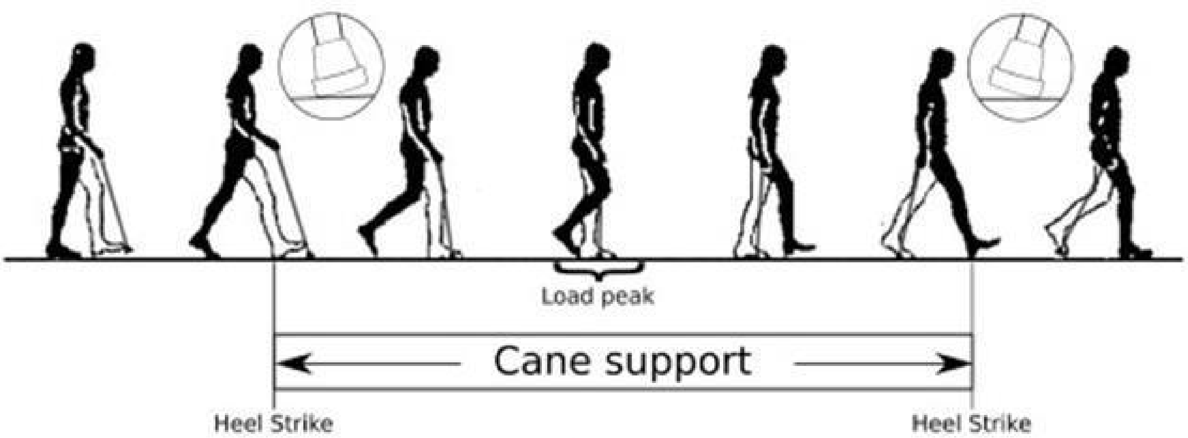

Fig 1. Concept of weight bearing on the walking stick

Name	Age	Gender	Weight	condition	L/R	Pressure points
Shantaben Patel	70	F	55	Hip operation	L	R1 AND R2
Jayshree korgaonkar	87	F	85	Rod in Right leg	R	Less pressure on R1
Kamlaben	84	F	60	Heavily bending forward	L	R1 AND R2
Indira gurav	75	F	50	Bending forward	R	R1 AND R2
Prafulaben	65	F	88	Gap in right knee	L	L2 AND R1
Smita Chitale	70	F	65	Pain in right knee	L	Maximum load on R1
manjuben	75	F	54	arthritis in both knees	R	Load on L2
Radha	88	F	62	High BP	R	R1 AND R2
Parvati	81	F	52	Arthritis in all joints	L	R2
Smita shah	83	F	59	Plate in left leg due to accident	R	L2 AND R1
Vaishali kolwankar	76	F	57	Hypertension patient and joint issue	L	Maximum load on R1
Shobna shah	84	F	52	Hypertension patient	L	L2 AND R1
Sangeeta barwe	81	F	52	Whole left side weak and Asthma Patient	R	L2 AND R1
Prakash usgaokar	82	M	63	Paralysis patient	R	Maximum load on R1
Ganpat Rao	78	M	81	8 kidney stones	R	L2 AND R1
Padma Ankham	69	F	45	Paralysis patient twice	R	L2 AND L1
Prakash Bisale	84	M	67	Heart Patient	R	Equally Divided
Vinod Sanghvi	77	M	110	arthritis in both knees and overweight	R	L2 AND R1
Mary d'souza	67	F	58	5-6 falls	R	R1 AND R2

Fig 2. Walkfit tested by Old People

4. Results

To forecast the target variable in our investigation, we used three different regression models. We can assess the Lasso Regression model's effectiveness by looking at its Mean Squared Error (MSE), which was roughly 8124.71. Similar to the previous model, the Ridge Regression model showed an MSE of around 8116.01, indicating its efficacy in predicting the intended variable. The Random Forest Regression model furthermore displayed an MSE of about 8063.46, demonstrating its efficacy in making predictions based on the supplied information. These MSE values provide important insight into how well each regression model in our study performed.

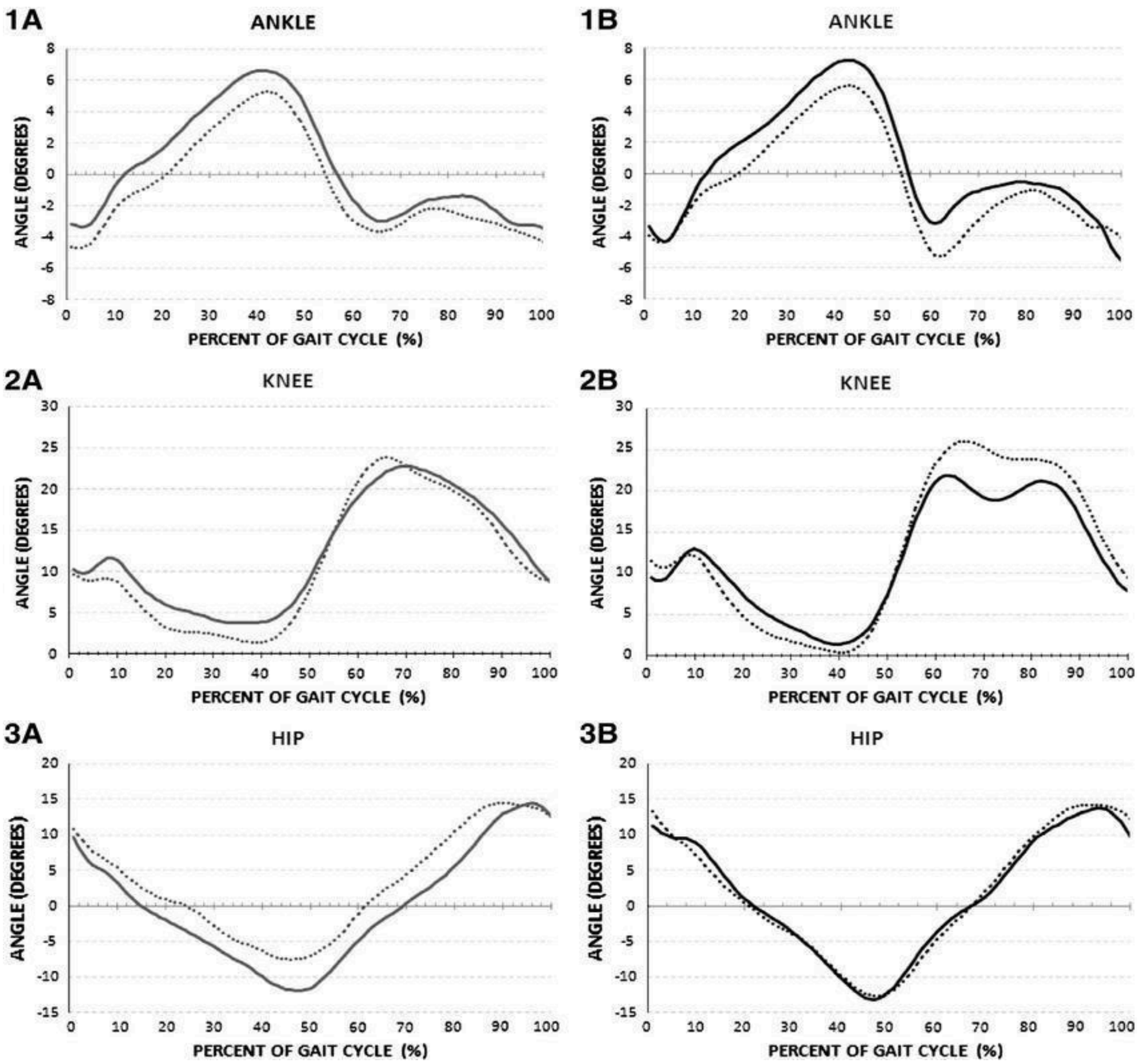

Fig 3. The graph shows the angle of tilt of people across a gait cycle for ankle, knee, and hip joints of the paretic lower limb.

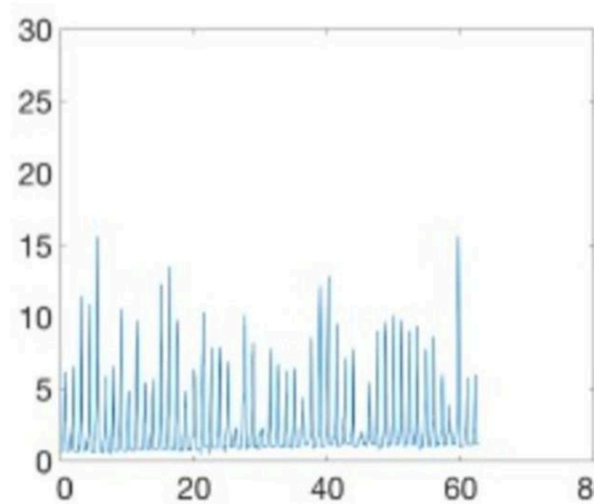

Fig 4. Parkinson's disease and neurological disorders portray significant changes in their gait cycle and accordingly their load on the walking stick. The weight bearing of the walking stick is 7.5% on average.

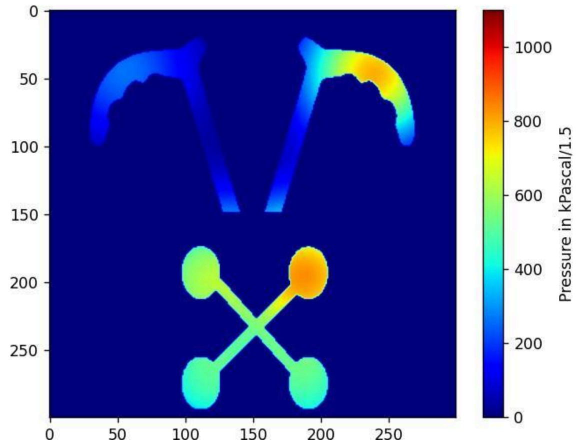

Image 3. Blue shows low pressure and increases from green to yellow, orange, and red with the highest pressure.

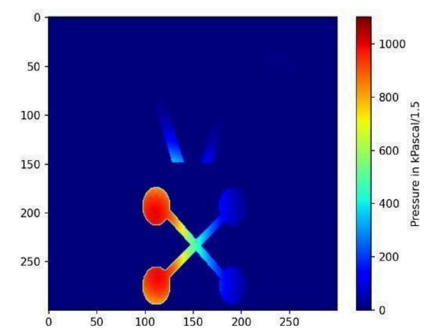

Image 4. Name:- Padma Ankham Age: 69 Weight(kg) :- 45 Condition: Paralysis Pressure on L2 and L1

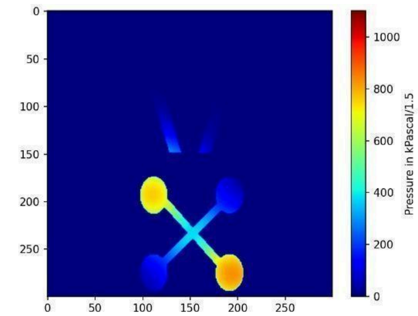

Image 5. Name: Vinod Sanghvi Age: 77 Weight(kg):110 Condition: Overweight and both knees arthritis Pressure on L2 and R1

5. **Conclusion**

In conclusion, unequal pressure distribution resulting from using the right side of the body more than the left when walking with a cane to support the weaker side might be a sign of early-stage stiff knee osteoarthritis or paretic knees. The probability of falling is increased by this imbalance, with an estimated 50–60% possibility. The increased strain on the right side and underlying knee problems increase the risk of unstable walking. Sideways falls are more common, especially when knee pain or stiffness is present. This imbalance must be corrected, and people should think about speaking with medical professionals for a thorough assessment and advice on suitable walking assistance or exercises that improve stability. Preventive care is crucial to controlling knee issues in the future and lowering the chance of falling.

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