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Review on Analysis and Optimization of Gait Stroke Detection using Variable Sensors with Machine Learning Approach

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Abstract: Gait monitoring is considered an important marker of impairment, disability and gait symmetry. This research aims to develop a real-time consumer health monitoring system based on IoT sensors and machine learning technology to detect health disorders such as the onset of stroke. The proposed consumer stroke prediction system consists of IoT-based gait monitoring sensors, real-time vital signs monitoring, and a machine learning-based disease prediction model that predicts impaired and healthy gait. This study is useful for post-stroke walking coordination rehabilitation and consumer health monitoring service.
Keywords: Stroke, Gait, Health Monitoring, Machine learning Algorithms etc.

I. INTRODUCTION

Better understanding of health and life; In addition to the development of medical technology, health has become an important object of interest today. To feel good, it is necessary to use a significant part of the daily time for walking, moving here and there [1]. Walking causes some health problems such as heart problems, stroke and so on; Mobility is reduced due to health problems such as stroke [2].

Apoplexy is a fatal disease; especially for people over 60 years old and its importance is increasing [3, 4]. Many health problems occur after a stroke. A stroke is the sudden collapse of brain cells due to lack of oxygen caused by blockage of blood flow to the brain or rupture of blood vessels [5]. Symptoms of stroke include arm or leg weakness or both on the same side, loss of balance, sudden headache, dizziness, incoordination, visual disturbances, difficulty speaking and facial muscle weakness [6]. Gait disorders are considered one of the most common injuries after stroke [7-9]. People who have suffered a stroke lose their conscience and the ability to contact the emergency center or hospital. Without rapid detection and treatment of stroke, complications are very difficult to avoid and recover [10].

To study the walking of man; acceleration, foot pressure is usually measured. Accelerometer, gyroscope, internal pressure sensor, pedometer, GPS (Global Positioning System) and foot switches are mostly used to record walking parameters [11]. Several important parameters are distinguished, such as the number of steps or walking path, step time and time, step length and stride length, reliability, GRP (ground reaction force), speed, etc.

The Internet of Things (IoT) plays an important role in the development of network connectivity, providing cloud connectivity, intelligent integration, security and healthcare [12, 13]. Several researchers are working to develop an IoT-based health monitoring system for various purposes [14, 15]. Gait monitoring is one of the most interesting applications of mobile devices for clinical and daily regular activity monitoring. Step tracking is also widely used in healthcare and sports.

II. OBJECTIVE

Following are the main goals of this paper:

1) Identify and recruit authors who have used ML systems in step reconstruction and analysis.
2) Assesses the strengths and weaknesses of gait analysis based on recent applications in gait activity, event, perturbation, asymmetry, and neurological gait detection.
3) Assess which ML methods are most commonly used in performance evaluation, gait improvement, and analysis.

This paper briefly focused on the classification of walking patterns of stroke patients and the elderly using machine learning algorithms such as support vector machines and neural network. Here, we also proposed a real-time gait monitoring system specially designed for the elderly to successfully detect stroke.

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III. LITERATURE SURVEY

A lot of research has been done and the process is still going on; This section summarizes existing research in the field of gait analysis and IoT applications.

A research paper (Qi et al., 2018) describes a sensor-based activity detection system for IoT health applications. The process included in the study combines healthcare and the Internet of Things so that efficient data transfer from one place to another is possible and human costs are reduced. The use of cloud networks in medical applications can provide important medical care from one place to another without a physical presence.

A research paper (Qi et al., 2017) describes various IoT-related healthcare systems as a study. It provides accurate information about this proposed research model on the integration of health applications with the Internet of Things. The implementation of gait analysis in the Internet of Things is based on these health applications, and this literature highlights the advantages and disadvantages of existing research.

The literature (Godfrey, 2017) describes the problems of a gait analysis system of prediction and the advantages of portable models for independent living in the elderly. The monitoring system used in the model works based on electromechanical motion-based values and there is a threshold level for each process. If the wearable sensor detects a threshold value that exceeds the level, a warning or alarm is given to the person so that he can change the ongoing process, which is very suitable for the elderly.

The research paper (Gadaleta and Rossi, 2018) proposes a smartphone-based recognition model whose recognition process is obtained through a neural network. The process includes an intelligent application that checks the person's information and provides relevant communication or warning to the relevant persons.

The literature (Llamas et al., 2017) provides a sensor-based platform for step recognition using open source hardware. The presented work uses sensors to receive information about a person walking, so that the analysis can recognize the person. As an alternative to a standard authentication system, some applications use a stream token in the authentication process.

Research articles (Nweke et al., 2018; Llamas et al., 2016) describe a portable sensor application connected to mobile human activity monitoring. The process involves multiple sensors, each providing data from each location, to combine them all into a mobile app that alerts you when something unusual is detected.

A research paper (Ing-Jr and Chang, 2017) provides details on a recognition system based on gesture commands. The feature-based extraction process compares current and existing data for better analysis and also provides a better data flow detection system.

A gait analysis model based on sensors as a medical application is also described in the literature (Zhang et al., 2018). To provide an intelligent healthcare application, the proposed model uses sensor signals for processing, and then the predictive analysis generates a report for the respective user.

Research model (Gravina et al., 2017) reflects the problems and solutions of cloud-based human activity process in mobile computing. Using the cloud in a human identification system increases accuracy and also reduces errors.

In the literature (García et al., 2019), a medical application for stroke detection is described and the results are transmitted via a cloud network. The process provides a simple detection mechanism and its research problems do not allow predictive analysis.

The literature (Gavrilova et al., 2018) describes a sensor-based action detection application of cognitive systems. The process is different from other activity tracking systems. Due to its cognitive nature, the application is limited to a specific tracking process.

A research paper (Stack et al., 2018) describes a wearable sensors and video-based recognition system for a person with Parkinson's disease. The conclusions of the article (Kaur and Sood, 2017; Paraskevopoulos et al., 2017) are about resource-constrained routing and planning in the service industry in allocating scarce resources to different locations. The research addresses various issues of constrained routing caused by various factors and highlights the benefits of scheduling algorithms based on eligibility, services and other problem modules. Based on the above research, it is found that the previous step detection model only performs either fall detection or fall prediction. Their effectiveness falls into the background when it detects a person in crowded places, in which case the degree of accuracy also decreases. The proposed model provides a better classification algorithm and an optimized road model for fall forecasting and detection and a communication model through the Internet of Things (IoT).

IV. CONCEPT AND METHODOLOGY

A. Gait Monitoring System

The proposed gait monitoring system consists of a single pressure sensor and an accelerometer attached to the foot like a shoe sole to collect walking speed, foot pressure and other walking signals. In addition, an ECG chip is necessary for patients at high risk of stroke. As shown in Figure 1, an internal foot pressure and acceleration sensor was designed, prototyped and tested. The walking patterns of a normal person and a stroke patient, such as walking speed, foot pressure, etc., are significantly different.

The walking pattern of a stroke patient is unstable compared to a normal person [7]. IoT devices and machine learning technology can detect stroke in older adults. The entire system inputs the subject's physiological data into the cloud engine to compare real-time data and already recorded reference data for stroke detection. The layout of the smartphone health monitoring application is shown in Figure 2 .

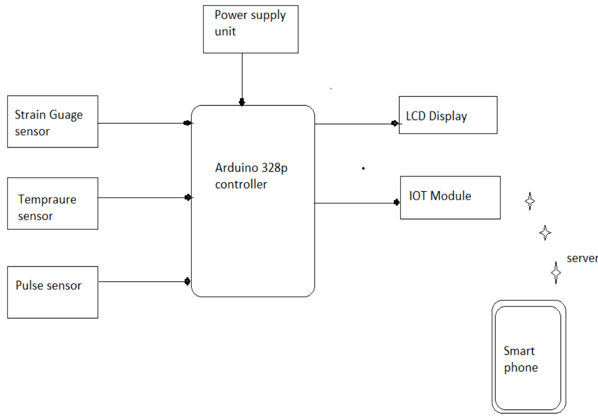

Fig.1. Block Diagram of system

B. System Architecture of Stroke Monitoring System

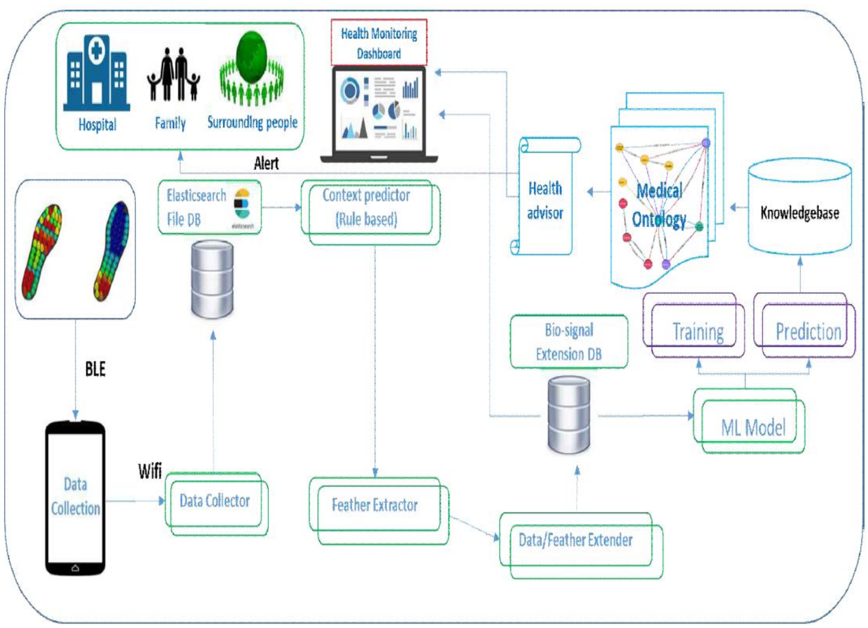

Fig. 2. Dataflow of Stroke prediction System based on Gait monitoring

Physiological parameters are a sign of the physiological and health status of an individual. Picture. Figure 3 shows the general framework and data flow of the walking impact monitoring system using an IoT pacing sensor and a machine learning model. The motion sensor data is transferred to the Elasticsearch DB by the phone's data collection application using BLE and Wi-Fi network. Data context prediction and gait feature extraction are performed. ML models are then involved in data training and irregular gait prediction by analyzing changes in gait signals. The medical ontology framework finds possible diseases based on the walking sickness. The health advisor will recommend the necessary measures. If there are deviations in important walking parameters while walking, the stroke monitoring system detects and generates an alarm or notifications for timely medical help. The self-learning engine system consists of Big Data, real-time monitoring and network security. The database system generates a stroke alert so that patients receive timely medical attention. Various biosignals can be measured, analyzed and classified using this framework. This study focuses specifically on walking cues.

Applying machine learning to gait recognition using different sensors usually consists of several steps:
1) *Data Collection:* A large amount of data is collected from the sensors to cover different walking styles, steps and walking conditions.
2) *Data Preprocessing:* Collected data is cleaned and preprocessed to remove noise, normalize the data and convert it into a format suitable for machine learning models.
3) *Feature Extraction:* Relevant features are extracted from the pre-processed data that capture the patterns and characteristics of walking. These characteristics can be derived from raw sensor data or higher-level summary statistics such as mean and standard deviation.
4) *Model Selection:* The appropriate machine learning algorithm for the trigger detection task is selected based on the data type and problem requirements. Common algorithms used for this task include decision trees, random forests, support vector machines (SVMs), and neural networks.
5) *Model Training:* The selected model is trained using extracted features and labeled data. The performance of the model is evaluated during the training and its parameters are adjusted to improve accuracy.
6) *Model Validation:* The performance of the trained model is validated using a particular data set and its accuracy and generalization properties are evaluated.
7) *Model Implementation:* The final model is implemented in the desired application, such as a portable device or mobile phone, and its performance and accuracy are continuously monitored.

V. ADVANTAGES

1) Improved accuracy of gait impact detection compared to traditional methods
2) Ability to monitor gait in real time and monitor changes over time
3) Increased robustness due to the use of multiple sensors
4) Ability to be used in various medical and health applications, such as fall risk assessment and movement disorder monitoring

VI. DISADVANTAGES

1) Wearable sensors and cost and complexity of data processing systems
2) Privacy and security risks when using personal health information
3) Need for careful system calibration and validation for each user
4) Potential for errors in data processing and analysis, especially in noisy or cluttered environments.

VII. CONCLUSION

Using machine learning to detect step motion using different sensors has shown promising results in recent studies with better accuracy and generalization compared to traditional methods. However, further research is needed to address issues such as limited availability of labeled data, selection of relevant features and generalization of models to different populations and walking conditions. These studies highlight the potential of machine learning to improve accuracy, generalization, robustness, and real-time performance using variable sensors. However, further research is needed to address issues such as limited availability of labeled data, selection of relevant features and generalization of models to different populations and walking conditions.

VIII. ACKNOWLEDGMENT

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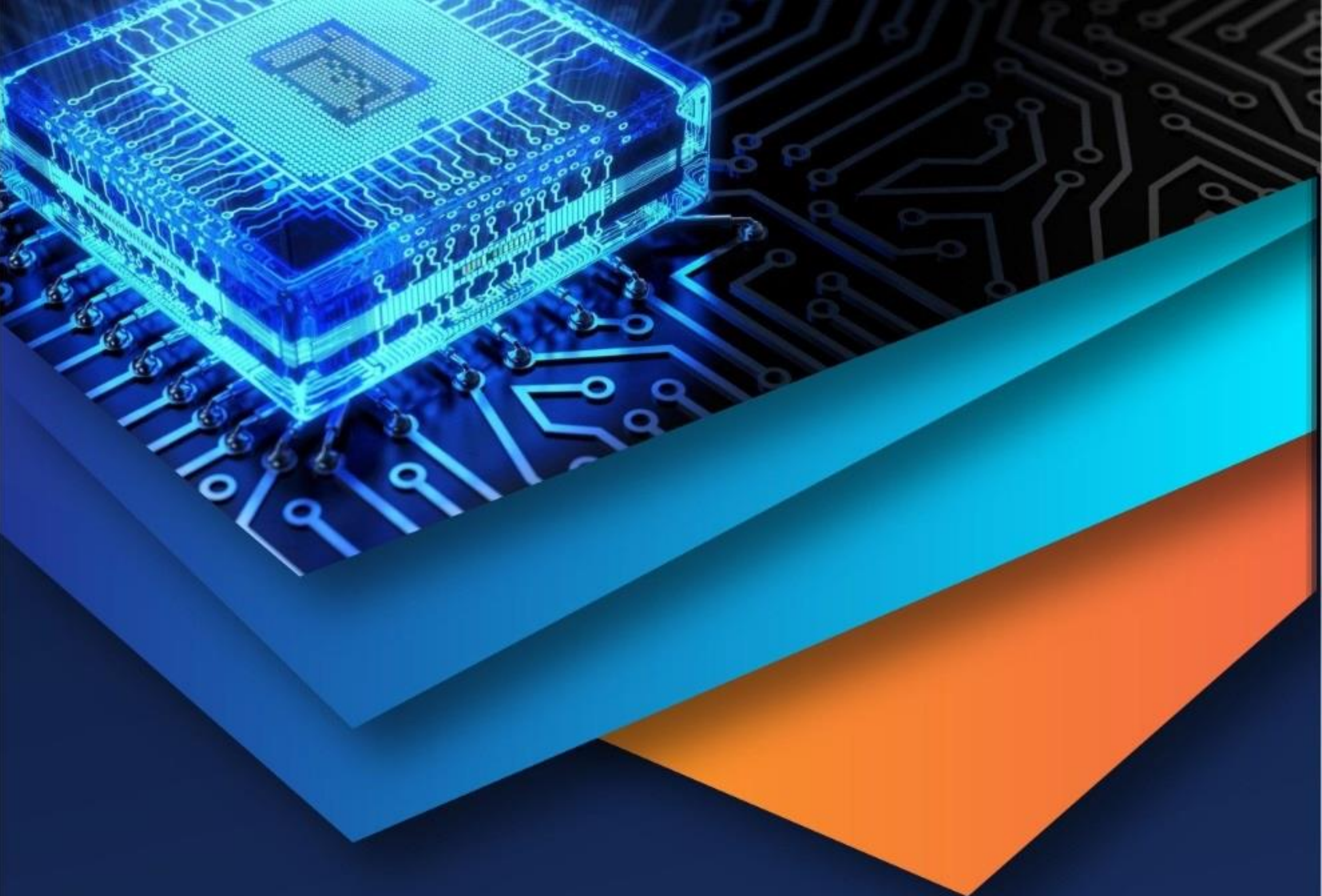

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