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Blockchain based Health Monitoring and Rewarding System

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Abstract:- One of the most important devices in our lives is a mobile phone. It is currently a robust computer platform with a variety of sensors. Embedded sensors are very useful in various domains, like monitoring the environment, social networking, safety and most importantly healthcare. The applications available in the market at the moment are usually only able to do specific tasks, such as calorie tracking, fitness tracking or blood pressure tracking. To maintain or improve health and fitness we need to take into account a combination of several factors, which require users to use different applications.

In this paper, we developed a mobile application that has combined health-relevant features: a calorie tracker to help user loss or maintain weight and fitness tracker. These are essential factors to help user live a healthy life and prevent heart disease. In addition, we also implemented a simple rewarding feature to boost users' motivation to use the application and exercise more. The aim of this application is to help people keep a healthy heart and get fit.

I. INTRODUCTION

Regular physical activity is a must to maintain the personal health and well-being of an individual. The key to maintaining or regaining personal health is to encourage people to exercise more but, unfortunately, it is hard to achieve in practice. One barrier to exercise is that lay people are often insufficiently knowledgeable about effective and safe physical exercises. To maintain an exercise regime over a long time period requires one to have high levels of motivation. The fact that access to a personal trainer significantly impacts both adherence and motivation to stick to a program of physical exercise, is established [1], and the quality of the undertaken exercise as well [2]. Continuous monitoring of the exercises and provision of personalised advice and motivate the trainee. Personal trainers also aid in rehabilitation, e.g., exercise programs for recovery of muscle post-surgery, for which advice with respect to effectiveness and safety is required. Unfortunately, it is expensive over long time, and in situations where financial factors do not pose a barrier, personal preferences (privacy) can

Smartphones, being permeating devices, are ideal to support and contribute to performing regular exercises. Applications for all purposes have turned the phone to a multi-functional device, far beyond its classic domain of application. They transform the smartphone into a platform hosting various applications: reading news, location-based services, games, hobby applications. Musicians can use their phone as a tuner, gourmets as a wine guide, and so on. This is also applicable in the sports domain. Increasing processing power, integrated sensors, and the ability for rich, multimodal interaction qualify smartphones not only as personal assistants, but also as personal fitness coaches for supporting individualized training and skill assessment.

Smartphones of the current generation have a sensing capabilities, communication and computing capabilities and are ideal to replicate services of personal fitness trainers in a way that is accessible to and affordable for virtually everyone. Enabling professional evaluation of physical activities and/or rehabilitation in real-world (sports) scenarios further integrates mobile engagement into the physical world and has the potential to significantly improve people's lives.

Obesity in itself can lead to several non – infectious diseases, with the number one killer being cardiovascular disease [3]. This kind of disease needs a high cost treatment, which ultimately will lead to high medical burden on the family. The prevalence of obesity varies by age, gender, location (geographic and socioeconomic), etc. in India. According to ICMR-INDIAB study 2015, prevalence rate of obesity and central obesity are varying from 11.8% to 31.3% and 16.9%-36.3% respectively. One of the main risk factors for cardiovascular disease (CVDs) in India is abdominal obesity. Numerous studies have revealed that women are much more likely than males to be obese. One of the biggest medical and financial expenses for the government is obesity. By raising public knowledge of obesity and its effects on health, this problem of obesity may be avoided. Typically, an energy imbalance between calories burnt and calories ingested leads to obesity. If a person consumes lot of high-fat, high-energy foods, obesity may result. Another issue may be the rise in physical inactivity brought on by the sedentary nature of many occupations. People who work at the office and sit for a long time can be exposed to obesity.

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According to World Health Organisation (WHO), individuals in large cities prefer fast meals and foods with a high fat and sugar content over those in rural towns. [4]. This happens due to the fact that most people have no or poor knowledge or awareness about healthy food [5]. There are several ways to get fit and keep our heart healthy, one of them are by eating clean and healthy, reducing calorie intake and exercise regularly [6]. All forms of exercise are generally beneficial to health. Aerobic workouts, like jogging, running, or swimming, are the greatest for the heart. It is advisable that older persons engage in low-intensity exercise. However, these kinds of exercises would not directly reduce the weight. In addition, they also have to monitor their calories intake.

One of the most crucial things to do to get fit is to maintain a balanced diet. Thus, keeping track of the calories consumed and expended is one way to combat the obesity problem. People are growing more health aware over time. This trend has led to many smartphones developing and incorporating more and more health and fitness related features.

Currently many programmes are already available that allow monitoring of daily calorie intake and expenditure. Numerous apps now available allow us to track exercises and their history independently. However, we must record combinations of various activities if we want to maintain a fitness regime that is balanced. For instance, to maintain body weight, we must determine the number of calories consumed and expended during a specific time period. Thus, having an application that can track a user's physical activity, calorie intake, sleep pattern, blood pressure, and pulse can aid users in maintaining a balanced fitness regime to stay in shape and maintain health. In order to make the users more engaged and motivated we also implement rewarding, which is the use of a cryptocurrency called “HEALTHI” which is built on the binance blockchain network. In this research, we devised and created a mobile application that tracks a user's physical activity levels, calorie consumption, sleep patterns, blood pressure, and pulse. We then used this information to assess the user's health state and help them establish objectives for improving their health.

The following sections make up the remaining portions of this paper: Section II examines the related terms and knowledge base used in the application and the related works that are relevant to health.; section III outlines the solution's design and trials; section IV summarises the outcomes of the experiments; Section V then wraps up the essay.

II. PRELIMINARIES

Staying fit is no new trend. However, ways to get fit have been changing for years. With evolution of technology and introduction of tracking devices, a new wave has overtaken the fitness industry. Researchers notice that mobile sensors open new horizons for mobile healthcare applications, but they did not review a lot of such applications, so the main use cases of mobile phone sensors in fitness applications were not disclosed.

A mobile phone's inbuilt sensors may be categorised into two groups. The first has environmental sensors, and the second one has sensors for position and orientation. The environment around a mobile phone can be measured using environment sensors. The first sensor category includes devices like microphones and cameras. Position and orientation sensors are a collection of sensors that includes accelerometer, digital compass, gyroscope, and GPS.

According to Statista.net, global end-user spending on wearable devices is predicted to reach $63 billion by 2021.[7] It goes without saying that the prospect of collecting personal health and fitness data when exercising, going for a run in the morning, or riding a bicycle appeals to the majority of consumers.

Even though wearables and phone sensors can provide continuous data flow and can make individual data collection much more accurate, they need apps running on end-user devices to make sense of users’ personal data. Numerous fitness applications support healthy lifestyles worldwide. In a recent study, it was discovered that participants who used fitness apps were significantly more active than those who did not.

Numerous fitness tracking applications exist but most only show basic details. or aim to change behaviour without researching effective tools to keep users persistent. Sophisticated and company-specific closed technology is used in development of these applications. The focus is more on promotion and monetization. There is a lack of logs or rewards on completion of workouts. There is also lack of excitement or motivation due to lack of creativity in keeping the user engaged.

This paper focuses on a solution, an application: Healthi. This application will have its own token (cryptocurrency) called “Healthi Coin” which will be built on Binance blockchain network and will be used as rewards. It will collect the number of steps the user takes during the day and reward them according to their achievements. Blockchain can bring more security and reliability to the existing system by the virtue of its various features as it provides improved data privacy & security, enables cryptocurrency payment methods, eliminates middlemen and third party and untamperable and immutable systems. The aim is to solve the above-mentioned issues through this app by:

- Providing result based interactive platform
- Promote self-motivated goal-based system
- Building an organic community base.

Mobile phones have environmental sensors and sensors for position and orientation. Different aspects of the mobile phone environment are measured using environment sensors. Examples include microphones and cameras. Sensors such as accelerometer, digital compass, gyroscope and GPS form position and orientation sensors group. They are used to locate devices and determine the mobile phone's orientation. All phones are equipped with a microphone sensor, which allows them to capture environment sounds. Prevalence of sensors make them attractive for various sensing applications, such as

automatic phone context detection.

The sensors used to determine a device's orientation in space are accelerometers and magnetometers. The acceleration in two or three directions is measured by an accelerometer. [8]. Accelerometers can also offer a fresh method of interacting with the phone. While a mobile device's accelerometer can be used to measure linear acceleration, a gyroscope can be used to identify the device's orientation in relation to the earth's magnetic field. These sensors are often used for navigation, but they can also be utilised in novel ways to communicate with mobile devices by using correctly structured permanent magnets. [9].

III. USE OF BLOCKCHAIN

Blockchain technology, along with the existing underpinning technology that manage online fitness services, can be implemented. The first blockchain-based platform in the world, FIT token runs on the Ethereal network. In essence, it's a decentralised method to acquire subscription services and place orders via websites or mobile applications, speeding up the subscription service buying process and making it easier for new users to navigate. Though the health and fitness sector may not be new, interest in it is nevertheless rising quickly, much like that of token currencies and blockchain technology. By virtue of its numerous properties, which are detailed below, blockchain can increase the security and dependability.

- Improved data privacy and security: With Blockchain, it is impossible for customers' personal information to be altered. Data is susceptible to cyber-attacks and theft if it is kept on centralised servers. Users must use extra caution while determining the validity and legitimacy of the fitness app they utilise. Complete data privacy and security is guaranteed by immutable nature of blockchain technology and its encryption algorithms. Users will have complete access to their health information due to the decentralised model, which eliminates concerns about data tampering.
- Elimination of intermediaries and third parties: Due to Blockchain technology, customers will have direct online access to their trainers without dealing with intermediaries or needing to purchase club memberships in order to contact a trainer. Blockchain may be used to create smart contracts for fitness advice and lessons from a specific trainer to a specific client.
- Cryptocurrency payments: Cryptocurrency payment mechanisms like Bitcoin and Ether may be enabled via blockchain. It will not be surprising if the fitness sector begins to accept cryptocurrency payments online as the globe moves toward digital payments and currencies.

IV. PROPOSED SOLUTION

The idea proposed will make use of a react native library to integrate the fitness application to get the count of steps that a user takes and store in the database. This data will be processed and will be represented in graphical form. Using solidity language, a smart contract will be created for “Healthi Coin” and which will be deployed on Binance Blockchain Network.

Once the user achieves a milestone, based on the level of performance in BMI-calculated challenges that he takes up, he will be rewarded and the reward will be stored in the profile.

After a minimum balance is achieved, the user can withdraw the reward amount. The user can be updated on the latest news in the fitness world. Using this app Users can also keep a track of previous achievements which will help him in self-improvement. The application developed follows the data flow diagram in figure 1.

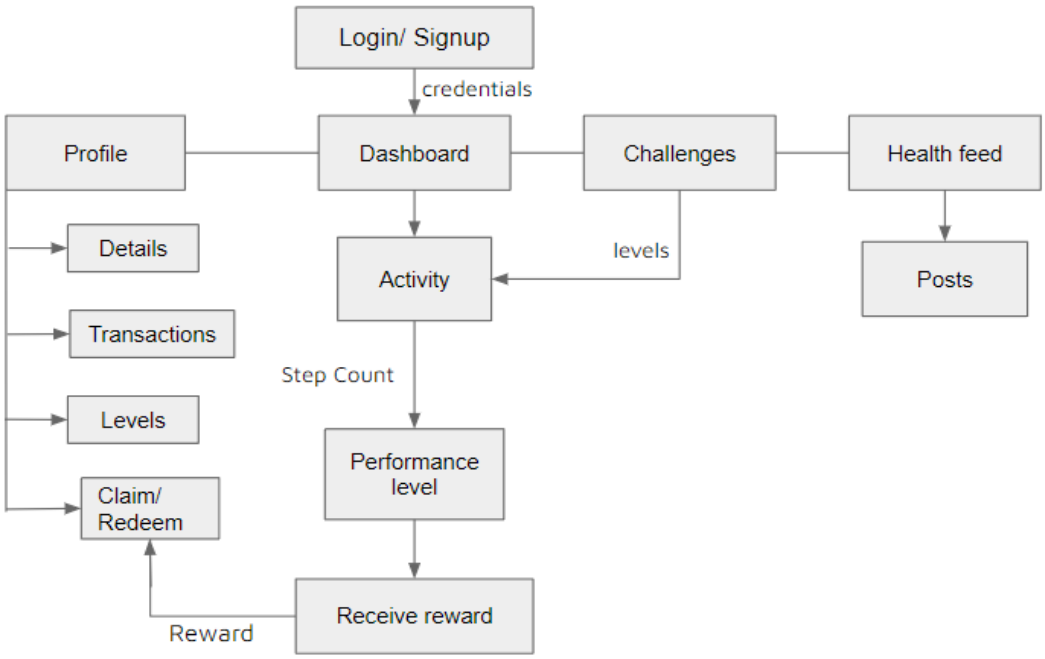

Fig 1: Data Flow Diagram

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In this application, there are four modules and each module represents a feature of the application. The modules are Dashboard, Challenges, Health feed and User Profile.

V. PROTOTYPE AND RESULTS

The prototype of the application is developed using React native (frontend), Next.js (backend), MySQL(database), Redux and Saga (state management) while the blockchain module for the reward is configured using Solidity language.

Figure 2 shows the Dashboard screen, which is the first module of the application. In the dashboard component, the user can find the distance covered, step count, calories burnt and time taken. It also shows the amount of the challenge completed which is set by the user through a progress circle chart. The user can also check activity history in graphical form on the dashboard. To start and stop a challenge activity, the corresponding buttons have been provided.

Figure 3 shows the Challenges screen, which is the second module of the application. In the challenges module, the user will have challenges available which will be pre-defined based on the user's BMI by the application. On completion of the challenge the user will unlock the next challenge and could be eligible to win the token-based reward. The selected challenge will be reflected on the Dashboard, and once completed, rewards will be reflected in the User profile

Figure 4 shows the Health feed screen, which is the third module of the application. In this module the user can read health-related news articles and newsletters about the latest trends and updates in fitness and health care world which will be refreshed and updated regularly. With this the user can stay in touch with current fitness trends and health issues.

Figure 5 shows the User profile, which is the fourth module of the application. In the profile, the user can view personal details, change settings as well as logout. Also provided is a facility to claim or redeem the tokens achieved after completion of the challenges, check their transaction history for previously achieved and claimed tokens. The locked token balance shown gets unlocked after a month and can be claimed in the wallet. Finally, user can check wallet balance as well as level of performance through this module.

Fig 2: Dashboard

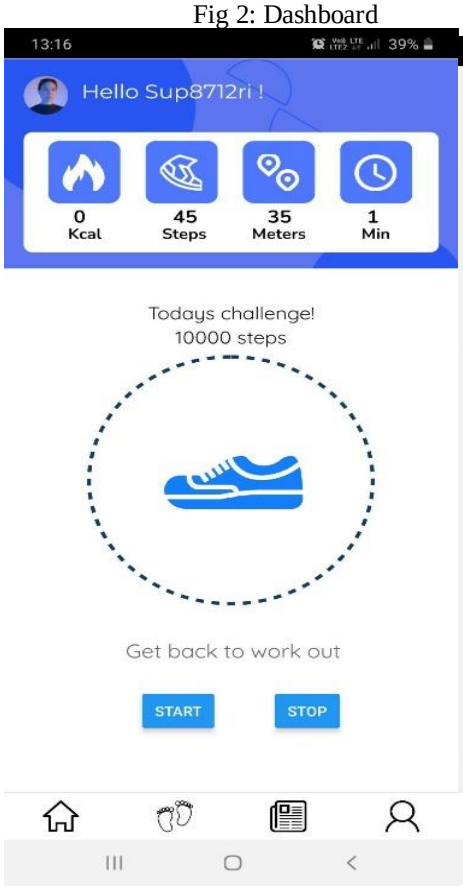
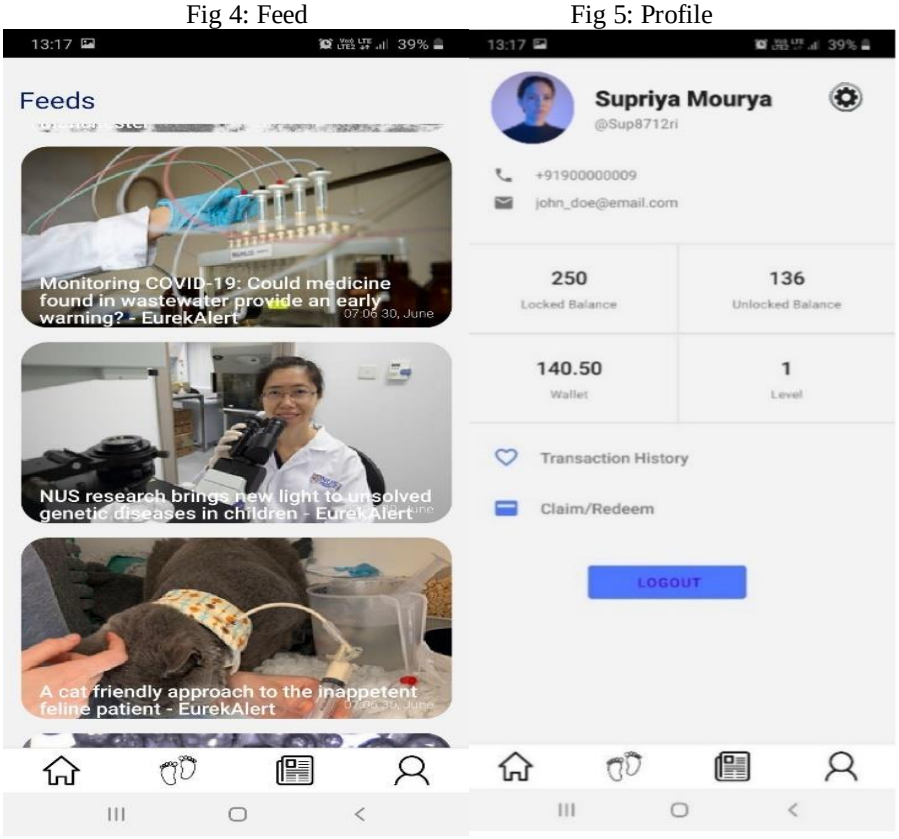


Fig 3: Challenges

Fig 4: Feed Fig 5: Profile



VI. HUMAN FALL DETECTION

The future scope of the application is including Human Fall Detection as a feature. Falling is one of the most prevalent issues that elderly individuals experience. According to the Center for Disease Control and Prevention, one out of three older people falls each year [10]. The consequences of falls are serious and include: broken bones, head injury [11][12], traumatic brain injuries [13]. If prevention solutions are not invested in the immediate future, the number of injuries caused by falls will double in 2030 due to the increasing portion of old people [14].

A fall detection system is initially intended to warn when a fall event occurs rather than to lessen the likelihood of falling. However, it has been shown that fall detectors have a direct effect in lowering fall apprehension. Falling and the fear of falling are actually related. A person who regularly trips and falls seems to be afraid of falling, and this anxiety might ultimately make them more likely to fall. [15]. Quality of life of the elderly is significantly impacted by their fear of falling, which can lead to a worse quality of life.

The relationship between automatic fall detection system and fall fear has been proved by Brownsel [16] et al. In the study conducted, elderly people who had fallen at least once in the preceding six months were the subjects of a research. At the conclusion of the trial, those who wore the fall detector reported feeling more secure and having less fear of falling, as well as thinking the detector had increased their safety. Limiting the amount of time that older people spend on the floor after falling is a fall detector's second major goal. The period of laying on the floor after falling determines the severity of a fall because long lie may lead to hypothermia, dehydration and pressure sores [17,18]. This is extremely critical in case person lives alone without any assistance from families and neighbours. Lord et al. [19] indicates that about 20% of fallen patients admitted in the hospital after laying on the ground for more than one hour. Despite the fact that there were no immediate injuries, the morbidity rates were much higher than they were for patients who arrived at the hospital in less than 30 minutes. The ultimate goal of the detector system is to realize a fall event and notify an assistant immediately. A robust fall detector should be able to classify the falls and non-falls in real life condition as people sometimes intentionally stand up or sit rapidly, which could confuse the system.

In addition, people are losing confidence in the detector system, which leads to increase the fear of falling and fallen probability. On the other side, a detection system that is overstated may alarm too many false activations, leading caretakers to believe it is ineffectual or worthless. Although there are many commercial items on the market, they have not yet had a significant influence on the lives of the elderly, making it difficult to strike a balance between these two goals. [20,21].

The feature to be incorporated makes use of a system with machine learning model that predicts location based on these coordinates and algorithm to calculate sensor output. It must be used in conjunction with a system having mmWave sensor that detects position and change in three coordinates. Without using a camera, the system's primary goal is to

achieve high accuracy while protecting the user's privacy. Along with sensing, an alerting feature is also proposed. [22]

VII. CONCLUSIONS

Striving to stay fit and healthy is the main goal of life in today's world. For some people, it is just a matter of following a trend while for others, prevention of major health issues is the ultimate concern. Due to this, the demand for fitness-related devices and fitness activity tracker applications has tremendously increased.

Fitness activity tracking applications facilitate easy maintenance of a healthy life. Additionally, they support the creation of various fitness objectives and the exchange of creative training concepts, making exercise fun and simple. In a nutshell, we can say that building a fitness activity tracking app is a combination of a well-built software, perfect API tool and hardware.

Our proposed solution aims to keep the user motivated and also on the other hand, cater to the reward system that drives our behaviour. Fitness and health tracking application with a blockchain based rewarding system is developed and experimented along with a calorie tracker feature and activity progress, history feature. Furthermore, to check the health of the heart, the application also has a blood pressure, pulse, and BMI measurement along with recommendations for different cases. In addition, we also implement a simple challenge gamification and rewarding feature in order to engage and motivate the users to use the application to maintain a healthy regime.

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Any mistakes or errors we make are our own, and therefore shouldn't tarnish the reputations of the esteemed and respected persons.

REFERENCES

[1]. R. Ryan, C. Frederick, D. Lepes, N. Rubio, K. Sheldon, Intrinsic motivation and exercise adherence, International Journal of Sport Psychology 28 (1997) 335–354.
[2]. R.W. Jeffery, R.R. Wing, C. Thorson, L.R. Burton, Use of personal trainers and financial incentives to increase exercise in a behavioral weight-loss program, Journal of Consulting and Clinical Psychology 66 (5) (1998) 777–783.
[3]. A. Hruby, & F.B. Hu. The Epidemiology of Obesity: A Big Picture. PharmacoEconomics, 33(7), 673–689, 2015. http://doi.org/10.1007/s40273-014-0243-x
[4]. World Health Organization, "Obesity and Overweight," WHO, February 2018. [Online]. Available: http://www.who.int/newsroom/fact-sheets/detail/obesity-and-overweight [Accessed 30 July 2018].
[5]. E. B. Faizal, "Obesity, a growing problem," the Jakarta Post, 5 April 2012. [Online]. Available: http://www.thejakartapost.com/news/2012/04/05/obesity-a-growingproblem-nation.html. [Accessed 25 February 2016].
[6]. National Health Services, "Preventing cardiovascular disease in adults," National Health Services, 9 September 2014. [Online]. Available: http://www.nhs.uk/conditions/cardiovascular-disease/pages/preventionadults.aspx. [Accessed 28 February 2016].
[7]. Easternpeak: https://easternpeak.com/blog/apps-for-fitness-integrated-with-wearables-how-to-create-an-activity-tracking-app/
[8]. K. Hinckley, J. Pierce, M. Sinclair, and E. Horvitz, Sensing Techniques for Mobile Interaction, in Proceedings of ACMUIST, 2000, pp. 91100.
[9]. H. Ketabdar, K. A. Yksel, and M. Roshandel, Magitact: interaction with mobile devices based on compass (magnetic) sensor, in Proceedings of the 15th international conference on Intelligent user interfaces, 2010, pp. 413414.
[10]. Centers for Disease Control and Prevention. Important Facts about Falls. Available at: http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html (accessed 3/2016)
[11]. Alexander, B.H., Rivara, F.P. and Wolf, M.E., 1992. The cost and frequency of hospitalization for fall-related injuries in older adults. American journal of public health, 82(7), pp.1020-1023.
[12]. Sterling, D.A., O'Connor, J.A. and Bonadies, J., 2001. Geriatric falls: injury severity is high and disproportionate to mechanism. Journal of Trauma and Acute Care Surgery, 50(1), pp.116-119.
[13]. Stevens, J.A., Corso, P.S., Finkelstein, E.A. and Miller, T.R., 2006. The costs of fatal and non-fatal falls among older adults. Injury prevention, 12(5), pp.290-295.
[14]. Igual, R., Medrano, C. and Plaza, I., 2013. Challenges, issues and trends in fall detection systems. Biomedical engineering online, 12(1), p.1.

[15]. Friedman, S.M., Munoz, B., West, S.K., BandeenRoche, K. and Fried, L.P., 1997, September. Falls and fear of falling: Which comes first? In JOURNAL OF THE AMERICAN GERIATRICS SOCIETY (Vol. 45, No.9, pp. P186-P186). 351 WEST CAMDEN ST, BALTIMORE, MD 21201-2436: WILLIAMS & WILKINS.
[16]. Brownsell, S. and Hawley, M.S., 2004. Automatic fall detectors and the fear of falling. Journal of telemedicine and telecare, 10(5), pp.262-266.
[17]. Rubenstein, L.Z. and Josephson, K.R., 2002. The epidemiology of falls and syncope. Clinics in geriatric medicine, 18(2), pp.141-158.
[18]. Tinetti, M.E., Liu, W.L. and Claus, E.B., 1993. Predictors and prognosis of inability to get up after falls among elderly persons. Jama, 269(1), pp.65-70.
[19]. Lord, S.R., Sherrington, C., Menz, H.B. and Close, J.C., 2007. Falls inolder people: risk factors and strategies for prevention. Cambridge University Press.
[20]. Noury, N., Fleury, A., Rumeau, P., Bourke, A.K., Laighin, G.O., Rialle, V. and Lundy, J.E., 2007, August. Fall detection-principles and methods. In 2007 29th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (pp. 1663-1666). IEEE.
[21]. Bagalà, F., Becker, C., Cappello, A., Chiari, L., Aminian, K., Hausdorff, J.M., Zijlstra, W and Klenk, J., 2012. Evaluation of accelerometer-based fall detection algorithms on real-world falls. PloS one, 7(5), p.e37062.
[22]. Mubarak A. A, Abdullah K. A, Chris Y., Vamsy P. C, 2021. Machine Learning Models for Human Fall Detection using Millimeter Wave Sensor: 55th Annual Conference on Information Sciences and Systems (CISS)