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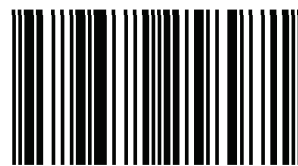
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REAL-TIME FALL DETECTION AND VITAL SIGNS MONITORING SYSTEM FOR ELDERLY LIVING ALONE USING WEARABLE SENSOR

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Abstract

Malaysia will become an ageing country by 2030. Data show that number of elders aged above 60 is increasing, while the percentage of young people aged 14 and below declined over the years. The rising number of elders results in socioeconomic issues including healthcare costs and social support from family members, community, and policymakers in terms of living arrangements. Especially for elders living alone, falling is a serious health problem, and it can lead to serious injuries such as hip fractures. When a person is immobilised due to an injury or unconsciousness, they are unable to aid themselves. Not being found for hours after a fall is fairly prevalent among the elderly who live alone, which dramatically raises the severity of fall-related injuries. Wearable fall detection systems have gotten a lot of interest in academia and business. Some monitoring gadgets, however, are difficult for older persons to wear or singularly only detect falls without monitoring vital signs. This project combines real-time vital signs monitoring system with a fall detection alert function by using wearable sensors and IoT technology. The system has proven able to detect all falls in FIVE (5) varieties of common falling patterns among the elderly.

Keywords: fall detection; variable sensor; elderly people; prevention; automatic; wireless.

1. Introduction

According to Malaysia's demographic age structure, the percentage of people in their golden years (60 years and up) is growing. The percentage of people aged 60 and more has risen from 4.6 percent in 1991 to 5.3 percent in 2005, and it is anticipated to rise to 8.0 percent by 2020. Around 7% of Malaysia's 1.4 million people aged 60 and over live alone, according to census data from 2000. This study looked into the socioeconomic factors that influence this vulnerable group's quality of life. Data from a subsample of the study on Mental Health and Quality of Life of Older Malaysians was used in this paper. Around 10% of the original sample, or 299 seniors aged 60 and over, were living alone[1].

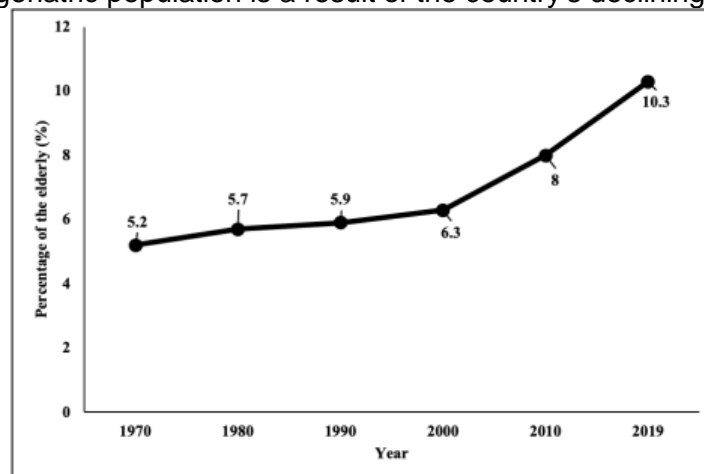
A variety of causes can induce falls in the elderly. "Accidental" or "environmental" is the most often mentioned cause of falls among older persons living in a variety of settings, according to one of the largest retrospective studies of falls among older adults living in a variety of settings, accounting for 30–50 percent of most series. Many falls attributed to accidents, on the other hand, are the result of a combination of identified environmental dangers and increased human vulnerability to hazards as a result of age and sickness. The gaits of older people are stiffer, less coordinated, and potentially harmful than those of younger people. With age, posture control, body-orienting reflexes, muscular strength and tone, and step height all deteriorate, making it more difficult to prevent falling following an abrupt trip or slide. After a slip, the "method" for maintaining balance goes from the rapid-correcting "hip strategy" (fall avoidance via weight shifts at the hip) to the "step strategy" (fall avoidance via a rapid step) to absolute lack of ability to correct in time to prevent a fall as people get older. Vision, hearing, and memory problems are all common in people as they get older. Trips and stumbles are more likely as a result of this[2].

2. Literature Review

2.1 MALAYSIAN AS AGEING COUNTRY

Malaysia will become an ageing country by 2030. Data show that number of elders aged above 60 is increasing, while the percentage of young people aged 14 and below declined over the years. The number of elderly people in Malaysia from 1970 to 2019 is depicted in Figure 1, however the 2019 figure is simply an estimate. According to Figure 1, there were 3.4 million seniors in 2019 compared to 546,000 annually in 1970, which is the period covered by the graph. In contrast, just 5.2 percent of the population was over the age of 65 in 1970, but by 2019, that number had risen to 10.3 percent. In terms of Malaysian states, the Department of Statistics (2019a) said that Perak had attained the "old" classification when the proportion of residents aged 60 and above reached 15.3 percent in the state in 2020. (MyMetro, 31 October 2019).

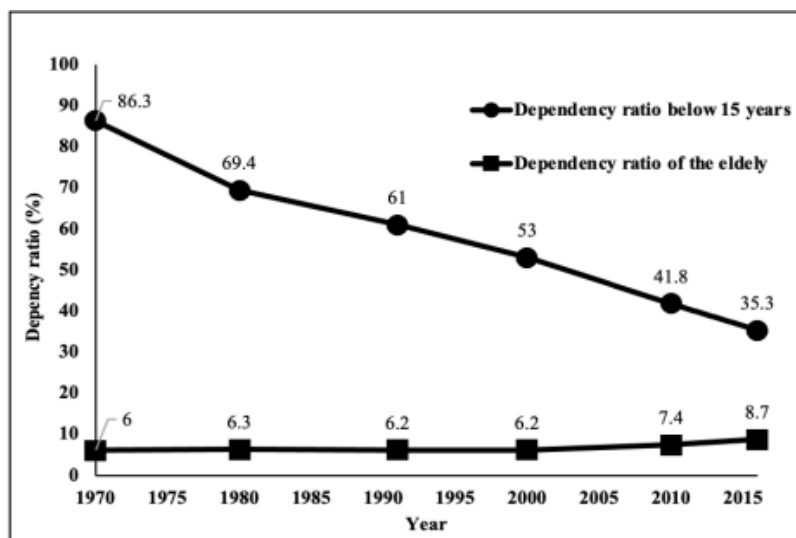
According to statistics, Malaysians' life expectancy rises as their socioeconomic condition and access to medical care improve. Because to advancements in healthcare, the death rate has decreased over time for all age groups. By 2020, the Malaysian population's life expectancy is anticipated to reach 80. A birth in 2018 was anticipated to live, on average, 75 years until 2093, per the Department of Statistics Malaysia (2018). In addition, it is anticipated that Malaysian men and women would live an additional 15.0 and 17.2 years, respectively, after they turn 65. Malaysia's growing geriatric population is a result of the country's declining fertility rate.



Source: Department of Statistics Malaysia (2019a)

Figure 2.1: Percentage of the Elders in Malaysia, 1970-2019

Additionally, the dependence ratio of the population aged 65 and above is impacted by the rise in the elderly population. This demonstrates the current and predicted future burden of caring for the elderly on the working class. The number of dependents per 100 persons in the working-age group is known as the dependency ratio. The juvenile dependence ratio (those under 15) and the old-age dependency ratio (those 65 and beyond) make up the overall dependency ratio (Department of Statistics Malaysia, 2017). In 1970, there were 92.3 dependents per 100 working persons (15-64 years old), but by 2015, that number had dropped to 44.0. To 43.0 percent, the reliance ratio dropped. From 86.3 per 100 working persons (15-64 years old) in 1970 to 35.3 per 100 working people in 2010, there was a 32.6 percent fall in the ratio of young dependents aged 0 to 14. Due to Malaysia's dropping birth rate, there are fewer persons in this age group, which results in a decrease in the youth dependence ratio. Unlike the old-age dependence ratio, which went from 6.0 per 100 working persons (15-64 years old) in 1970 to 8.7 per 100 working people in 2016, this ratio increased, showing a gain of 8.0 percent over the course of the time period (1970-2016).



Source: Department of Statistics Malaysia (1975; 1984; 1995; 2001; 2011; 2017).

Figure 2.2: Dependency Ratio of the Population in Malaysia, 1970-2015

Low reproductive rates can either lengthen or shorten a person's lifetime. As a result, there are population ageing challenges that need to be addressed in order to manage the senior population's needs for healthcare, housing, general care, and family assistance. The neighbourhood should be ready to accept the increasing number of older residents and act to solve this problem, especially for elderly men. The longevity of a person might be increased or decreased by low fertility rates. This is due to an increase in the number of older men who struggle to govern alone, particularly after the death of their wife. However, more senior citizens are now aware of these self-care difficulties, and some have turned into contributing members of society. One worry is that since children do not want to live with their parents, the elderly is left to live alone without any assistance from the family, especially when it comes to their nutritional and medical needs. The reality of elderly individuals living longer makes this issue more obvious in both developed and developing nations. In major cities, being alone has become the norm.

2.2 RISK FALL FACTOR

126 individuals reported 251 falls during the course of the 28-week study (36 percent). 57 people (16%) reported having at least two falls, while 26 people (7%) reported having at least three falls, with two participants reporting having as many as nine falls. The great majority of the falls (79%) happened inside. The time of the fall was documented in 65 percent of cases; peak incidence hours were 8:00-10:00 a.m. and 1:00-3:00 p.m. There was no discernible seasonal pattern. Six hip fractures, one wrist fracture, one humerus fracture, one nose fracture, and several soft tissue injuries were documented as a result of the falls.[3]

This study is a 'conventional review' of the fall prevention literature, with the goal of presenting the current state of knowledge on a specific topic. Evidence-based risk fall variables were included in the review. The ProFaNE partners, working with worldwide specialists in the field, have come up with a definition that encompasses all types of falls, i.e. an unexpected incident in which the participant comes to rest on the ground, floor, or lower level.[4]

2.3 SOCIODEMOGRAPHIC FACTORS AS A RISK OF FALLING

After the age of 60, the risk of falling rises, and multiple studies have found that age, as well as past falls, is a major predictor of falling. It is commonly known that 30 percent of the community's residents over the age of 65 die each year (48 percent). Over 40 percent of individuals over 75 years old and nearly one in every two persons are affected. Those above the age of 80 will fall at least once a year. [7]

The number of injuries caused by falls rises dramatically as people get older. Falls appear to be a sign of frailty, poor mobility, and acute or chronic health problems. The sheer fact that you've fallen before tells you very nothing about what caused it. The relationship between falls and gender is not well understood, according to community sample studies. Some writers claim that women are more prone than males to fall whereas others claim that there are no differences in the incidence of falling between men and women. Other research skip gender analysis since their samples are largely or exclusively female.[8]

2.4 PREVIOUS RESEARCH

Falling among the elderly occurs for a variety of reasons and has a variety of effects. Researchers, designers, and developers of fall detection and prevention systems might produce numerous innovative solutions for the problem of geriatric falls if they are aware of the reasons and repercussions.

a. Causes

Seniors fall for a variety of reasons. Age, gender, and being a woman are just a few examples. You can't be controlled if you're unconscious or have long-term neurological or mental issues. Other factors, such as drug side effects, impaired vision, hearing loss, or physical weakness, can be managed or reduced.

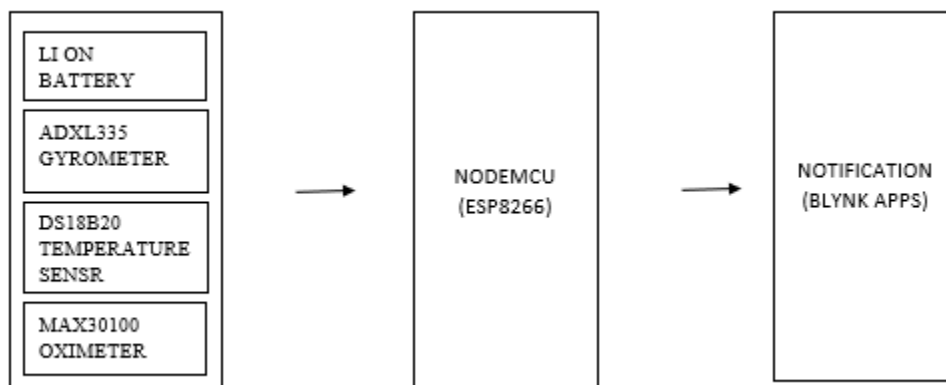
b. Consequence

For adults over the age of 65, the average length of hospital stay is more than twice as long for falls than for other causes of hospitalisation in each age group. Falls among the elderly are becoming more widely recognised as a source of concern in industrialised and developing countries alike. Falling can have a variety of harmful consequences for anyone, especially the elderly[9].

3. Methodology

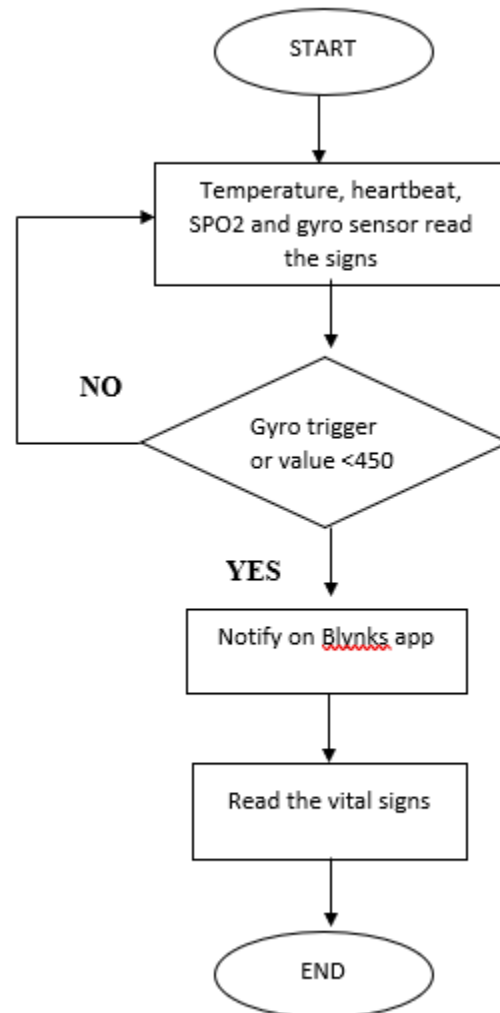
3.1 BLOCK DIAGRAM

Based on figure below as stated in the Block Diagram, at the section input there have the type of components that I used in this project which is LI-ON Battery, ADXL335, DS18B20 and MAX30100 will give some input to the NODEMCU to begin the process of the programming. And the last results will be an output that I used Blynk Apps to notify the user or guardian for elderly.



3.3 FLOWCHART

After one of the algorithms detects a fall, the fall detection programmes proceed through what is known as the post-fall process. The process flowchart may be seen here. All falls recognised by the if gyro gets the trigger and the value we set is below 450 “possible falls” in this process, guardians will be notified through Blynks App along with real-time reading vital signs as shown in Figure 3.4. If the gyro does not get triggered by user action, the process will repeat again.



4. Result & Discussion

4.1 DEVELOPMENT OF PROJECT

This section shows the hardware and software of the real-time fall detection and vital signs monitoring system for elderly living alone using wearable sensor that can be used by guardian to their parents.

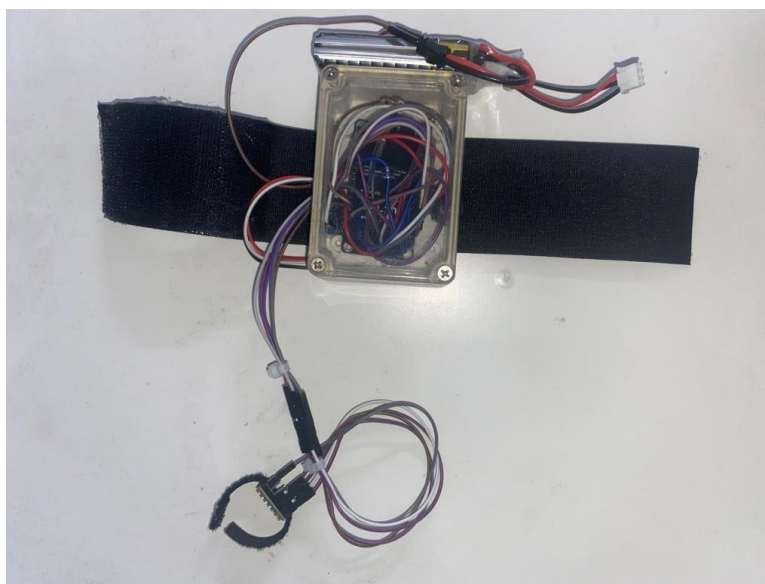


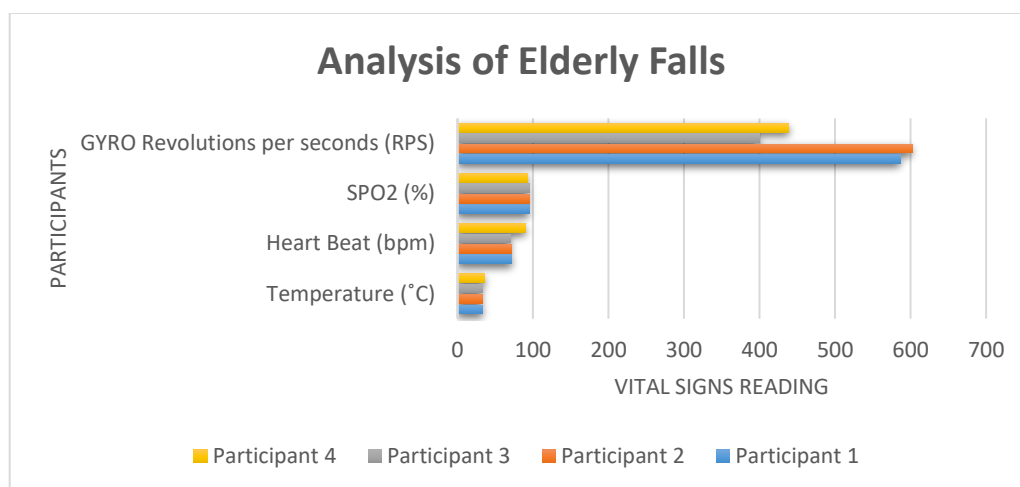
Figure 4.1: The prototype of The Project

The figure above shows project prototype with full casing. The micro motor vibration is put in the headrest to able to put at the driver's seat in the car. It is to be adjusting the micro motor vibration at the neck of driver while their driving. The heart rate pulse sensor is design to be put at the driver's wrist to detect the heartbeat of the user. Lastly, the NodeMCU, rechargeable battery and power switch that connecting with motor micro vibration and heart rate pulse sensor is put in the casing, so the user is comfortable wearing them at their arm.

4.2 Result Analysis

The results of 4 participants doing commonly elderly falls. As shown in the table, the result is accompanied by reading vital signs.

PARTICIPANTS	TEMPERATURE (°C)	HEART BEAT (bpm)	SPO2 (%)	GYRO Revolutions per seconds (RPS)
1	33.25	72	95	586
2	32.75	71	95	602
3	32.94	70	95	400
4	35.83	90	93	439



4. Conclusions

In conclusion, based on existing policies and activities, Malaysia is equipped to deal with the issue of an ageing population or the status of an "old" nation. The outcome of this project is the wearable sensors being able can build a system that can detect falls in the elderly. Furthermore, I also successfully can design system that will alert the guardian of the elderly if they fall unnoticed. Besides that, I being able to periodically update the health vital signs of the elderly by utilizing IoT Technology by builds a real-time monitoring system. However, I hope that a special provision is signed into law in Malaysia to guarantee that children are more worried about their parents' well-being and do not abandon their parents living alone, as reported by local media, in order to prevent congestion in welfare or old folk's homes.

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