Elderly Fall Detection by MEMS and Dynamic Time Warping.

Manisha Ojha, Dr. Rakesh Rathi

M.tech Scholar, HOD of Computer Science and Engineering of Govt. Engineering College Ajmer
[1]Computer Science and Engineering,
Govt. Engineering College, Ajmer, India.

Abstract: Physical and cognitive health of millions of elderly people is affected by sudden fall. Falling can have dire consequences for the elderly. Fall statistics show the seriousness of the problem: According to the research senior falls lead to over 2.8 million emergency room visits annually. The fall can caused by Diabetes, Insomnia, Anxiety, Depression, Allergies, Bladder problems, Chronic pain, Hypertension Cognitive issues, including Alzheimer's disease etc. But by using medical alert system we can reduce the harmful effect of fall detection. A medical alert system can also give us a greater sense of independence. The impact of fall can be reduced to a great extent by using medical alert systems. Additionally such systems can give a better sense of independence and reduce cost of hiring companions. Due to these reasons many elderly fall alert systems have been proposed. The aim of our project is to design an elderly fall detection system by MEMS. Dynamic Time Warping (DTW) will be used for accurate fall detection. The novelty in our approach is we will procure dataset in normal conditions such as walking, sitting, foot tapping etc and compare it with fall condition to improve efficiency.

***Index Terms*–Fall Detection, MEMS, Dynamic Time Warping.**

I. INTRODUCTION

Falling among the older is a prevailing purpose behind coincidental passing in the populace above age 65 [1]. The passing rate brought about by such falls has risen rapidly in the course of recent years [2]. Studies have demonstrated that the result would be improved if medicinal intercession could be started quicker after a fall [3, 4]. So therapeutic result improvement is critical if the mediation time can be decreased when the fall is recognized consequently and answered to the related nursing staff.

Reports demonstrate that 90 percent of grown-ups over the age 65 like to remain in their home as they age [5]. As of late, loads of research has been given to various fall discovery techniques. By and large, fall checking gadgets can be separated into two classes: wearable and non-wearable gadgets. The wearable gadget requires to be connected regarding the matter to report a fall, for example, Push-catch, Accelerometers, Mobile telephone, wearable remote gadget, wearable camera and others.

During the most recent decades, numerous arrangements have been proposed for old fall discovery. Such arrangements can be ordered into three kinds. Probably the soonest arrangement included ultrasonic sensor organize framework; such a framework persistently screens the older individuals in a nursing room and, when it identifies a fall, parental figures are told about the event of such an occasion [6]. The fundamental impediment of this arrangement is the need to put a progression of spatially circulated sensors inside nature where the senior lives. Video and sound location frameworks are normally utilized arrangements at present [7]. Be that as it may, likewise this sort of arrangement is restricted to a given space under perception and it cannot accomplish universal checking.

The third sort of arrangement utilizes wearable gadgets with incorporated Micro Electro-Mechanical Systems (MEMS, for example, a few movement sensors [8] so as to naturally identify a fall and create an alert. Non-prominent wearable gadgets have been acknowledged [9], [10] utilizing a solitary accelerometer connected on the body of the subject.

Kinsella and Phillips [11] found that the number of inhabitants in 65- and-over matured individuals in the created nations will approach 20% of all out populace in the following 20 years and will clearly turn into a genuine human services issue sooner rather than later. In China alone, the populace beyond 60 million years old is 133.9 Million [12], [13]. Among the older, the fall occasions can be a flighty and hazardous occasion. Measurements demonstrate that one among three 65-and-over matured individual falls each year [14]. Among these fall occasions, 55% happens at home and 23% happens close to the home. In 2003, the worldwide number of passing brought about by fall occasions was roughly 391,000 and explicitly 40% of the falls were from individuals more than 70 years old [15]. In this way, dependable customer based fall location frameworks should be structured, tried and monetarily conveyed to nations all around the globe. Moreover, the expense of social insurance is profoundly identified with the reaction and salvage time, and can be significantly diminished by quick recognition and conveying sign to the predetermined administrator for prompt thought [16].

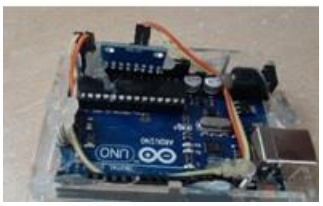


Fig 1.1: Fabricated Device

II. RESEARCH METHODOLOGY

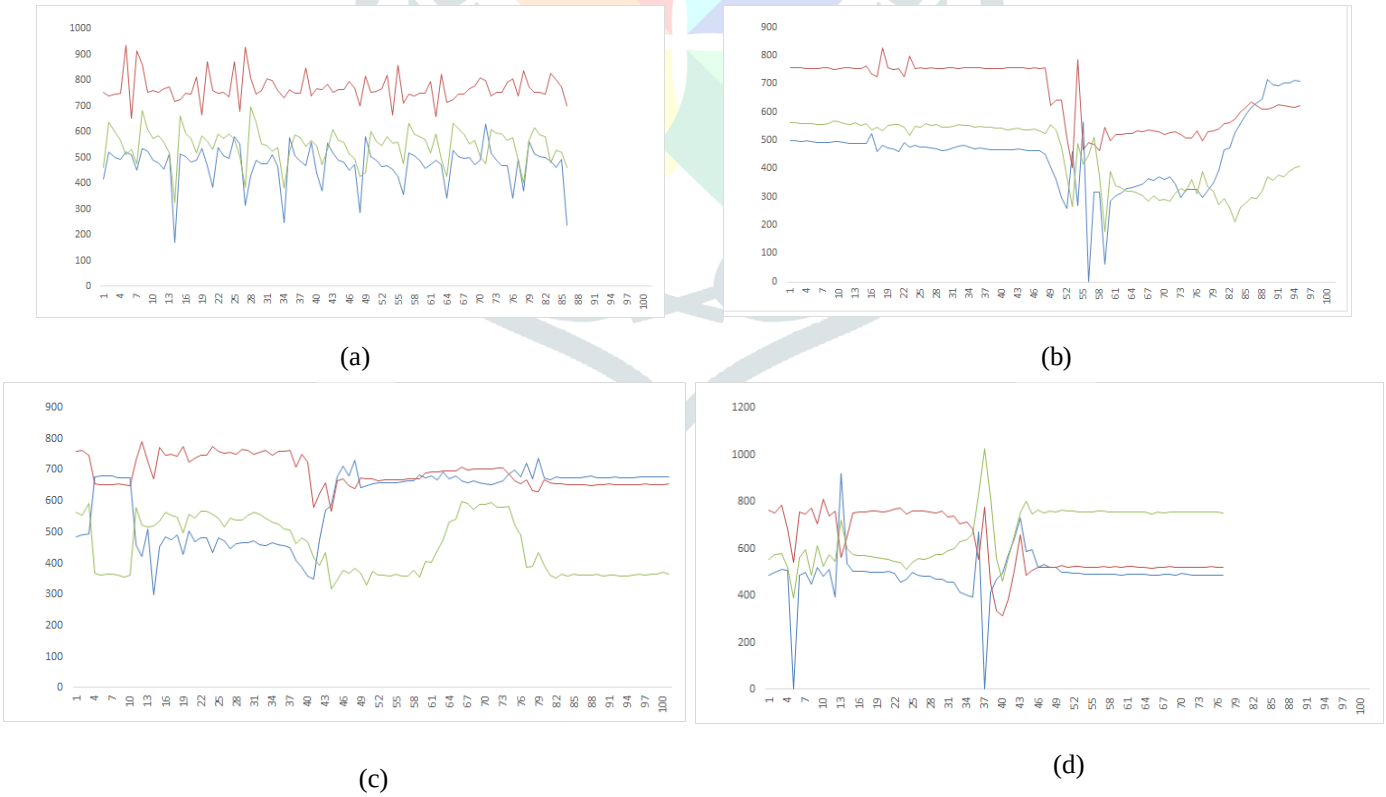
The aim of this research is to develop an efficient fall detection algorithm by dynamic time warping. For this purpose a device is fabricated as shown in figure 2.1.The device consists of Arduino UNO microcontroller board and MPU 6050 accelerometer. In the literature various approaches are presented for the same but no research as per our knowledge considers time dependency of vibration signals during fall. Or in other words previous researches employ a threshold value for fall detection.

The fabricated fall detection device is placed on leg of the person. Block diagram of the proposed system is depicted in Fig 2.1. The proposed algorithm is deployed with help of two sub routines namely data acquisition unit and data analysis unit.

2.1 Data Acquisition Unit: This unit reads data from the fall detection device and sends it to data analysis unit for further processing. The fabricated fall detection device consists of MPU 6050 which is a six axis accelerometer and Arduino UNO microcontroller. The process starts with parameters settings of MPU 6050. The data held in cache is cleared. DPS processing signal is set to 2000. Data labels, range, clock source and other related settings are done appropriately. MPU 6050 reads acceleration at all three axes and sends it to Arduino UNO's pins A4 and A5 by I2C protocol. The data received by Arduino UNO is in raw form therefore data normalization and separation takes place. After data normalization essential parameters such as system date and time and label is appended with the data and sent to data analysis unit for fall detection by RS232 communication protocol.

Fig 2.1: System Model

2.2 Data Analysis Unit : The aim of this unit is to continuously receive data from data acquistion unit and detect fall. This unit can be classified into two sub units namely testing unit and training unit. Training unit consists of datasets of the vibration signatures obtained while regular activities such as walking and different vibration signatures obtained during different falls as mentiond in Fig 2.2. The training unit is active in real time.The task of traing unit is to acquire data from data acquisition and identify fall by contrasting the data with the dataset. Dynamic time warping algorithim is used for classification purposes. Dynamic Time Wraping algorithim is best suited for comparison between two time series vectors.



(a) (b)

(c) (d)

Fig 2.2: (a) Vibration signature during walking, (b) Vibration signature during back fall, (c) Vibration signature during left fall, (d) Vibration signature during right fall

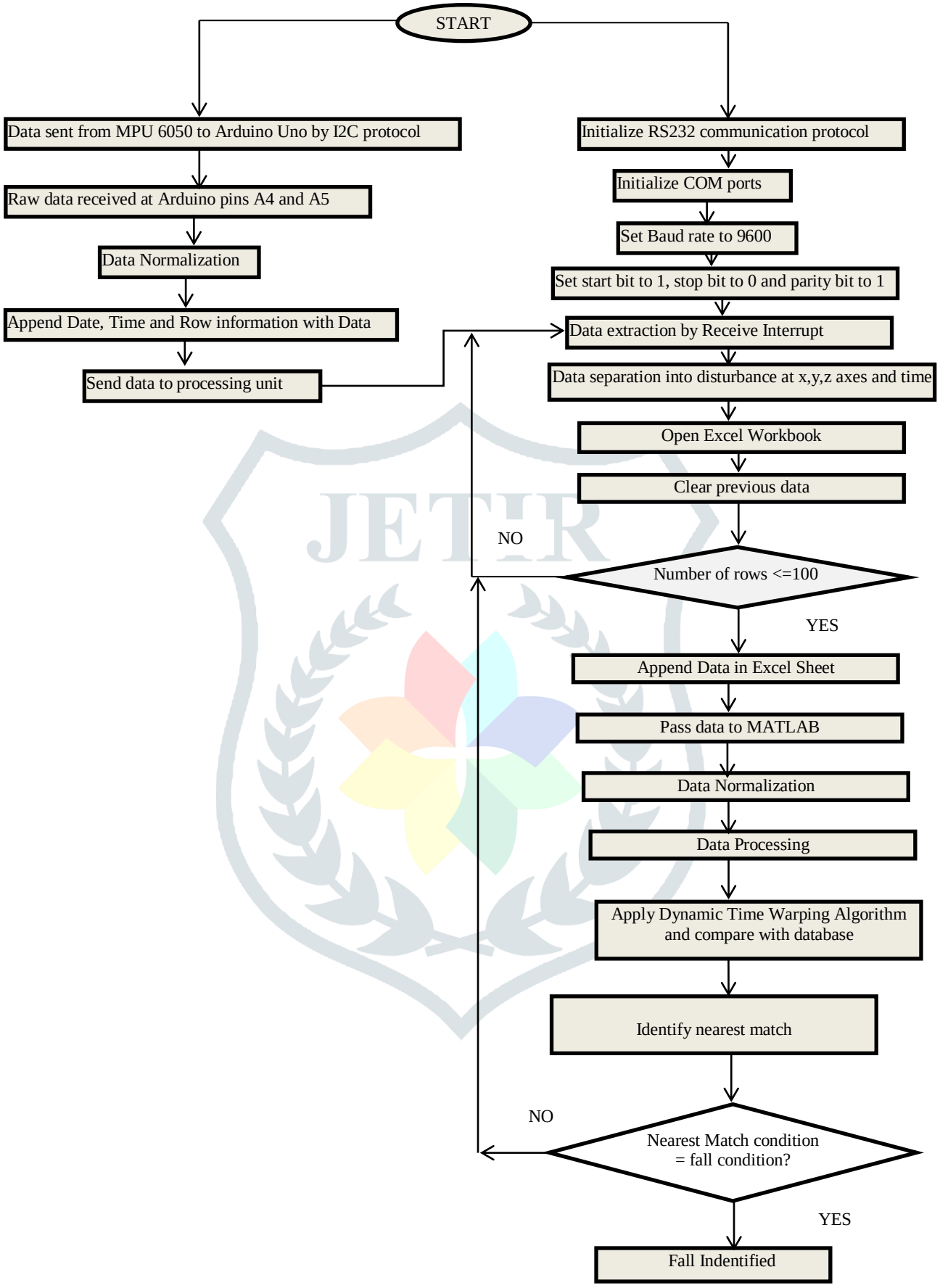


Fig 2.3: Process Flow

III. RESULTS AND DISCUSSION

The proposed algorithm of Automatic fall detection by dynamic time warping is deployed in real time. Fig 3.1 shows the developed user interface in MATLAB. In the developed Graphical User Interface a test case can be selected using the list box. When the button 'START' is pressed system first loads dataset. Then applies dynamic time warping algorithm on the test case, compares it with the loaded database and shows the nearest match. Fig 3.2 shows the resultant test and identified waveforms. The proposed system shows efficiency of 94 percent in fall detection.

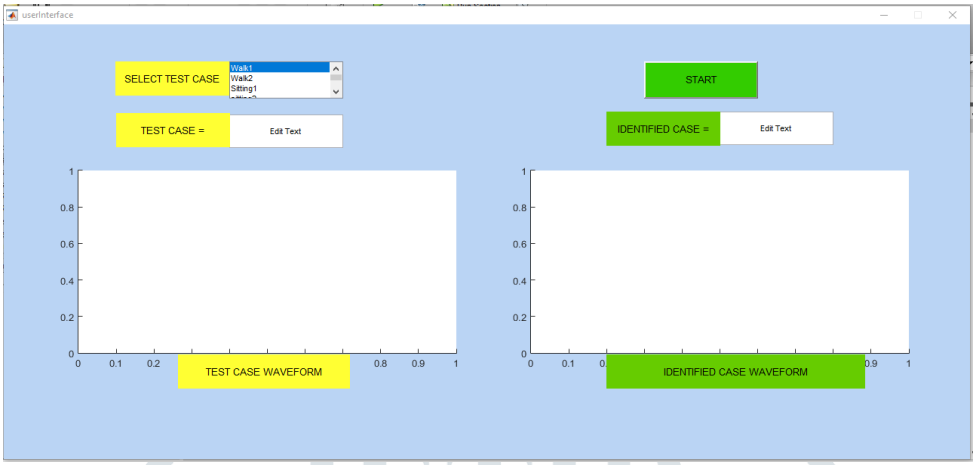


Fig 3.1: Developed System for analyzing fall

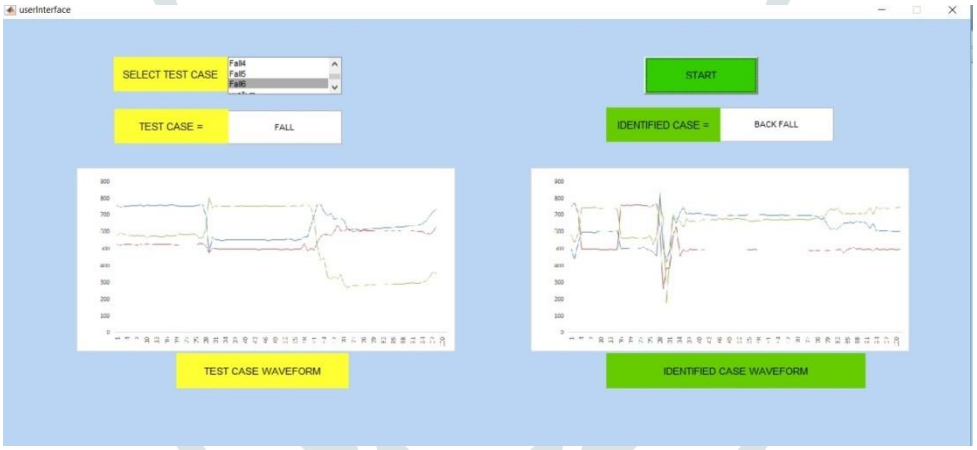


Fig 3.2: Result

IV. CONCLUSION

The proposed algorithm for automatic fall detection for elderly is successfully deployed in real time. The algorithm is both lightweight and efficient which is much required for commercialization aspect. The system can prove as a useful aid not only for elderly and disabled persons but their caretakers as well.

V. FUTURE SCOPE

In future author plans to make entire system wireless. The communication between data acquisition and data analysis system can be carried out via Bluetooth or Internet of Things technology. Further the data analysis system can be deployed on various cloud computing platforms to increase the processing speed.

REFERENCES

[1] S.L. Murhy, "Deaths: Final Data for 1998," National Vital Statistics Reports, vol. 48, no. 11. Hyattsville, Maryland: National Center for Health Statistics, 2000.
[2] J.A. Stevens, G. Ryan, M. Kresnow, "Fatalities and injuries from falls among older adults – United States, 1993–2003 and 2001–2005," MMWR, Nov. 2006, 55(45).
[3] R.J. Gurley, N. Lum, M. Sande, B. Lo, M.H. Katz, "Persons found in their homes helpless or dead," N Engl J Med. 334(26):1710-6, 1996.
[4] C.G. Moran, R.T. Wenn, M. Sikand, A.M. Taylor, "Early mortality after hip fracture: is delay before surgery important," J. of Bone and Joint Surgery, pp. 483-9, 2005.
[5] "A Report to the National Livable Communities: Creating Environments for Successful Aging"[online]. Retrieved 2014-03-10.

[6] T. Hori, Y. Nishida, H. Aizawa, S. Murakami, and H. Mizoguchi, "Sensor network for supporting elderly care home," in Proc. IEEE Sensors. IEEE, Oct. 2004, pp. 575–578.
[7] S. Gasparrini, E. Cippitelli, S. Spinsante, and E. Gambi, "A depth-based fall detection system using a kinect sensor," Sensors, vol. 14, no. 2, pp. 2756–2775, 2014.
[8] C.-F. Lai, S.-Y. Chang, H.-C. Chao, and Y.-M. Huang, "Detection of cognitive injured body region using multiple triaxial accelerometers for elderly falling," IEEE Sensors J., vol. 11, no. 3, pp. 763–770, 2011.
[9] L. Tong, Q. Song, Y. Ge, and M. Liu, "Hmm-based human fall detection and prediction method using tri-axial accelerometer," IEEE Sensors J., vol. 13, no. 5, pp. 1849–1856, 2013.
[10] M. Kangas, I. Vikman, J. Wiklander, P. Lindgren, L. Nyberg, and T. Jams ¨ a, "Sensitivity and specificity of fall detection in people aged ¨ 40 years and over," Gait Posture, vol. 29, no. 4, pp. 571–574, 2009.
[11] K. Kinsella and D. R. Phillips, "Global aging: the challenge of success," Population Bulletin, vol. 60, 2005.
[12] [Tabulation on the 2010 population census of the people's republic of China, China Statistics, May 2013, on-line.
[13] S. Demura, S. Shin, S. Takahashi, and S. Yamaji, "Relationships between gait properties on soft surfaces, physical function, and fall risk for the elderly," Advances in Aging Research, vol. 2, pp. 57-64, May 2013.
[14] S. R. Lord and J. Dayhew, "Visual risk factors for falls in older people," Journal of American Geriatrics Society, vol. 49, no. 5, pp. 508-515, Dec. 2001.
[15] WHO, "The injury chart-book: a graphical overview of the global burden of injury," Geneva: WHO, pp. 43-50, 2012.
[16] M. Mubashir, L. Shao, and L. Seed, "A survey on fall detection: Principles and approaches," Neurocomputing, vol. 100, no. 16, pp. 144- 152, Jan. 2013.