Real-time Threshold-Based Fall Detection System Using Wearable IoT

Nur Izdihar Muhd Amir
Ubiquitous Broadband Access Networks Lab (U-BAN)
Razak Faculty of Technology and Informatics (FTIR))
Universiti Teknologi Malaysia
Kuala Lumpur, Malaysia
nizdihar4@live.utm.my

Rudzidatul Akmam Dziyauddin
Ubiquitous Broadband Access Networks Lab (U-BAN)
Razak Faculty of Technology and Informatics (FTIR)
Universiti Teknologi Malaysia
Kuala Lumpur, Malaysia
rudzidatul.kl@utm.my

Norliza Mohamed
Ubiquitous Broadband Access Networks Lab (U-BAN)
Razak Faculty of Technology and Informatics (FTIR)
Universiti Teknologi Malaysia
Kuala Lumpur, Malaysia
norlizam.kl@utm.my

Nor Syahidatul Nadiah Ismail
Faculty of Computing
Universiti Malaysia Pahang
Pahang, Malaysia
nadiahismail@ump.edu.my

Nor Saradatul Akmar Zulkifli
Virtual Simulation and Computing (ViSiC)
Faculty of Computing
Universiti Malaysia Pahang
Pahang, Malaysia
saradatulakmar@ump.edu.my

Norashidah Md Din
Institute of Energy Infrastructures
Universiti Tenaga Nasional, UNITEN
Malaysia
norashidah@uniten.edu.my

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***Abstract*—This paper presents a Real-Time Fall Detection System (FDS) in the form of a wearable device integrating an ADXL335 accelerometer as a fall detection sensor, and classify the falling condition based on the threshold method. This system detects the wearer's movements and analyses the result in binary output conditions of 'Fall' for any fall occurrence or 'Normal' for other activities. The transmitter or FDS-Tx which is attached to the user's garment will constantly transmit data reading to the receiver or FDS-Rx via XBee module for data analysis. Raspberry Pi as the processor in FDS-Rx provides computational resources for immediate output analysis, by using threshold method, the computed results are sent to the cloud utilizing the Wi-Fi to display the user's condition on the authority's dashboard for further action. The working conditions of the systems are validated through an experiment of 10 volunteers whose perform several activities including fall events. Based on the threshold proposed, the results showed 97% sensitivity, 69% specificity and 83% accuracy from the experiment. Thus, this system fulfilled the real-time working condition integrating (IoT) as accordingly.**

Keywords—Fall Detection System, wearable device, ADXL 335, IoT.

I. INTRODUCTION

Falls issues are a global problem as they are currently the second leading cause of unintentional injury deaths worldwide. Elderly (people aged over 65 years old) as the most affected population in this unfortunate event recorded an estimate of 25% cases every year and this figure grows to 42% for those over 70 [1] .Moreover, up to 50% of elderly living in long-term care facilities fall each year and with almost half of them experiencing recurrent falls. The concern grows for independent elderly that live alone [2]. They are more susceptible to adverse events such as health problems and accidents, which can lead to physical instability and eventually cause dangerous falls and stroke [3]. The statistics reveal that those without a caregiver are more likely to face fatality because they may not obtain immediate aid in the event of an accident. [4]

Unintentional falls afflict people of all ages, not just the elderly. For example, Children in China, for every death due to fall, there are four cases of permanent disability, thirteen cases requiring hospitalisation for more than ten days, twenty-four cases requiring hospitalisation for one to nine days, and 690 cases seeking medical attention or missing work/school. Nevertheless, anyone with a vulnerability, such as mild impairments or a post-operative condition, is at similar risk [5].

In conjunction with the advancement of medical technology and healthcare systems [6], researchers are working to aid these people by developing Fall Detection systems (FDS) to reduce the unfavourable consequences of falls. Throughout the study, various kinds of FDS were introduced. Wearable-type detection devices are among the emerging ones; they are considered cost-effective and less intrusive since the detection approach simply requires movement sensing rather than visual surveillance. Furthermore, wearable devices have bigger coverage on movement areas, which also enables them to perform monitoring of the user continuously [7].

One of the sought-after attributes of FDS is real-time detection. Hence, powerful algorithms, aside from highly accurate detection, are favourable in this case, such as machine learning (ML). By engaging high-performance detection algorithms, reliable data is concerned. Memory resources are required for data storing with an ample data number to obtain impressive detection performance. Not to mention, ML training requires powerful computational capability [8]. However, for resource constrained devices, this algorithm might overwhelm the processor or worse real-time output will be beyond achievable. Therefore, this work has decided to utilise a threshold-based fall detection method that is easy to construct. Furthermore, threshold-based classification is less computationally costly than ML and it is still among the extensively employed strategy for fall detection [9].

Other than giving real-time output. IoT platform is utilised to notify emergency services and carers in proper response time [10-12]. The purpose of this work is to present a Real-time threshold-based system using IoT-enabled wearable device fall detection, integrating an accelerometer for monitoring of a user in a setting such as a private residence, nursing homes, hospitals, or retirement homes. Section II