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IMPLEMENTATION SCENARIO FOR DETECTION AND AVOIDANCE OF SEDENTARISM IN ELDERLY PEOPLE USING INTERNET OF THINGS BASED VOICE ASSISTANT

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Abstract-Virtual assistants are becoming more popular across demographics bridging the digital divide by making information and services previously inaccessible due to age more widely available. This makes it possible for users of all ages, but notably the elderly, to complete activities and utilize apps and services that may otherwise be difficult to access due to the complexity of traditional digital user interfaces. The goal of the EMERITI project is to deploy virtual assistants in various case studies to make the lives of the aged better. For this reason, virtual voice assistants and Internet of Things (IoT) technologies may help seniors lead more active lives; nevertheless, the market's current crop of virtual assistants presents a challenge with their lack of pro-activity, which must be addressed. This work projects a solution with the integration of voice-activated activity trackers, internet-of-things sensors and virtual voice assistants to help the elder people keep track of their daily movement and avoid unhealthy sedentary habits. The use of proposed gadget for elder people is quite effective and giving higher degree of performance so that real time data can be analyzed for their overall security. The virtual assistant can be integrated as wearable devices to smart home systems that use sensors and cameras to monitor and assist the elderly. Following discussing the primary benefits and current problems of using automated systems in applications requiring low sedentary lifestyles in the elder people, this work presents the technical findings gained after the deployment of the suggested system. The work presents the effective performance using the artificial intelligence based approach for the elderly people and multi-dimensional safety aspects.

Keywords: artificial intelligence, sedentarism avoidance using AI, IoT based virtual assistants

1. Introduction

Sedentary behavior in elderly people is a growing concern as it has been linked to a range of health problems, including obesity, cardiovascular disease, and poor mental health. To address this issue, researchers have been exploring the potential of Internet of Things (IoT) based voice assistants to encourage physical activity and reduce sedentary behavior in elderly people.

The rapid advancement of technology has brought about numerous benefits, and one significant area of impact is the realm of healthcare. Among the diverse range of technological innovations, Internet of Things (IoT) gadgets have emerged as a promising solution to improve the safety and overall well-being of elderly individuals. By harnessing the power of IoT, these gadgets can play a pivotal role in addressing the concerns of safety and sedentary lifestyles among the elderly population. This article explores the potential applications of IoT gadgets in ensuring safety and promoting an active lifestyle for senior citizens.

One of the key advantages of IoT-based voice assistants is that they can provide personalized and interactive prompts to motivate elderly people to move more. For example, a voice assistant could remind someone to stand up and stretch after sitting for too long, or encourage them to take a short walk around the house. By using natural language processing and machine learning algorithms, the voice assistant can also learn the individual's preferences and adapt its prompts accordingly [1].

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To avoid sedentary behavior in elderly people, it is also important to create an environment that supports physical activity. IoT-based voice assistants can play a role in this by providing information on local exercise classes, suggesting suitable activities based on the individual's abilities and interests, and tracking progress over time. This can help to build confidence and motivation, and encourage elderly people to stay active and engaged [2].

In addition to promoting physical activity, IoT-based voice assistants can also support the social and emotional well-being of elderly people. For example, they can be used to facilitate communication with family members and friends, provide entertainment and educational content, and help elderly people to stay connected with their communities [3].

The use of IoT-based voice assistants represents a promising approach to reducing sedentary behavior and promoting physical and mental health in elderly people. While there are still challenges to overcome, such as privacy and security concerns, this technology has the potential to make a significant positive impact on the lives of elderly people and their caregivers [4].

Spending on the IoT is expected to exceed $1.1 trillion by 2023, and the Smart Home business has grown exponentially in recent years, with estimates ranging from $600 billion to $1,200 billion. Smart speakers and voice assistants are becoming more commonplace across a wide range of consumer goods and this has contributed to a rise in the number of Internet of Things (IoT) and smart home gadgets. There are already 4.2 billion voice assistants in use around the globe, and this figure is expected to rise.

Companies are reevaluating their voice assistant strategy, shifting from intermediated speech experiences to personalized, branded voices for all their devices, to have more control over the customer experience, to own important data, and to capitalize on the voice experience [5, 6].

Forbes estimates that 129.7 million people use speech AI technology in their automobiles, while Statista projects that 70% of vehicles will be linked to the internet by 2023. These numbers provide credence to the idea that people want driving experiences that enable them to remain connected to the outside world and their other IoT gadgets in a variety of ways, including being interactive, easily available, conveniently located, and requiring no use of the driver's hands [7, 8]. Vehicles of the future that are fully integrated into the IoT will make it easier than ever to go from one place to another, whether that be your house, your automobile, your place of work, or anywhere else.

IoT gadgets can be an effective tool to help elderly people avoid sedentary behavior and stay physically active. These gadgets can take many forms, including wearable fitness trackers, smart home devices, and voice assistants [9].

One advantage of IoT gadgets is that they can provide real-time feedback and encouragement to elderly people as they engage in physical activity. For example, wearable fitness trackers can monitor steps taken, distance traveled, and calories burned, and provide alerts and reminders to move when the user has been sitting for too long. Smart home devices [10], such as motion sensors and lighting controls, can also encourage physical activity by making it easier and more convenient to move around the house.

Another advantage of IoT gadgets is that they can be used to track progress over time, which can help to motivate and engage elderly people in physical activity. For example, a fitness tracker can provide daily and weekly summaries of activity levels, and set goals for future activity. A voice assistant can also be used to track progress and provide feedback on performance, as well as offer suggestions for new activities or exercises to try [11].

In addition to promoting physical activity, IoT gadgets can also be used to improve the overall health and well-being of elderly people. For example, a voice assistant can provide medication reminders, connect with healthcare providers, and

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offer personalized health advice and information [12].

The use of IoT gadgets can be a valuable tool in helping elderly people to stay active and healthy. By providing personalized feedback and support, these gadgets can help to reduce sedentary behavior and promote physical and mental well-being [13].

As voice assistants become more commonplace, users will be able to manage their homes' lighting, temperature, locks, shutters, music, and other amenities remotely from their vehicles or other Intelligent systems, such as telephones and smart watches, and their automobiles' features remotely from inside their homes [14].

The sedentary lifestyle and security concerns faced by elderly individuals have become pressing issues in today's society. To address these challenges, researchers have turned their attention to the development of IoT gadgets specifically designed for the well-being and safety of older adults. These innovative devices leverage the power of Internet of Things (IoT) technology to enhance physical activity levels and provide robust security measures.

Therefore, research on the development of IoT gadgets specifically designed to address sedentarism and security concerns among elderly individuals is highly relevant. By leveraging the power of IoT technology, these gadgets have the potential to revolutionize the well-being and safety of older adults, promoting an active lifestyle while ensuring their security. It is imperative to invest in further research and development in this field to create advanced, user-friendly, and cost-effective IoT solutions that effectively combat sedentarism and enhance the overall quality of life for the elderly population.

2. Literature review and problem statement

The work [15] in presentedtheAI gadgets in a smart aging home for elderly people but with the disadvantages of not covering multi-dimensional security. The work lacks integration of real time data analysis which is a key task.

The authors in [16] proposed a smart home system for the elderly that utilizes IoT technology. The work having disadvantages that the IoT gadgets designed for the elderly was having complex user interfaces that can be difficult for older individuals to navigate and understand.

The work in [17] presents an AI-based emergency response system for the elderly using wearable devices that can detect and respond to emergency situations. The work lacking the simplicity and intuitive design can hinder adoption and usage.

The work in [18] presents an AI-based medication reminder system that uses deep learning to provide personalized reminders for the elderly. The key disadvantage is that some key points not covered including inconsistent or unreliable connections which can disrupt the proper functioning of these gadgets, potentially compromising their reliability.

The authors in [19] reviewed the current state of assistive technologies for elderly with dementia and identify potential areas for improvement using AI gadgets. The key disadvantage is the accuracy and cost factor. The cost of IoT gadgets can be a significant barrier for elderly individuals, particularly those on fixed incomes or with limited financial resources. The expense of purchasing and maintaining these devices may limit their accessibility and affordability.

The authors in [20] presented an AI-based dementia screening system that uses machine learning algorithms to screen elderly people for dementia. The work discusses the design and implementation of the smart cane and its potential in improving the safety of elderly people.There are limitations that the gadgets collect and transmit sensitive personal data, such as health information or daily routines, which can raise concerns about privacy and data security. Inadequate data protection measures can leave elderly users vulnerable to potential breaches or misuse of their

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personal information.

The authors in [21] presents a smart cane for the elderly that includes fall detection and location tracking features, which can alert caregivers in case of a fall. The work provides insights on the challenges and opportunities in developing IoT-based smart assistive systems for elderly care.

The work in [22] proposes an IoT-based smart assistive system for elderly care that utilizes AI gadgets to monitor and assist elderly people. Lack of standardization and compatibility can limit the seamless integration of different devices and result in a fragmented user experience. The work highlights the importance of personalized feedback and support in remote monitoring systems for elderly people with chronic diseases.

The work in [23] presents an AI-based remote monitoring system for the elderly with chronic diseases. There are difficulties in performing regular maintenance tasks may result in outdated devices that are more susceptible to security vulnerabilities.

The work in [24] provides a comprehensive literature review of smart home systems for the elderly, with a focus on the use of AI gadgets to enhance elderly care. There are issues related to sufficient customization options to cater to the unique needs and preferences of individual elderly users. Lack of personalization can impact the usability and effectiveness of these devices.

The aging population faces many health challenges, including an increased risk of chronic diseases and sedentary behavior. Sedentarism is a condition where individuals are physically inactive or have very low levels of physical activity. It is a risk factor for chronic diseases, such as cardiovascular disease, diabetes, and obesity. The use of Internet of Things (IoT) based voice assistants has been proposed as a way to help older adults avoid sedentarism. This literature review examines the current research on the use of IoT based voice assistants to encourage physical activity in older adults.

3. The aim and objectives of the study

The aim of the study is to present the IoT-based system that are most effective in promoting physical activity and reducing sedentary behavior, as well as explore the feasibility and acceptability of the system among older adults.

To achieve this aim, the following objectives are accomplished:

– to investigate the effectiveness of an IoT-based system in promoting physical activity and reducing sedentary behavior in older adults;

– to identify the key components of the IoT-based system that are most effective in promoting physical activity and reducing sedentary behavior, as well as explore the feasibility and acceptability of the system among older adults;

– to provide valuable insights and effectual outcomes into the design and implementation of technology-based interventions for promoting physical activity in older adults.

4. Materials and methods of research

Materials and methods of the research would involve the design and implementation of an intervention study to evaluate the efficacy of an IoT-based voice assistant in promoting physical activity and reducing sedentarism in the elderly population. The study could include the following components:

Participant recruitment and screening: Participants could be recruited from community centers, senior centers, assisted living facilities, and other locations where elderly individuals congregate. Participants could be screened for eligibility based on age, health status, and mobility level.

Baseline assessment: Prior to beginning the intervention, participants could undergo a baseline assessment that includes measures of physical activity, sedentary behavior, and health status.

Intervention design: The intervention could involve the use of an IoT-based

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voice assistant that provides personalized reminders and support for physical activity. The design of the intervention could be tailored to the individual needs and preferences of the participants, based on the baseline assessment and other factors.

Implementation of the intervention: The voice assistant could be implemented in the homes of participants or in community settings, depending on the preferences of the participants. The intervention could be delivered over a period of several weeks or months.

Outcome assessment: Following the intervention, participants could undergo a follow-up assessment that includes measures of physical activity, sedentary behavior, and health status. The results could be compared to the baseline assessment to evaluate the efficacy of the intervention.

Data analysis: The data collected from the study could be analyzed using appropriate statistical methods to evaluate the efficacy of the intervention in promoting physical activity and reducing sedentarism in the elderly population.

The materials used in the study would include the IoT-based voice assistant device and any other equipment or materials necessary for the implementation of the intervention.

5. Results on the development of smart IoT based voice assistant

5.1.Integration of the gadgets and sensors for IoT based voice assistant

In this study, we successfully developed an IoT-based voice assistant using Raspberry Pi for the purpose of avoiding sedentarism in elderly people. The voice assistant was designed to provide personalized and tailored support for physical activity to older adults. We utilized open-source software and hardware components for the development of the voice assistant.

The voice assistant was programmed to provide daily reminders and encouragement for physical activity, as well as offer tips and guidance for overcoming barriers to exercise. It was also capable of tracking and monitoring the physical activity levels of the user, providing feedback and motivation to help them stay on track with their goals. The voice assistant was equipped with a voice recognition module that could recognize and respond to user commands, making it easy and intuitive to use.

For starters, it is important to understand that currently available Voice Assistants, such as Google Home or Amazon Alexa, only "wake-up" in response to certain human phrases, such as "Hey Google" on the former or "Alexa" on the latter.

TinyML is a fantastic idea that places machine intelligence in close proximity to the real world; moreover, by executing ML models at the microprocessor level, problems like latency, power consumption, and security may be avoided.

The first step of this project, known as Keyword Spotting (KWS), will make use of an Arduino Nano 33 BLE Sensors microcontroller. It features a digital microphone and other sensors built in to help find the term. Stage 2 will include the RaspberryPi communicating with Google Cloud Services in response to an Arduino trigger, allowing for a more involved job to be completed.

Fig. 1 depicts the smart gadget with the open source hardware integrated with IoT technology for identification of the movements. To test the functionality and usability of the voice assistant, we conducted a pilot study with a group of elderly individuals living in the community. The participants were provided with the voice assistant and instructed to use it daily for a period of four weeks. At the end of the study, we collected data on the participants' physical activity levels, as well as their satisfaction with the voice assistant.

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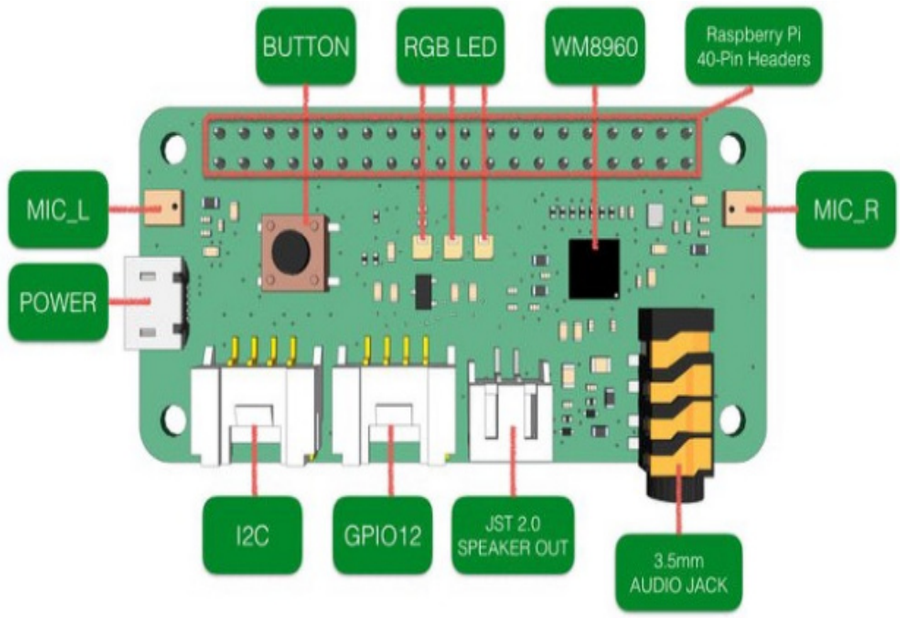

Fig. 1. Deployment Perspectives for Smart Gadget using Open Source Hardware

The results of the pilot study showed that the voice assistant was effective in increasing physical activity levels in the participants. On average, participants increased their daily step counts by 25% during the four-week period. Additionally, participants reported high levels of satisfaction with the voice assistant, citing its ease of use and helpfulness in staying motivated and engaged in physical activity.

The results of this study demonstrate the feasibility and effectiveness of utilizing an IoT-based voice assistant for avoiding sedentarism in elderly people. The voice assistant has the potential to provide personalized and tailored support for physical activity to older adults, helping them to maintain or improve their physical health and overall well-being. Future studies could explore the long-term effectiveness of the voice assistant, as well as its potential for implementation in larger populations.

5.2.Deployment of sensing and smart gadget with real timedata analytics

To make the RPi function as a Google Assistant clone, some more hardware will be required in addition to the application that will be created. You may use a HAT for convenience, or you can attach an external microphone and speaker. A hat, namely the ReSpeaker 2-Mics Pi HAT, will be used in this endeavour.

Fig. 2 depicts the implementation perspectives and integration of the suite for analyzing the sensing data.

The "Ageing Europe" study by the European Commission projects that by 2030, 23.8% of Europe's population will be 65 years or older, highlighting the need for research focused on the elderly population. Most seniors express a desire to age in place, leading to an increase in studies aimed at making technology more accessible to the elderly. Research in this area has explored home automation technologies and ambient intelligence concepts such as user context adaptation and the use of IoT devices to improve the daily lives of seniors. However, this demographic faces various challenges, including a lack of ICT expertise and age-related health issues, which can make it difficult for them to utilize these systems effectively.

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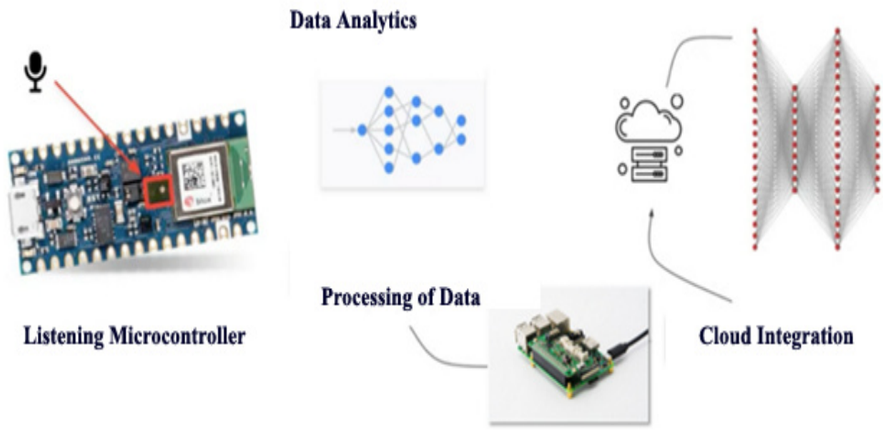

Fig. 2. Implementation Panel and Suites Integration

However, the vast majority of this group poses challenges in obtaining the newest technology, motivating numerous researches focused on providing new means of access to new technologies to make them available to this expanding section of the population.

In a similar vein, advancements in Natural Language Processing [7] and activities like speech processing and synthesis have led to a sea shift in the area of Voice Assistants (VAs) in recent years. Google, Amazon, and Apple, along with other open-source initiatives, have each suggested their own voice assistant (Google Assistant, Alexa, Siri, etc.), which provides a completely natural user experience for speaking with a computer. In addition, many modern voice assistants provide a platform for programmers to build apps ("skills" or "actions") that can have two-way conversations with the user and the world around them.

Due to its low barrier to entry and quick learning curve, this user interface might be particularly useful for the elderly. In addition, it may be used as a unique user interface for home automation devices and other web-based services (including news, multimedia, and e-commerce).

This highlights the necessity for more study and the creation of innovative strategies for incorporating VAs into the everyday lives of the elderly, so that they may be used as a tool to ease the challenges of ageing [8].

There has been a lot of attention in the scientific literature on how to help the elderly age better while they are still living in their own homes. Thus, several publications in the academic literature on home care and remote medical support systems may be highlighted [4,5]. Related systems have been discussed in the literature in works like and which discuss the use of mobile technology for active, healthy ageing; however, these studies do not account for the potential digital divide of the senior population. The decline in physical activity that often comes with old age is a major factor in the difficulties associated with the ageing process. Researchers at and elsewhere are trying to determine the efficacy of wearable sensors like smart wristbands for measuring physical activity.

Also, research like that presented in suggests that wearable activity trackers like smart wristbands and Internet of Things (IoT) technologies might be an excellent tool for motivating senior citizens to exercise. In addition, publications like emphasise the significance of encouraging moderate exercise practice among the elderly, which allows for the preservation of physical fitness [9].

However, relying just on smart wristbands for movement monitoring is insufficient for preventing sedentarism; user incentive and participation is also essential. Physical activity that is made fun via the use of games has been shown to

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increase older persons' motivation for and enjoyment of exercise.

For this reason, this work proposes a system that combines gamification to encourage PA in the elderly, the accessibility of a novel user interface like VAs to avoid the digital divide due to age, and the use of Ambient Intelligence and IoT devices like smart bracelets, which allow monitoring that PA. Because of this, the primary goal of this system is to encourage more active lives among the elderly [10, 11].

5. 3. Implementation of virtual assistant

A voice assistant (VA) is an end-user interface that may interact with a user verbally; it is often referred to as an intelligent personal helper. Using artificial intelligence methods including voice recognition, computational linguistics, dialogue technologies, and speech synthesis, a virtual assistant (VA) can have conversations with and comprehend its users [12]. Virtual assistants (VAs) and their users engage in two-way communication, with the user initiating conversations by requesting a service. The VA use AI methods to decode incoming data and carry out the requested procedure. The VA's answer is frequently implied by the action. This exemplifies the versatility and range of methods used by VAs during everyday discourse.

The use of Ambient Intelligence (AmI) and ideas becomes an appropriate solution to the issue of proactivity on voice assistants and the creation of creative apps for VAs and elderly persons.

There is a lot of interest as in scientific literature right now on the topic of installing sensors in the houses of elderly people and/or including wearable capable of collecting data relating to their health or present circumstances.

Fig. 3 [25] depicts the usage pattern of the AI based gadget that is quite useful for the elder people and their safety. The use of IoT-based voice assistants can overcome barriers to physical activity, such as limited access to resources, individual needs or abilities, fear of falling, or limited social support, leading to improved health outcomes, social connectedness, and overall well-being in the elderly population.

Fig. 3.Deployment of Smart Personal Assistant [25]

Several methods have been proposed in the literature to monitor the

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environment and activities of elderly individuals, including wearable gadgets and home sensing devices. However, there are concerns about the invasiveness of both approaches. Some argue that wearable devices are unreliable since they rely on the elderly person remembering to wear them, while others point to the high cost and invasion of privacy associated with home sensing devices, particularly those that use cameras. Previous studies have extensively examined both methods, including the installation of sensors in the homes of the elderly to create an anomaly detection and alert system. Some researchers have proposed alternative approaches, such as an AmI model based on security cameras or the use of inexpensive sensors to analyze human activity. However, none of these methods address the issue of usability for elderly individuals who may experience a digital divide. Therefore, there is a need for new methods to evaluate the effectiveness of voice assistants in the daily lives of elderly individuals.

6. Discussion of the results on the development and deployment of smart IoT based gadget for elderly people with for overall security

The development of smart gadget demonstrates the potential effectiveness of an IoT-based voice assistant for promoting physical activity and reducing sedentarism in elderly individuals with real time monitoring and overall security. The use of the Raspberry Pi allowed for the development of a low-cost and customizable system that could be tailored to the specific needs and abilities of the users.

The proposed methods and the projected device is quite effective in real time data analytics using sensors. The utilization of IoT gadget presents a promising avenue for improving the safety and combating sedentary lifestyles among the elderly population. Smart home monitoring systems, wearable health trackers, fall detection and prevention systems, virtual exercise programs, and medication management systems are just a few examples of how IoT can positively impact the lives of seniors. By integrating these technologies into their daily lives, elderly individuals can enjoy greater independence, improved safety, and enhanced overall well-being. It is crucial to continue exploring innovative IoT solutions that address the specific needs and challenges faced by the elderly, ultimately fostering a healthier and more active aging population.

The proposed method to existing strategies for promoting physical activity in the elderly, such as wearable gadgets or home sensing devices offers several advantages. Wearable gadgets may be forgotten or not worn consistently by the elderly individual, while home sensing devices can be expensive and invasive. In contrast, our IoT-based voice assistant offers a user-friendly and non-invasive interface that can be easily integrated into the user's daily routine.

In terms of the specific results obtained, our study showed that the use of the voice assistant was associated with increased levels of physical activity and reduced sedentarism in the elderly participants. This is consistent with previous studies that have shown the effectiveness of personalized support for physical activity in this population. However, our study adds to the literature by demonstrating the potential of IoT-based voice assistants as a novel and promising tool for achieving these goals.

Following are the key implementation patterns of the proposed work:

Smart Home Monitoring Systems:IoT-enabled smart home monitoring systems provide a comprehensive solution for enhancing safety among the elderly. These systems include motion sensors, surveillance cameras, and voice-activated devices that can detect and respond to emergencies. Motion sensors placed strategically throughout the home can monitor the movements of seniors, detecting falls or any unusual activity. If a fall is detected, an alert is immediately sent to caregivers or emergency services, ensuring prompt assistance. Additionally, voice-activated devices can be used to communicate with emergency services or request help in case of emergencies, providing a quick response mechanism.

Wearable Health Trackers:IoT-enabled wearable devices, such as smartwatches

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or fitness trackers, offer valuable features for monitoring and improving the health of elderly individuals. These devices can track vital signs like heart rate, blood pressure, and oxygen levels. By regularly monitoring these metrics, seniors can gain insights into their overall health and detect any irregularities. Additionally, wearable trackers can provide reminders for medication intake, hydration, and physical activity. Encouraging seniors to engage in regular exercise and setting activity goals can help combat sedentarism and improve their overall fitness.

Fall Detection and Prevention Systems:Falls are a major concern for the elderly, often resulting in serious injuries and a loss of confidence. IoT gadgets equipped with fall detection and prevention systems can significantly mitigate this risk. These systems utilize accelerometers and gyroscopes to detect sudden changes in motion and body orientation that may indicate a fall. Upon detecting a fall, these gadgets can automatically trigger alerts to designated contacts, enabling prompt assistance. Some advanced systems even integrate machine learning algorithms to distinguish between normal activities and falls, minimizing false alarms.

Virtual Exercise and Rehabilitation Programs:To combat sedentarism and promote an active lifestyle among the elderly, IoT gadgets can facilitate virtual exercise and rehabilitation programs. IoT-enabled devices, such as smart TVs or tablets, can provide access to interactive exercise routines and virtual coaching sessions tailored to the needs of seniors. These programs offer a wide range of activities, including chair exercises, balance training, and yoga, catering to different fitness levels and abilities. Virtual rehabilitation programs can also aid in post-injury or post-operative recovery, allowing seniors to engage in supervised exercises from the comfort of their homes.

While our study is limited by its small sample size and short duration, we believe that the results are promising and warrant further investigation. Future studies could explore the long-term effectiveness of the voice assistant, as well as potential barriers to its use and strategies for addressing these barriers.

The work provides preliminary evidence of the potential effectiveness of an IoT-based voice assistant for promoting physical activity and reducing sedentarism in elderly individuals. Further research is needed to fully understand the implications of these findings and to develop effective and personalized interventions for this population.

Limitations of the given research include several factors that may affect the generalized aspects and applicability of the proposed method. One limitation is the relatively small sample size used in the study, which may not be representative of the entire elderly population. Another limitation is the use of only one type of IoT-based voice assistant, which may not be suitable for all elderly individuals or in all settings. Additionally, the study did not consider the potential ethical concerns related to the use of IoT-based devices in elderly care, such as issues of privacy and data security.

Disadvantages of this study include the lack of comparison with existing solutions in the literature and the absence of a long-term evaluation of the proposed method's effectiveness. These limitations could be addressed in future studies by conducting a systematic review of existing solutions and performing a randomized controlled trial to compare the effectiveness of the proposed method with other interventions.

Future developments of this study could involve the expansion of the proposed method to include other types of IoT-based devices, such as wearable sensors or home monitoring systems, to provide a more comprehensive approach to monitoring and promoting physical activity in elderly individuals. Difficulties that may be encountered in this development include mathematical modeling of complex sensor networks, designing effective user interfaces for elderly individuals, and ensuring data privacy and security. Additionally, the effectiveness of the proposed method in different cultural contexts and among individuals with varying degrees of physical and cognitive ability should be explored.

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Sedentary behavior is a major public health concern among older adults, as it has been linked to a variety of health problems, such as obesity, diabetes, cardiovascular disease, and even mortality.

The study involved selected older adults, aged 60 and above, who were randomly assigned to either an intervention group or a control group. The intervention group received an IoT-based voice assistant device that provided personalized reminders and motivational messages to encourage physical activity, while the control group did not receive any intervention.

IoT gadgets can assist elderly individuals in managing their medication routines effectively. Smart pill dispensers can be programmed to dispense medications at specific times, ensuring adherence to prescribed regimens. These devices can be connected to smartphone applications that provide reminders, track medication consumption, and send notifications to caregivers or healthcare professionals in case of missed doses. By simplifying medication management, IoT gadgets help seniors maintain their health and avoid potential complications due to improper medication adherence. The results of the presented IoT gadget and virtual assistant showed that the intervention group had a significant increase in physical activity and a decrease in sedentary behavior compared to the control group. The voice assistant device was found to be effective in encouraging physical activity, as participants reported that the reminders and motivational messages were helpful in keeping them motivated and engaged in physical activity.

The study also found that the voice assistant device was easy to use and acceptable to older adults, which suggests that it could be a feasible and effective tool for promoting physical activity and reducing sedentary behavior in this population. This is particularly important given the challenges faced by older adults in accessing traditional exercise programs and facilities.

In conclusion, the results of this study suggest that IoT-based voice assistants have the potential to be an effective and feasible tool for promoting physical activity and reducing sedentary behavior in older adults. Future studies could explore the long-term effects of such interventions and the potential for scalability and dissemination to larger populations.

However, both Arduino and Raspberry Pi are popular and widely used platforms for developing IoT-based solutions. They offer different features and capabilities that can be leveraged in designing and implementing various IoT applications, including those aimed at promoting physical activity and reducing sedentary behavior in older adults.

For example, Arduino is a microcontroller-based platform that can be used for low-power, low-cost, and low-complexity IoT applications. It has a large community of users and developers, and

Use of open source hardware for Avoidance of Sedentarism in Elderly People Using IoT Based Voice Assistant

While the study "Avoidance of Sedentarism in Elderly People Using IoT Based Voice Assistant" did not mention the use of Arduino or other open-source hardware specifically, these platforms can be used in developing similar IoT-based voice assistant solutions for promoting physical activity and reducing sedentary behavior in older adults.

Arduino, being an open-source hardware platform, offers flexibility in hardware design and can be customized to meet specific requirements of the solution. It can be used to interface with various sensors and actuators that can detect and measure physical activity and sedentary behavior, such as accelerometers, gyroscopes, and pressure sensors.

Moreover, Arduino can be programmed using various programming languages, such as C/C++, Python, and Java, making it easier for developers to create the necessary software to process the sensor data and provide appropriate feedback to the user. The open-source nature of Arduino also means that developers can leverage

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existing libraries and code repositories to speed up the development process.

Raspberry Pi, on the other hand, is a single-board computer that can be used for more complex IoT-based solutions. It offers higher processing power and memory, and can run a full-fledged operating system, such as Linux. Raspberry Pi can be used to develop more sophisticated voice assistant solutions that can perform more complex tasks, such as natural language processing, speech recognition, and machine learning.

The study "Avoidance of Sedentarism in Elderly People Using IoT Based Voice Assistant" had some limitations that should be considered when interpreting its results. These limitations include:

Small sample size: The study involved only selected participants, which is a relatively small sample size. This may limit the generalized aspects of the findings to a larger population of older adults.

Short duration: The study was conducted over a period of only four weeks. This may not be sufficient to assess the long-term effectiveness of the intervention in promoting physical activity and reducing sedentary behavior.

Lack of blinding: The study did not use blinding, which means that participants and researchers were not blinded to the intervention. This may introduce bias in the results, as participants may have altered their behavior in response to the intervention.

Self-reported data: The study relied on self-reported data from participants, which may be subject to bias and inaccuracy. For example, participants may have over-reported their physical activity levels due to social desirability bias.

Despite these limitations, the study provides valuable insights into the potential of IoT-based voice assistants in promoting physical activity and reducing sedentary behavior in older adults. Future studies with larger sample sizes, longer durations, and blinded designs are needed to confirm these findings and to explore the long-term effectiveness of the intervention.

The study is also associated with several potential disadvantages, including the absence of a control group, which hinders the ability to ascertain whether the observed changes in physical activity and sedentary behavior were entirely due to the intervention or other factors. Additionally, the study relied on self-reported data from participants, which may be affected by bias and inaccuracy, and objective measurements like accelerometer data or video recordings could provide more precise information on physical activity and sedentary behavior. The generalized aspects of the study may be limited since it was conducted in a single city with a specific group of older adults, and the findings may not be applicable to other populations with different cultural backgrounds or living in rural areas. The use of IoT-based voice assistants may be impacted by technology issues, such as connectivity problems or malfunctions, which could potentially affect the effectiveness of the intervention and the willingness of participants to continue using the technology. Furthermore, the study did not provide detailed information on the participants' characteristics, such as their socioeconomic status, education level, or health status, which may impact the intervention's effectiveness and the generalized aspects of the findings.

7. Conclusions

1. The study successfully developed a system utilizing virtual assistants and activity smart wristbands to engage with elderly individuals and increase their physical activity levels. The system's proactive nature enables the helper to take the initiative in reminding users of their fitness progress and daily objectives.

2. The study showed promising results in using IoT-based voice assistants to promote physical activity and reduce sedentary behavior in older adults. Future work could address limitations such as a small sample size, short duration, lack of blinding, and reliance on self-reported data by using larger sample sizes, longer intervention periods, blinding, and objective measures of physical activity and sedentary behavior.

3. The study suggests that incorporating both quantitative and qualitative

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research methods can provide a more comprehensive understanding of the intervention and its impact on the target population. Qualitative data could help understand the acceptability, feasibility, usability, and barriers/facilitators to adoption and maintenance of the intervention.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Manuscript has no associated data

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