Enhanced Home Elderly Care: integrating Fitbit technology within Android Studio evolutionary prototypes.

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Abstract

This project aims to develop an architecture that facilitates self-care for elderly individuals while enabling continuous health monitoring by healthcare professionals. This paper focuses on the initial phase of a larger project, emphasizing vital signs monitoring using FitBit Versa 4 and a cognitive decline management game. Wearable sensors track vital signs and compile historical data for analysis. Through continuous research and refinement, we aim to provide personalized and comprehensive care, improving the quality of life for elderly individuals.

Keywords

Evolutionary Prototypes, Wearable Sensors, Data Visualization

1. Introduction

The European Region is expected to have a larger population of individuals aged over 65 years than those under the age of 15, according to the World Health Organization (WHO)[1]. This demographic shift presents new social, economic, and health challenges that require a focus on healthy ageing to mitigate the impact of an ageing population. Assisting the elderly population in effectively managing age-related conditions such as chronic illnesses and anxiety, and maintaining their independence and self-sufficiency as much as possible, is crucial for improving their well-being and quality of life. Maintaining some level of quality of life is closely associated with managing several forms of chronic conditions, including cardiovascular disease, chronic respiratory disease, diabetes and mild cognitive impairment that are common with age [1]. In our previous study [2, 3], we highlighted the importance of monitoring vital signs, specifically referring to the Modified Early Warning Score (MEWS) system. Recording vital signs is a crucial aspect of nursing. Vital signs are part of the data set collected by nurses during

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[1]World Health Organization, 11 Oct 2023. UR: https://www.who.int/europe/news/item/11-10-2023-by-2024–the-65-and-over-age-group-will-outnumber-the-youth-group–new-who-report-on-healthy-ageing

patient assessment or monitoring. It is important to continuously update these parameters for patients who require it due to various reasons[2]. They provide a rapid and efficient method for evaluating the patient's condition and identifying any issues or the patient's response to specific interventions. The term 'vital parameters' conventionally refers to the measurement of heart rate (HR), blood pressure (BP), body temperature (T°), and respiratory rate (RF). The clinical condition of patients also requires observations of other parameters, such as the state of consciousness, body weight, or emotional state.

This research will also refer to the factor of dementia. Dementia is a loss of cognitive function (i.e. thinking, remembering and reasoning) that affects a person's daily life and activities[3]. Some people with dementia cannot control their emotions, and their personalities may change. Dementia is predicted to affect 152 million people worldwide by 2050 [4]. Cognitive decline, which is much more common than dementia, can still cause serious limitations in daily activities, independence, and quality of life in older age [5, 6, 7]. It also predicts that poor health and poor cognitive plasticity can be a precursor to dementia, disease, and mortality [8, 9]. Cognitive plasticity refers to an individual's latent cognitive potential under specific contextual conditions. It is the capacity to acquire cognitive skills [10, 11]. Cognitive function is a critical aspect of maintaining independence among the aged. According to various studies, a multi-therapeutic approach may be more effective for the pathology of dementia [12, 13, 14]. For seniors, engaging in memory games is an effective strategy to sharpen cognitive function and preserve mental acuity. These activities act as proactive measures against cognitive decline[4].

2. Related Works

The article [16] discusses the significant health risk posed by falls, especially among the elderly, where falls can be fatal. According to the authors, prevention and timely intervention are crucial in reducing this risk. Moreover, the authors in [17], consider the inactivity and medication reminders as a means to better control the elderly routine. They developed a tool for caregivers to assess patient vitality, with a focus on predicting falls. Other studies, focus their attention on monitor tracking through wearable sensor technologies. For example, in [18], the authors investigate the accuracy of wearable sensors in monitoring healthcare parameters for the elderly in smart home environments. The authors of [19] proposes a health detection system for smartwatches targeting the elderly, utilizing biosignal analysis to effectively monitor physiological parameters such as body temperature, pulse, and respiration. Through the analysis of Lipschitz exponent of maximum value column transform, the system achieves accurate health signal detection. It incorporates multiphysiological parameter acquisition and monitoring, ensuring

[2]E. La Montagna, 'Vital parameters: assessment and nursing responsibility (Parametri vitali: accertamento e responsabilità infermieristica)', *www.nurse24.it*, published 08.11.16 and update 01.06.22, https://www.nurse24.it/infermiere/i-parametri-vitali-accertemento-e-responsabilita-infermieristica-2.html, (03.02.2024).

[3]This content is provided by the NIH National Institute on Aging (NIA). NIA scientists and other experts review this content to ensure it is accurate and up to date., 'What Is Dementia? Symptoms, Types, and Diagnosis', *www.nia.nih.gov*, Content reviewed: December 08, 2022, https://www.nia.nih.gov/health/alzheimers-and-dementia/what-dementia-symptoms-types-and-diagnosis#:~:text=Dementia%20is%20the%20loss%20of,and%20their%20personalities%20may%20change. (03.02.2024).

[4]World Health Organization, 11 Oct 2023. UR: https://www.who.int/europe/news/item/11-10-2023-by-2024–the-65-and-over-age-group-will-outnumber-the-youth-group–new-who-report-on-healthy-ageing

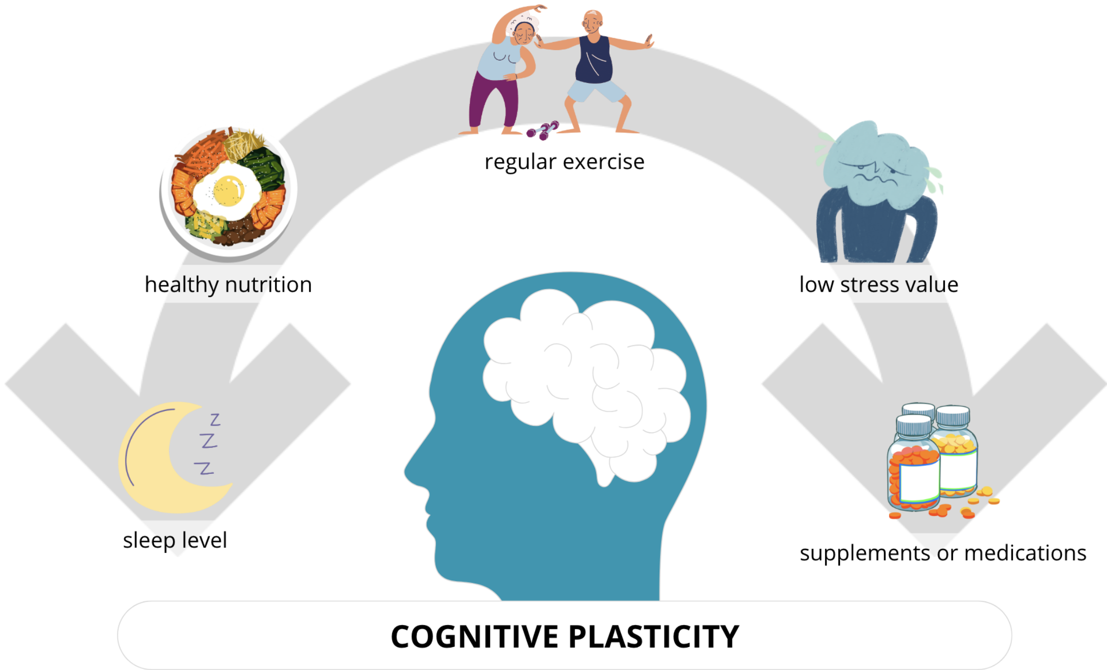

Figure 1: Several studies have highlighted the importance of considering sleep levels, healthy nutrition, regular exercise, low stress levels, and adherence to prescribed drug therapy to promote the cognitive plasticity [12, 13, 14, 15].

continuous monitoring over extended periods. The system demonstrates high recognition rates, reaching up to 96.5%, and provides precise calibration accuracy and synchronization with national time standards, validating its effectiveness in extracting biosignal features and achieving high classification accuracy for elderly health detection.

Several studies have highlighted the pivotal role of various lifestyle factors in fostering cognitive plasticity [12, 13, 14, 15]. These factors encompass not only sleep levels but also encompass healthy nutrition, regular exercise, maintaining low stress levels, and adhering to prescribed drug therapy. Through a multidimensional approach encompassing these elements, individuals can potentially enhance their cognitive flexibility and adaptability. Figure 1 provides an overview of some of the most important aspects to be considered with regard to the cognitive plasticity of the elderly population.

3. Assist the elderly throw a Health System

The project aims to design an architecture that enables elderly individuals to care for themselves while also allowing doctors and caregivers to continuously monitor their health status. This paper discusses a section of our ongoing project, focusing on vital signs collected by wearable sensors and a game designed to control cognitive decline. Figure 2 illustrates how technology collaboration can enhance the monitoring of vital signs through the use of sensors. In the home environment, the elderly can maintain their independence while the technology passively assists

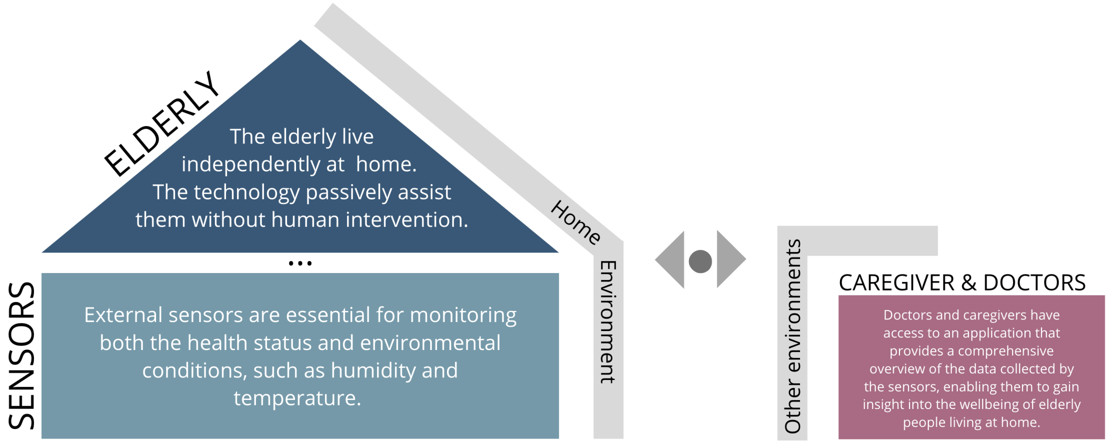

Figure 2: Use technology to enhance the situational awareness of older people and their caregivers and/or doctors. Elderly wears a smartwatch to monitor health in the home environment. In the other environment, caregivers or doctors have a comprehensive overview of the parameters measured by the sensor.

them without the need for human intervention. Wearable sensors enable us to track the elderly's vital signs and compile a historical record of measurements. Other relevant environments may include the caregiver's home, the doctor's surgery or the hospital. An application provide a comprehensive view of the data collected by the sensors, enabling them to gain insight into the well-being of the elderly. Moreover, a memory game has been developed to enhance the cognitive function of the elderly.

To evaluate the well-being of elderly individuals, we use the Fitbit Versa 4[5], a cutting-edge wearable device equipped with advanced health monitoring technology. The Fitbit Versa 4 includes features such as continuous heart rate tracking, sleep analysis, activity monitoring, and SpO2 monitoring, providing comprehensive insights into the individual's health status. This device detects anomalies in vital signs, allowing for prompt intervention when necessary to ensure the health and safety of the elderly. Its sophisticated capabilities are leveraged for our purpose. We also use Postman[6], a powerful tool for testing and debugging Application Programming Interface (API) in collaboration with Swagger UI[7]. To design the interfaces, we employ Android Studio, a comprehensive Integrated Development Environment (IDE) specifically tailored for Android app development.

We use the resources available on the Fitbit developer website, combined with Swagger UI, to generate a token through Postman. This token was a key component in our process, enabling us to efficiently generate APIs and send requests directly from Android Studio[8]. Based on the data

[5] fitbit is a smartwatch powered by Google. Official website https://www.fitbit.com. Developers website: https://dev.fitbit.com/

[6] https://www.postman.com

[7] https://swagger.io/tools/swaggerhub/?utm_source=aw&utm_medium=ppcg&utm_campaign=SEM_SwaggerHub_PR_EMEA_ENG_EXT_Prospecting_Tier2&utm_term=swagger%20ui&utm_content=665457100541&gad_source=1&gclid=CjwKCAjwoa2xBhACEiwA1sb1BK7Um8IrSGUSMbLwkRoe6ldg6AXxKAw1ToNiSkFP-tGlE1IHzK-VQxoCVdEQAvD_BwE&gclsrc=aw.ds

[8] https://developer.android.com/studio?hl=it

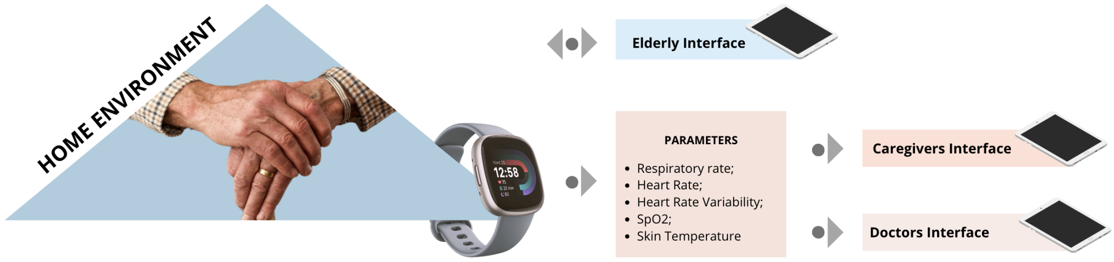

Figure 3: The elderly person wears the smartwatch, which provides some parameters (respiratory rate, heart rate, heart rate variability, SpO2, skin temperature). These parameters need to be displayed in different ways to caregivers and doctors. Aldo the elderly has his own personal interface to play some useful interactive memory games.

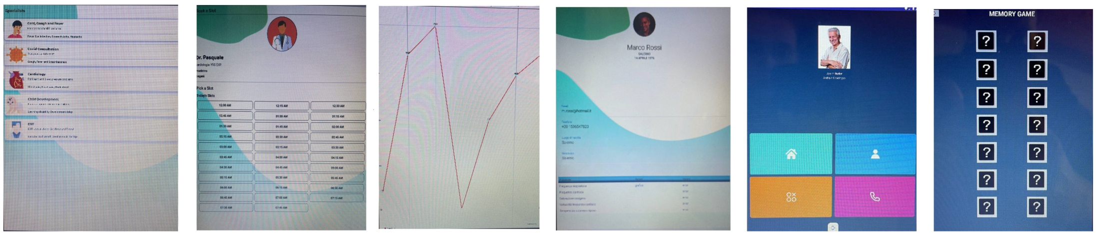

Figure 4: Evolutionary prototypes of data visualization. All the data received from the FitBit4 is displayed on the application. This evolutionary prototype allows us to evaluate if the data measured by the smartwatch is displayed correctly on the interface.

collected with FitBit, we have designed three distinct interfaces to ensure that users can interact with the data seamlessly, gain meaningful insights, and facilitate informed decision-making processes.

The data collected by the sensors should be viewed on an interface by the doctors and caregivers. We design various tablet interfaces (see Figure 3), tailored to specific end users. These evolutionary prototypes (see Figure 4) of the application are a basic framework for testing and validating the integration of FitBit technology into our system. The future aim will be to customize the evolutionary prototypes, to create interfaces that are well structured for the specific user. For instance, doctors require a comprehensive overview of the data collected by the sensor, while carers only need a quick overview of the elderly person's health. Additionally, older individuals can exercise their minds by playing games on the tablet.

4. Conclusion and Future works

The project aims to support the elderly population and address the challenges associated with aging. Vital sign monitoring is one of the key components of our efforts, but it is only one facet of our multi-faceted approach. In the future, we plan to integrate additional devices into the home environment to comprehensively monitor not only physical health but also the mental and emotional well-being of the elderly. A social robot is planned to be introduced within this architecture to enhance communication skills among the elderly and improve situational control. Furthermore, our future work will focus on refining and customizing the interfaces to meet the unique needs of each stakeholder within the system. This iterative approach will ensure that our interfaces not only meet generic requirements, but also provide optimized functionality and a user experience tailored to individual roles and preferences. Our goal is to offer comprehensive care and improve the overall quality of life for the elderly community. We accomplish this by providing support throughout their daily lives. We consistently improve our services to meet their changing needs through ongoing research.

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