

A PROTOTYPE OF BIG DATA PLATFORM FOR SENIORS CARE

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Abstract

The global elderly population is on the rise. By 2050, it is projected to reach 1.5 billion. That is why society should pay attention to this phenomenon with due attention. One effective strategy for this challenge is leveraging modern IT technologies. In line with this, we propose the prototype of a new platform designed for elderly care. Its architecture is structured into four layers: UX/UI, business logic, service program, and a diverse device layer. A significant strength of this platform is its comprehensive suite of microservices, which includes a medical manager, a personal daily schedule (PDS) manager, and a questionnaire manager. Another notable feature of the platform is its capability to work with Big Data, enhancing its utility and scope. Additionally, the prototype incorporates a variety of Internet of Things (IoT) technologies. The platform is implemented with FIWARE components.

Key words: Big Data, software platform, FIWARE, IoT, elderly care, programs for seniors

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1. Introduction. The emergence of modern information technology has revolutionized many facets of daily life. Among its most significant contributions is the capacity to efficiently process vast volumes of data, a capability commonly referred to as Big Data. This advancement enables the analysis and utilization of large datasets within practical timeframes, unlocking new opportunities for insight and optimization across diverse sectors [1,2]. This capability has broadened the scope of IT applications in many human activities [3]. A prime example is the creation of digital systems designed to assist the elderly in different aspects of their lives.

It is accepted with the term ‘elderly adults’ to denote individuals aged 65 and over. As of 2019, there were over 700 million elderly people worldwide, and this number is projected to rise to 1.5 billion by 2050. This demographic shift poses new challenges for society, particularly in developing smart systems tailored to assist the elderly. Various issues in smart solutions for the elderly such as work policy, health, facility management, community services are discussed in [4].

In this paper, we introduce a prototype of a Big Data platform specifically designed and developed for the care of the elderly. The purpose of this article is closely related to the tasks of the project “Strengthening the capacity to build a friendly environment for adults in Bulgaria based on modern IT technologies”.

The paper is structured as follows. The subsequent section presents a review of relevant literature, exploring unresolved issues and potential solutions in smart care for the elderly. Section 3 details the design and development of the proposed Big Data platform for the intelligent care of seniors.

2. Literature overview. Caring for seniors encompasses a wide range of challenges, from addressing health issues to ensuring social inclusion. There is a lot of literature on this topic. Several key aspects of senior care can be identified [5].

Physical health is a major area of focus, as many older adults struggle with chronic conditions such as arthritis, hypertension, heart disease, diabetes, and osteoporosis. Mobility issues are also common, manifesting as difficulty in walking or changing positions. Another significant issue is the deterioration of sensory abilities [6]. Mental health presents significant challenges for seniors [7]. Cognitive conditions such as dementia and Alzheimer’s disease can significantly impede daily activities and lead to behavioural changes. Additionally, factors like isolation, the loss of peers, and existing physical health issues often contribute to depression.

Medication management is another crucial concern [8]. With advancing age, it is common for seniors to be prescribed multiple medications. This situation can lead to complex drug interactions and side effects, a challenge referred to as polypharmacy. Furthermore, issues such as forgetting to take medications or the high cost of prescriptions can affect their adherence to their medication plans.

Social challenges are also a significant issue for many elderly individuals. Feelings of isolation are common due to physical limitations, lack of adequate transportation, or the loss of peers [9].

Furthermore, the generational gap poses additional challenges. Differences in values, communication styles, and technological skills can lead to misunderstandings between seniors and younger generations. Financial issues are a serious concern too. Many seniors struggle with inadequate savings for retirement, rising healthcare costs, and susceptibility to financial scams due to limited financial literacy [10].

The vital role of caregivers should also be emphasized, though they face their own set of challenges. Caregiver burnout, often experienced by family members, is a significant issue, resulting from the physical and emotional demands of caregiving [11]. This situation is often compounded by financial pressures and a lack of adequate training.

The Internet of Things (IoT) and FIWARE refers to the interconnected network of devices and systems communicating over the internet [12–16]. In elderly care, the application of IoT and FIWARE presents vast opportunities to improve the quality, efficiency, and safety of the care provided to older adults.

We will enumerate the specific ‘things’ that can be employed to facilitate the functions related to elderly care, as previously outlined in the text:

1. Medical and health monitoring: Smart pillboxes can remind seniors when it is time to take medication, monitor pill intake, and alert caregivers if a dose is missed. Wearable devices can continuously monitor vital signs such as heart rate, blood pressure, and glucose levels, transmitting the data in real-time to healthcare providers or family members.
2. Appointment and medication reminders, and personalized care plans: The “things” are represented by software components designed to manage and execute personal plans. These plans can integrate crucial features like appointment and medication reminders, enhancing the daily management of health-related tasks for seniors. We will delve deeper into the specifics of how these functionalities are incorporated within personal plans later in the presentation.
3. Emergency alerts: Emergency alert systems, or “things” in the context of IoT, are specifically designed to notify caregivers, family members, or medical professionals of potential emergencies involving elderly individuals. These systems can be triggered either manually by the individual in need or automatically by specialized devices. Commonly integrated into wearable accessories such as pendants or wristbands, these devices are equipped with buttons that, when pressed, send a distress signal to a monitoring system. In smart home environments, some devices are capable of detecting unusual activities, like an oven being left on for too long, and can autonomously issue alerts. A vital function of these systems is fall detection, which is crucial given the high risk of injuries from falls among seniors. Advanced technolo-

gies have been developed to identify falls promptly and alert caregivers or emergency services [17].

4. Communication tools in elderly care: In the realm of elderly care, “things” utilized for facilitating communication are pivotal in enhancing the overall quality of life and ensuring the safety and well-being of older adults. Key tools in this domain include video cameras and remote medical sensing devices. These technologies not only aid in regular monitoring but also play a critical role in health management.

Additionally, software components are integral for the efficient coordination of daily care. They are adept at capturing alerts and responding to them in a timely manner, thereby ensuring prompt attention to any arising needs or emergencies. Digital personal daily scheduling is another essential aspect of these communication tools. It helps in organizing the day-to-day activities of the elderly, ensuring that all their appointments, medication times, and other important tasks are systematically managed and adhered to [18].

5. Activity tracing: Activity tracing service is based on a multitude of things including wearable devices, mobile applications, home monitoring devices, bed sensors, specialized footwear, GPS trackers, etc.

The implementation of Medical Care and Coordination, Social Well-being services, and Resource Allocation and Management is based on software components that utilize the previously described hardware devices.

3. A prototype seniors’ care platform. We will showcase the principal features and architectural framework of ‘AgeWare’, a platform meticulously engineered to fulfill the care requirements of the elderly. AgeWare is a web-based platform currently in development. It is devised as a multi-layered software system, whose intricate architecture is depicted in Fig. 1. The foundation of AgeWare incorporates components from FIWARE (<https://www.fiware.org/foundation>), emphasizing its scalability, Big Data processing capabilities, and seamless integration with diverse IoT devices. Contrary to the conventional reliance on IoT technology in existing literature, our methodology leverages FIWARE. This strategic choice facilitates the effortless addition of new devices courtesy of the IDAS Generic Enabler, which accommodates a broad spectrum of straightforward protocols originating from the device side, thereby streamlining the integration process.

The architecture of the platform developed comprises four primary layers: UX/UI (User eXperience/User Interface), business logic, service program, and a multifaceted device layer.

The Business logic layer is composed of a collection of microservices that implement the functionalities of systems for senior care:

- The Medical Manager serves as an essential microservice that facilitates doctors in uploading outcomes of hospital examinations, diagnoses, and health

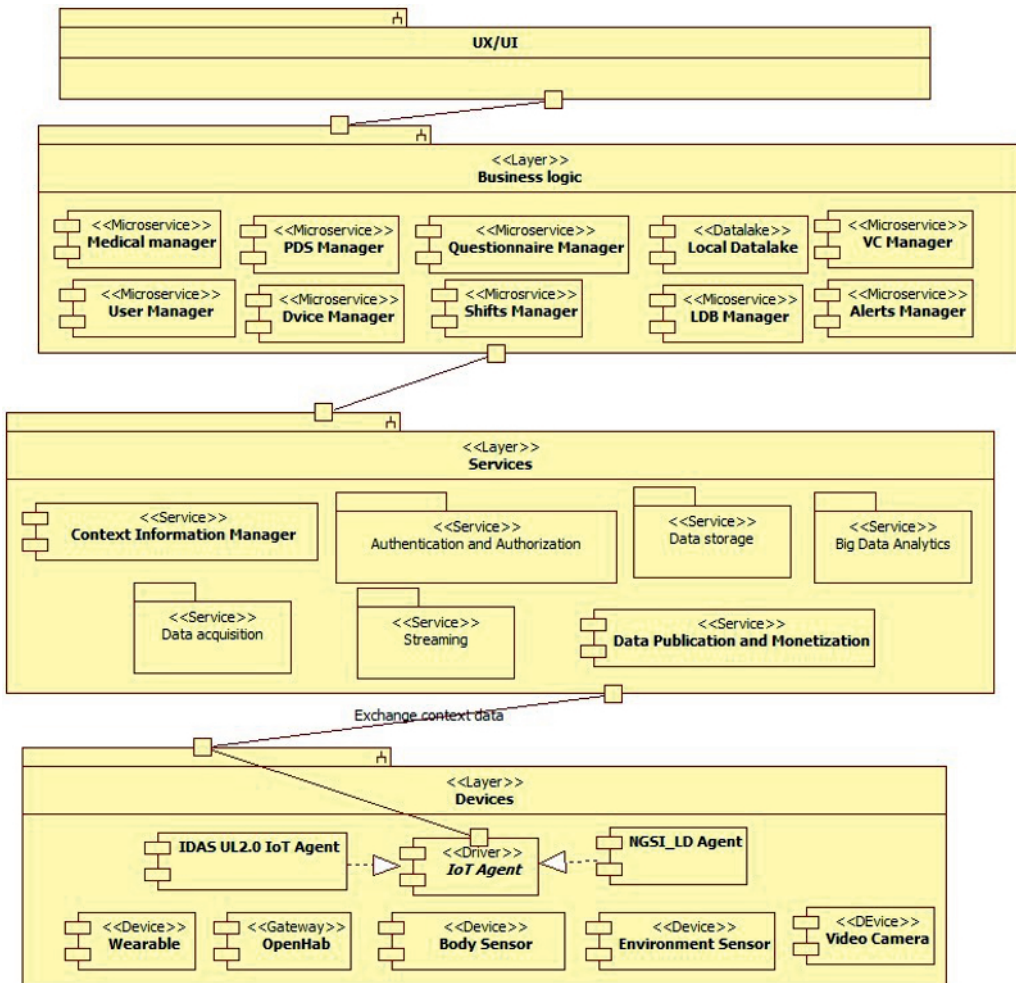


Fig. 1. AgeWare high level architecture

prescriptions, showcased in Fig. 2. It encapsulates functions related to Medical and Health monitoring. Through this microservice, fitness trackers are allocated to elderly patients, covering devices designed to monitor crucial health metrics like blood pressure, oxygen saturation in the blood, and heart rate. In addition, the Medical Manager is instrumental in distributing a bespoke fall detection or alarm device, enhancing safety measures for the elderly.

- The User Manager microservice is specifically designed for the registration of system users and the management of their identities and access permissions to various functions and resources within the system. This module serves a diverse group of users, including system administrators, hospice administra-

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Fig. 2. Medical examinations

tors, caregivers such as nurses, doctors, orderlies, etc., as well as the elderly individuals under care, their relatives, and friends.

- The Personal Daily Schedule (PDS) Manager is a pivotal element in the elderly care framework, featuring Appointment and Medication Reminders, along with Personalized Care Plans and Activity tracking, as depicted in Fig. 3. This tool acts as the main conduit for communication between the elderly and their network of caregivers, including nurses, medical personnel, and even relatives and friends. The PDS meticulously organizes the senior's daily activities and tasks, which can be classified as either one-time or recurrent. Among its key functionalities, the ability to add reminders prior to the commencement of a task and to set alert levels for uncompleted tasks stand out, ensuring that crucial activities are neither overlooked nor neglected.
- The Questionnaire Manager is a crucial service featured in the described platform, tailor-made to administer a sequence of questionnaires filled out by caregivers on a daily, weekly, or monthly basis. Its main goal is to collect self-assessments from elderly individuals about their health and psychological state. Should a self-assessment from any questionnaire fall below a predetermined threshold, an alert is automatically triggered. The Questionnaire Manager introduces a novel dimension of data collection, capturing individuals' self-evaluations of their physical and mental health.
- The Device Manager is responsible for overseeing devices that monitor and manage the living environment and physiology state of elderly individuals. The current version integrates sensors for motion detection, open/closed sta-

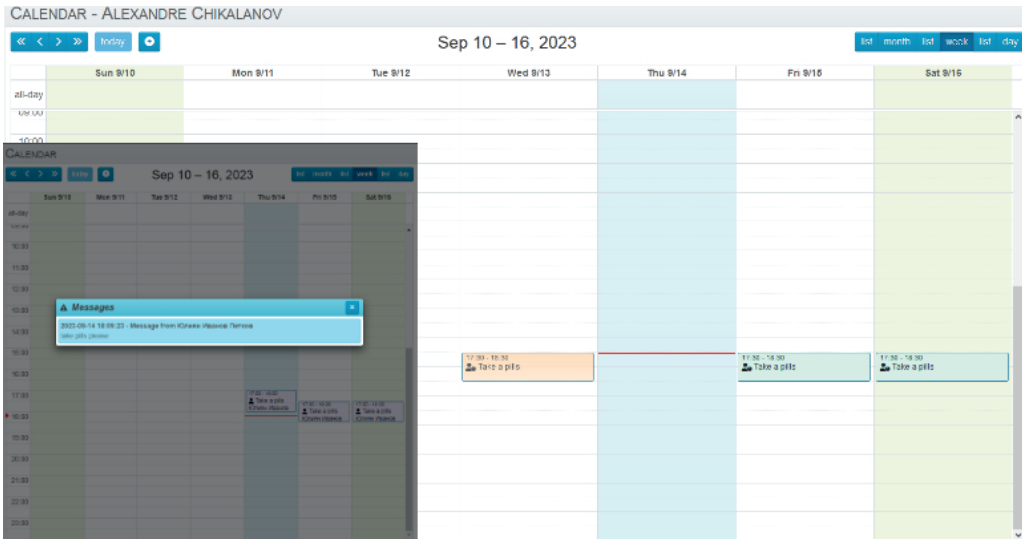


Fig. 3. Personal daily schedule

tus, temperature, humidity, and air quality, along with smart thermostats and sockets. This component is crucial for enabling Activity Tracking functionality, ensuring a comprehensive approach to the well-being and comfort of the elderly within their living spaces.

- Emergency Alerts are facilitated through the Alerts Manager, which is closely integrated with the Personal Daily Schedule (PDS) Manager, Questionnaire Manager, and Device Manager. The primary function of the Alerts Manager is to dispatch generated alerts to subscribed users and monitor the resolution process of each alert's cause. Additionally, it archives the complete history of every alert – from its initial trigger to the final resolution of the underlying issue, including all communication exchanged between alert observers and any responding rescue teams.
- The Video Conferencing (VC) Manager is a key component within Communication Tools for Elderly Care, serving as a crucial instrument for maintaining social contacts, sometimes being the sole means of such interaction. This manager orchestrates video conferences by managing participant inclusion and ensuring that all participants have concurrent access to the video stream. It functions in seamless coordination with the Personal Daily Schedule Manager and the User Manager, integrating essential communication functionalities into the care and social engagement of the elderly.
- Shifts Manager is responsible for allocating shifts of caregivers. A carer is responsible for a group of caretakers.

- Local Database (LDB) and Local Database Manager (LDBM) are responsible for data storage.

4. Conclusion. The global elderly population is on the rise, projected to reach 1.5 billion by 2050. Addressing their needs is one of the most pressing issues, and modern IT technologies offer promising solutions.

This paper introduces a functional prototype of a platform architecture designed specifically for elderly care. The architecture is structured into four main layers: UX/UI (User Experience/User Interface), business logic, service program, and a detailed device layer. A significant advantage of this platform is its broad array of micro-services. These include a medical manager, a personal daily schedule (PDS) manager, and a questionnaire manager, each tailored to meet the fundamental goal of providing comprehensive care to the elderly.

Another significant feature of the platform is its capability to work with Big Data. Elderly care computer systems often deal with a multitude of parameters such as the number of care takers, various health indicators like blood pressure and temperature, and individual medications. Additionally, the system accommodates multiple users, including care givers, doctors, and relatives, often requiring real-time access. Thus, the ability to handle Big Data efficiently is crucial for the platform. The platform can be found at <https://ageware.virtech.bg/> [19].

All this makes the proposed platform surpass others with its features and comprehensiveness. The main advantages of the offered platform for AgeCare compared to other similar platforms are: it is a Big Data platform; it is implemented with components of FIWARE, making it an open architecture plus all the technological advantages of FIWARE components; it fulfills all five requirements for comprehensiveness of platforms for AgeCare that we have formulated in Section 2. In the Big Data platforms for aged adults care the main focus is on medical aspects of this service. In our approach we are focused on streamlining of care giving process. The main reason is that the shortage of qualified caregiver staff is critical not only in Bulgaria but worldwide. Additionally the presented platform has social aspect allowing caretakers to not only to have a 24 hour communication with their relatives and caregiver but also to extend their social contacts and communication with other people [20].

Looking ahead, several avenues for future development are identified. One of these is enhancing the platform's functionalities to improve the social lives of the elderly, such as organizing group activities (excursions, meetings, etc.). Another is to facilitate essential services like supply requests for food and goods, implement chat and chat groups, and integrate with e-government services. These enhancements aim to broaden the platform's scope to become a facilitator for a better quality of life.

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