Applications of the Insieme Platform: A Case Study

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The information society has significantly changed the field of medicine. Several decades ago when a person got sick, a doctor examined a patient and prescribed some medicine with a patient more or less unaware of the true nature of the problem. Even if explained, many patients did not understand much due to the lack of medical knowledge. Today, knowledge is widely accessible through the web and many patients try to self-diagnose or at least get another opinion using popular search engines and specialized web applications. However, many of them provide misinformation due to the lack of proper education of the provider or the lack of understanding of the user. To overcome these issues, we developed a verified medical platform (Insieme platform) that includes medical data, applications and services. This article provides a list of applications in the Insieme platform, their descriptions and how to use them.

Povzetek: V prispevku so opisane zdravstvene aplikacije na platformi Insieme. Aplikacije nudijo uporabnikom različne funkcije, od osnovnega informiranja do zaznavanja zdravstvenih težav. Poleg tega aplikacije pripomorejo tudi k boljši strukturi in razdelanosti platforme Insieme.

1 Introduction

The Insieme platform is being developed as part of the ISE-EMH project [1], with the collaboration of three Italian and three Slovenian partners. The platform is a continuation of the EkoSMART project [2], where one of the segments was electronic and mobile health. EkoSMART was a three-year project where we explored the potentials of eHealth systems. The Insieme platform is available in English, Slovenian and Italian. The backbone of the platform are services. A service consists of a name, a short description, and sections. We defined 10 sections, but not all sections need to be included in the service.

In this paper we describe a list of applications in the Insieme platform, their descriptions and how to use them. They all belong to the field of electronic and mobile health (EMH). The Insieme platform includes data on around 40 applications. We list representative 15 of them and describe four in detail. The most relevant Insieme applications are:

- Motiphy [3]
- HEMS-based elderly behavioral change [4]
- DaVinci [5]
- Platomics [6]
- Depression app [7]
- Narcissistic personality disorder app [8]
- Bigorexia or muscular dysmorphia quiz [9]
- Schizophrenia app [10]
- Lymphoma app [11]
- Thyroid Cancer app [12]
- ASPO app [13]
- HEP-Y app [14]
- Senior helper app [15]
- Nala-care app [16]
- Skin vision - skin cancer app [17]

The four applications described more thoroughly are the following. The first application, Senior helper, is intended for elderly people and their caregivers. It enables the elderly to prolong stay in their homes. The second application is HEMS (Home energy management system) smart house that includes embedded sensors in rooms of a house or a flat to help users and physicians to detect potential prostate problems. The third one is ASPO (Application for informing about sexually transmitted diseases). It is a questionnaire which assigns a weight to the answers to evaluate the probability that a person has a sexually transmitted disease. Finally, the fourth one is HEP-Y, the questionnaire for evaluating the probability that a person has contracted hepatitis.

2 Senior helper

By the latest statistics, every fifth resident of Slovenia is older than 65 years [18]. Here we are denoting every person older than 65 years as an elderly. By the year 2050 every third person will be older than 65 years on the global scale [19]. As a consequence, the number of health problems in the population will rise, while at the same time the number of medical doctors and nurses will probably not increase accordingly (but might even decrease). To tackle this issue, we need a demographic solution or an ICT (Information communication technology) solution. We have developed the Senior helper application within the Insieme project that addresses this problem. The platform builds upon the previous H2020 project INLIFE [20].

The application consists of two integral parts, one for each user role. The first role is the caretaker and the second is the senior (the elderly person).

2.1 The functions of the Senior role

The senior-specific part of the application has five main components: Alarms, Settings, Fall detection, SOS function and Contacts. While most of the functions are self-explanatory, the fall detection needs more clarification. Every smartphone has integrated a special chip (MEMS - micro electro mechanical system) to detect acceleration. We developed an algorithm for fall detection, which measures acceleration in all three axes. When the application detects a high acceleration in any axis and shortly afterwards none, a fall is reported, i.e., an SMS is automatically sent to the caretaker that the fall has occurred [21]. In case of a false-positive event, the senior has an option to hold the button, which sends an SMS to the caretaker that the fall has not occurred.

2.2 The functions of the Caretaker role

The caretaker has a comprehensive view of the data of a specific senior. This includes additional features implementing the inaccessibility function, pedometer, location, and alarms. It also has options to view a senior's daily activity history.

The main purpose of the inaccessibility function is to enable the caretaker to disable regular messages for a particular senior or to set the alarms. The caretaker can select one of three options for inaccessibility: none, partial or complete. If the caretaker selects no inaccessibility, the senior can fully use the application. If he/she selects partial inaccessibility, the senior cannot use all the functions, but can unlock the partial inaccessibility if he/she remembers how to. This can be done if the senior holds the Settings button for five seconds or more. If the caretaker selects complete inaccessibility, the senior cannot unlock the selected functions in any way. In general, the caretaker can disable any kind of activities for the senior if the senior does not know how to use these functions.

In the interactions with elderly and caretakers on relevant events, such as the workshop in which the application was presented to elderly, significant interest was expressed in using this application, even by the older

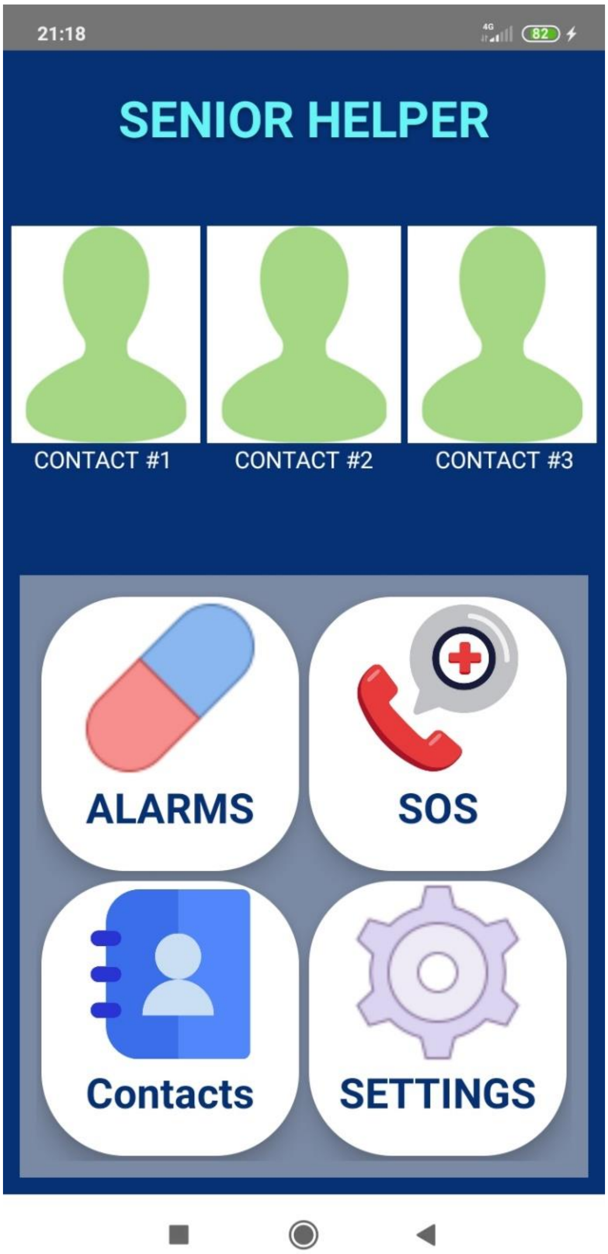

Figure 1: Basic view of the Senior role in the Senior Helper application.

persons with basic ICT knowledge. Figures 1–2 show views, i.e., screenshots of the application.

3 Detecting prostate problems from the HEMS data

Medical issues with prostate affect men when they get older (in their last period of life). More than 50 % of men have an enlarged prostate when they are older than 60 years [22]. Enlarged prostate is not cancer and also, it does not lead to cancer. The exact causes of enlarged prostate are unknown. Also, some men have symptoms and some do not. Men who have these symptoms can either have an enlarged prostate or prostate cancer. For both diagnoses, the symptoms include difficulties urinating and frequent

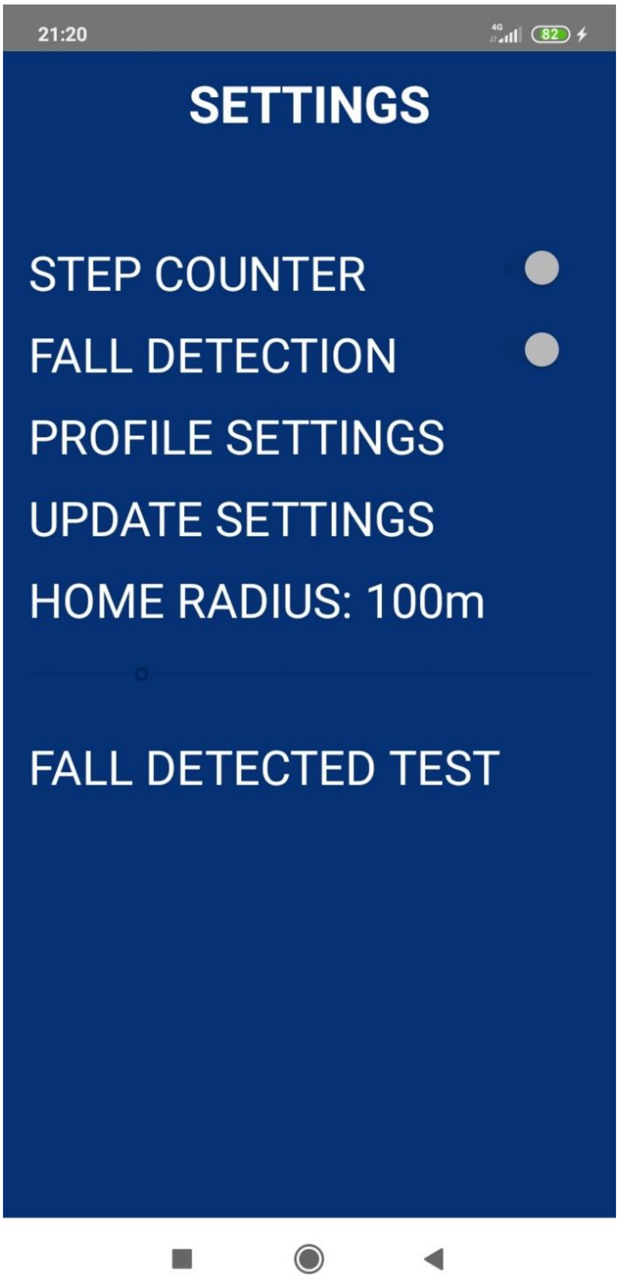

Figure 2: Settings view of the Caretaker role in the Senior Helper application. Home radius setting is intended as a geofencing option for people with dementia that are at risk of wandering off and getting lost. If the GPS detects the user outside the home radius, the application will send an alarm to the caregiver.

urinating (especially at nighttime). Additionally, blood in the urine or burning pain when urinating are the first signs of prostate cancer. This application aims at detecting such problems in the early stage thus preventing them from worsening the condition.

Several tests exist for diagnosing an enlarged prostate. If the patient's personal doctor cannot determine the cause of the problems, he/she can send the patient to the urologist for further examination and tests. In the following section, we will describe some typical tests urologist perform to either confirm enlarged prostate or prostate cancer.

Besides medical tests, ICT solutions for detecting prostate problems are also being developed. These solutions include, e.g., mobile applications or computer systems that assess the parameters from blood and urine results [23], [24], [25]. Such programs automatically assess the risk (i.e., multivariable risk calculator) for prostate cancer. Other systems assess non-medical data. For example, we have developed a system that asserts the risk of having a prostate problem based on HEMS data as described in Section 3.2.

3.1 Medical procedures for prostate problems

Several medical procedures for detecting prostate problems exist.

Urine test: For this test, a patient urinates into a cup. With a special piece of paper placed into the urine, the urologist can detect if a person has an infection or if there is some blood present in the urine. The blood in urine can be a cause of prostate cancer. Although other tests are needed, some latest research with a new type of biomarkers is promising [26].

Blood test: Through blood tests, specialists can detect abnormal levels of PSA (Prostate-Specific Antigen) [27]. PSA is a protein that is produced by the prostate. If a person has high levels of protein in the blood, this is a sign of prostate cancer or enlarged prostate. But typical medical specialists need to make other tests to confirm it.

Urodynamic tests: This is a group of tests that show how the person's urine is released from the bladder and how it is stored in the person's bladder. Urodynamics is the measurement of the relevant physiological parameters of the LUT to assess its (dys)function [28]. Some tests include flow measuring, where a person pees in a special container used to calculate the urine flow. Another option consists of a physician placing a thin tube into the urethra after the person pees and measuring how much urine is left in the bladder.

Transrectal ultrasound: Transrectal ultrasound was first developed in the 1970s. Transrectal ultrasound-guided biopsy, under local anesthetic and prophylactic antibiotics, is now the most widely accepted method to diagnose prostate cancer [29]. A technician places a transducer into the person's rectum. While he moves it around, it shows different parts of the bladder and prostate on the screen while the transducer emits ultrasound waves. The obtained images show if there is a tumor in the prostate, or if the prostate is bigger than normal size for a man that age.

Biopsy: The transrectal ultrasound-guided systemic biopsy is the recommended method in most cases with suspicion of prostate cancer. Transrectal periprostatic injection with a local anesthetic may be offered as effective analgesia [30]. For this test, the physician while taking an ultrasound or CT scan inserts a needle into the person's prostate and takes a sample of tissue for further laboratory exams. In the laboratory, a technician can see under the microscope if it is cancerous.

Do you have any problems when urinating?

- *No.*
- *Yes, burning urination.*
- *Yes, frequent urination.*
- *Yes, it often forces me to urinate.*

Figure 3: An example question from the questionnaire of the ASPO web application.

3.2 A HEMS approach to detect problems with prostate

An average healthy person who drinks about two liters of liquid (e.g., water) goes to the toilet about six to seven times per day (in 24 hours) [31]. Abnormal behavior starts when this number is above seven or eight. We developed a HEMS-based system for detection of prostate problems, which enables the caretakers to detect abnormal urinating behavior based on the electricity consumption in the bathroom, associated with the bathroom visits. This approach may be appropriate for older men who also have dementia or problems with memory and thus do not count/remember the number of toilet visits, and may serve as an early warning system for prostate problems.

4 ASPO

The Application for sexually transmitted infection risk assessment (ASPO) [13, 32] was designed as an informative questionnaire, in which the algorithm assigns weights to different answers from the user. Then the application sums up all the weights and returns an answer in a natural language. Basically, it provides the user an overall risk report. The strong point of the application is that it selects the following questions based on the answers from the previous questions. For example, if a person answered that he/she did not have any symptoms, the application will not ask a question regarding particular symptoms in the following. The application also consists of user stories (personal stories from users who also had such symptoms and problems). The application is available as a web app [13], and a person can access it through a mobile phone, computer or tablet. Figures 3–4 show an example question from the quiz and the possible answers.

5 HEP-Y

The liver is an organ that processes nutrients from food and drink which we consume. It also has a function to filter blood. Due to various reasons (e.g., alcohol abuse, medication, or infection by the hepatitis viruses) the liver may become inflamed. The main problem for patients is that the symptoms are not present at the beginning of inflammation, resulting in many patients only seeking medical assistance when the condition has already progressed very far or is even fatal, and thus treatment is difficult.

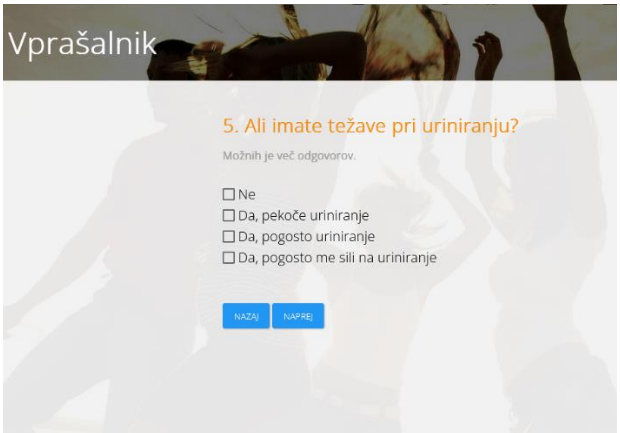

Figure 4: The user interface with an example question from the questionnaire of the ASPO web application (in Slovene).

To inform the general public about liver issues, the researches have created a platform called HEP-Y (Application for Viral Hepatitis Infection Risk Assessment) [14]. The platform is a continuation of the ASPO platform research [13]. As ASPO, HEP-Y also implements questionnaires. For this purpose, it uses a special data structure called a queue. Every question has an assigned id and an order property. When the user begins answering questions, the platform constructs a priority queue based on this order. Each question includes several (possible) answers. Every answer also includes a set of references to the questions that should not be provided to the user if he/she chooses this answer. For example, if the user selects an answer with reference to question no. 3, the system removes question no. 3 from the queue [33]. This approach allows the user to reach the risk assessment in the most straightforward and user-friendly way. A screenshot of the platform is shown in Figure 5.

6 Conclusion

We presented the most relevant applications available on the Insieme platform. This included the Android application for elderly, Senior Helper, which is fast, responsive, and easy to use. A HEMS-based approach for detecting problems with prostate was also presented. Finally, we described the ASPO and HEP-Y applications that implement questionnaires and share similar algorithm for generating questions. The ASPO web application estimates the risk of a person having a sexually transmitted disease, while HEP-Y does it for hepatitis. Overall, we believe that the Insieme platform has a potential for disseminating information about a large variety of health-related applications developed by several academic and private entities.

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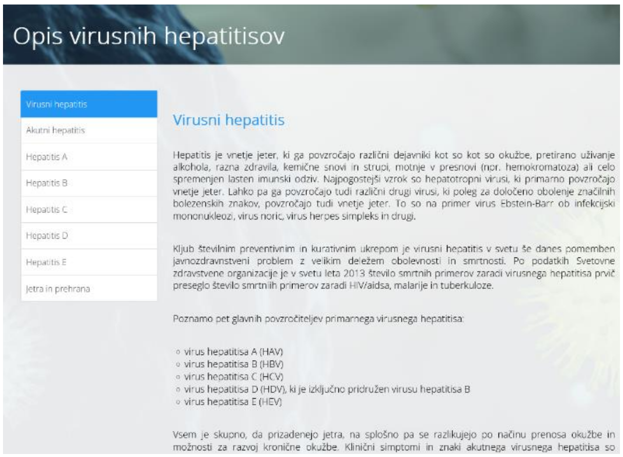

Figure 5: A screenshot of the HEP-Y platform (in Slovene), describing different types of hepatitis.

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