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MOBILE SYSTEMS

A Systematic Review for Mobile Monitoring Solutions in M-Health

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Abstract A systematic review allows us to identify, assess, and interpret all possible relevant work associated with a question in particular or the subject of an area. Different authors can use several methodologies to learn about research related to their own research in different fields. The main objective of this review is to identify work, research and publications made in the field of the mobile monitoring of patients through some application or commercial or non-commercial solutions in m-Health. Next, we compare the different solutions with our solution, MoMo (Mobile Monitoring) Framework. MoMo is a solution that allows for patient mobile monitoring through mobile phones and biometric devices (blood pressure meter, glucometer and others). Our systematic review is based on the methodology of B. Kitchenham. She proposed specific guidelines for carrying out a systematic review in software engineering. We prepare our systematic review base in the selection of primary and secondary research related to mobile monitoring solutions following criteria with a specific weight to compare with each part of our research.

Keywords Mobile monitoring · Systematic review · Ubiquitous computing · M-health

This article is part of the Topical Collection on *Mobile Systems*

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Introduction

Global behavior change as a means of treating diseases has been a widely discussed topic in recent years. Many studies have been conducted in the hope of providing a more manageable life to patients and enabling the ill to continue carrying out their daily activities. This is no longer an exclusive activity of the medical and healthcare field and has become a multidisciplinary research field. New proposals have been initiated to change the way in which health services are provided to patients.

The evolution of different technological devices has become integrated in the treatment and follow-up of diseases. The extensive integration of mobile devices, allowing for high technical characteristics and wide communication, has emerged, permitting a wide range of activities that include greater functionality than the purposes for which they were initially developed.

We have developed a mobile monitoring application. This application is generic, adaptable, remote and mobile. This application is ***generic*** because it allows for the development of applications for multiple diseases following the conceptual design of the developed *framework*; ***adaptable*** because it offers services tailored to each type of disease and personalizes the user's characteristics, making the interaction more transparent; ***remote*** because the medical staff can be aware of data obtained by the patient biometric devices through the mobile device in a non-intrusive manner; and ***mobile*** because development is based on the integration of small, portable and wireless devices. This application provides greater autonomy for the patient.

On the other hand, a systematic review allows us to identify, assess, and interpret all possible relevant work associated with a question in particular or the subject of an area. For this review, we will use some techniques or protocols [1] that will

allow us to properly select primary and secondary research related to mobile monitoring solutions. The main objective of this review is to identify work, research and publications made in the field of the mobile monitoring of patients through a framework or application generators. Specific guidelines will be proposed to carry out the systematic review in software engineering.

The proposal is based on similar guidelines for researchers with the objective to re-use the knowledge and experience of a known and consolidated area of research. The main intention of the guidelines is to introduce the concept of a rigorous review of current empirical evidence to the software engineering community. There are several characteristics that differentiate a systematic review from a conventional literature review:

- **Definition of the review protocol**: This section will specify the question of the research being addressed and the methods that will be used to carry out the review.
- **Definition of the strategy of search**: The search strategy aims to detect as much of the relevant literature as possible.
- **Search for documentation**: This section is used by readers to assess the rigor and integrity of the documentation.
- **Explicit inclusion and exclusion criteria**: This section is used for each primary study for assessment (a systematic review is a secondary study based on primary studies).
- **Systematic reviews**: Specify the information that will be obtained from each of the primary studies, including quality criteria used to evaluate each primary study. A systematic review is a prerequisite for quantitative meta-analysis.

Definition of the review protocol

A review protocol defines the methods to be used to undertake a specific systematic review. A predefined protocol is necessary to reduce the bias of the researcher [1]. The following points are indicated in the guidelines for the development of a review protocol:

- **The research question:** The intent of the systematic review is to answer a question that identifies areas of future research activities. The question of research of this systematic review is as follows: ***Is possible the development of a framework that allows the generation of parameterized applications that facilitate monitoring through communication between mobile and biometric devices for the medical monitoring of patients?***
- **Definition of the search strategy:** Our search strategy is based on two evaluated aspects: mobile patient monitoring and the development of applications for mobile devices.
- **Search and data extraction:** The steps to follow for search and data extraction are based on the following steps: topic selection, search for articles with titles related to this topic, reading of summaries (abstracts) and keywords, selection of primary studies and comparative analysis of primary studies.

– *Topic selection*: We select the topic issues concerning the development of mobile applications, framework solution, mobile monitoring and patient monitoring. We used the following search query:
– *(((mobile monitoring OR medical systems) AND (((framework OR mobile application OR software architecture) AND (design patterns AND design guide)) AND mobile health) AND (biometric devices OR human sensors devices))*
– *Search for articles with titles or abstract related to the search query*: We have included topics related to the generation of applications for mobile devices that facilitate the monitoring and patients control's.
– *Reading summaries (abstracts) and keywords*: We have read the abstracts and keywords related our search query for the selection of primary studies. The keywords selected for our search are: framework, application generators, mobility, design patterns, design guides, software architecture, monitoring. They have been included written in English and Spanish studies.
– *Selection for primary studies*: Studies or documents that similar to the study area and search query were read and categorizing by keywords.
– *Comparative analysis of primary studies*: We have evaluated each of the items compared with the proposed development of these articles. We have been extracted knowledge that differentiate the work done with the framework developed.

The mains list of databases for our search are:

- IEEE Xplore (http://www.computer.org)
- ACM (http://portal.acm.org)
- Portal de SpringerLink (http://www.scopus.com)
- ELSEVIER (http://elsevier.com/)
- SCOPUS.

We have also evaluated articles in congresses and conferences on topics of AAL (Ambient Assisted Living), mobile application development, mobile communication, among others. When finally, we select the primaries studies, we define criteria for the evaluation of some aspect explained in section 2.1.

Criteria of evaluation

For the analysis and evaluation of each of the related works, we have defined a set of criteria that will enable us to assess and locate aspects of design, adaptability, communication, security and costs in each research.

The selection of criteria has been made regarding the reading of all selected as primary school paper. After selected the papers that were to analyse the most relevant criteria to be defined as starting criteria. Later a group of four evaluators was organized. Each of these evaluators proposed a list of related software development area (we started from the basic list comparative studies to evaluate software solutions) criteria.

These criteria were compared between all evaluators and criteria were selected in common that were linked to the criteria initially proposed in the basic list. The evaluation criteria for each evaluated work are:

- **Design**
- ***Cohesion***: The way in which we physically divide system parts (particularly those regarding the structure of the problem) can significantly affect the structural complexity of the resulting system and the total number of intermodular references. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- ***Coupling:*** Highly "coupled" modules will be linked by strong interconnections, loosely coupled modules will have few weak interconnections, and "decoupled" modules will have no interconnections between them and will be independent. "Coupled" is an abstract concept that indicates the degree of interdependence between modules. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- ***Usability:*** The usability of a system has a component functionality (functional utility) and another based on how users can use this feature. This component is what interests us. Usability can be defined as the extent to which a product can be used by users to achieve specific objectives with high of effectiveness, efficiency and satisfaction in a specified context. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) 2 and Low (BJ) = 1.
- **Adaptability**
- ***Change and adaptive capacity:*** These allow us to know the ability of an application to adapt to changes occurring in the environment, that is, the ability of applications to evolve over time. This is the ability to adjust to other changing needs relative to the initial idea of the application's implementation. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- ***Migration of the domain application:*** Along with the evolving capacities, this is an important aspect to evaluate. This is simply the ability to adapt to the initial proposal when used in other areas deferens to the initially developed. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- ***Technological Migration:*** The development of an application within a particular environment must be able to continuously adjust to technological changes that occur continuously, especially when developing applications for mobile devices, where technological advances in software and hardware constantly occur rapidly. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- **Communication**
- ***External communication or data transmission:*** Data transmission is one of the most important aspects because it involves response time, type of communication, functional time of the device in which the mobile application is installed and, importantly, the security of the data to be transmitted (these criteria will be evaluated as a separate criteria). The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.

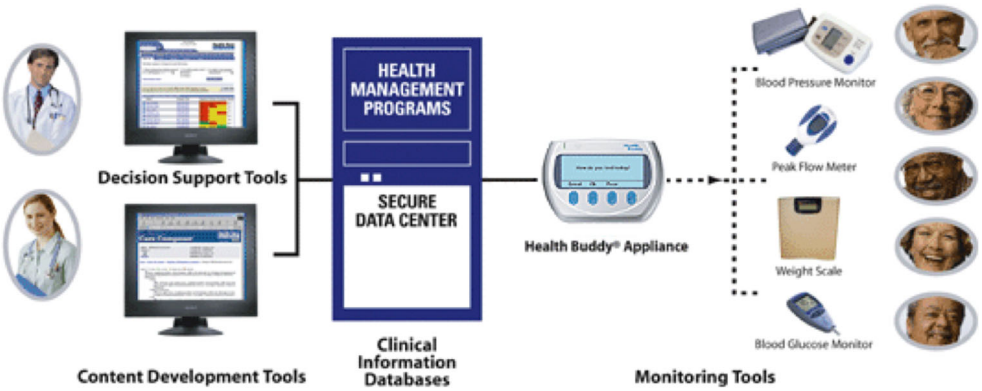

Fig. 1 Health buddy system functionality

Fig. 2 AirStrip patient monitoring functionality

- **Security**
- ***In data treatment:*** Treatment of patient data is one of the main drawbacks when developing such applications. In this approach, the aspects related to the private processing of these data are evaluated, following guidelines for the protection of the data used. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- ***In data transfer:*** Data transfer between devices is a question that originates from different areas. One involves the certainty with which the data is transmitted, that is, maintaining the integrity and avoiding the possibility that these data are lost in transit or captured by others. There are various computer techniques for maintaining a high degree of security in data transfer. The following abbreviations and weights have been used for these sub-criteria: High (AT) = 3, Medium (MD) = 2 and Low (BJ) = 1.
- **Costs**
- ***Implementation:*** When implementing the software architecture, the cost that entails its development must be taken into account, that is, we must know in advance what type of handset will be used and what platform it will run**.** The following abbreviations and weights have been used for these sub-criteria: High (AT) = 1, Medium (MD) = 2 and Low (BJ) = 3.
- ***Maintenance:*** Beyond the economic costs assessed in the previous opinion, there is the cost of maintenance. This cost refers to the effort it takes to update, change or improve the initial or other settings in the same environment with the new requirements proposed. The following

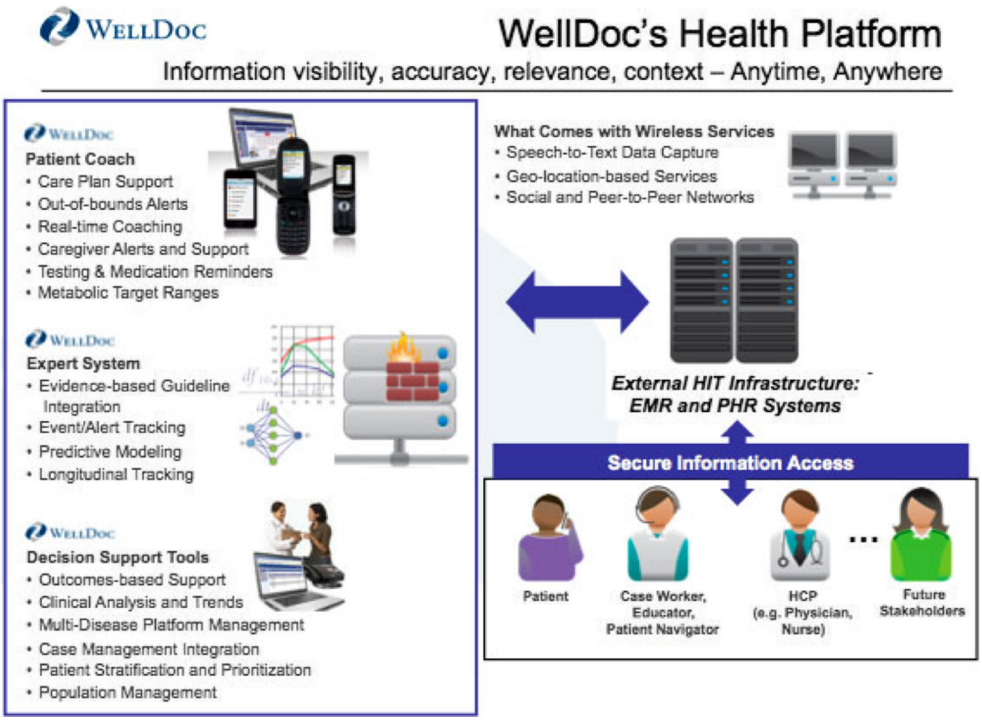

Fig. 3 High-level of WellDoc architecture overview

Fig. 4 Functional diagram of SenSAVE

abbreviations and weights have been used for these sub-criteria: High (AT) = 1, Medium (MD) = 2 and Low (BJ) = 3.

Patient mobile monitoring review

This research has brought with it the creation of different technological platforms that have offered a timely solution to problems of health care, among which we can find:

Health Buddy System [2]: This is a system that provides health monitoring of patients by reducing the chances of hospitalization. In Fig. 1, the application communicates with the patient at home to provide care. Every day, patients respond to a number of questions regarding their health and well-being using the simple Health Buddy application. The data are sent over a telephone line or an Ethernet connection to a secure data center; data are available for review on the Health Buddy website.

AirStrip Patient Monitoring: This is a software platform with a vision of sending critical patient information securely and directly from the monitoring systems of the hospital bedside devices and health mobile clinical records [3]. AppPoint was also designed to solve the key challenges in the development of software for mobile phones, such as the development of native applications that provide rich user-experience requirements, while at the same time being able to scale and adapt to an ever-changing world of operating systems and mobile devices. This application has been developed for devices such as iPhone, iPod and iPad. As shown in Fig. 2, stored information is related to values obtained from electrocardiograms, vital signs, medication, laboratory results, and allergies, among other lists.

WellDoc: This is an application designed as a monitoring service for diabetics [4] that is integrated with Ford Sync and designed for iOS, allowing for monitoring the current condition of a patient through the manual entry of food and glucose. Thanks to its integration with Sync, it can

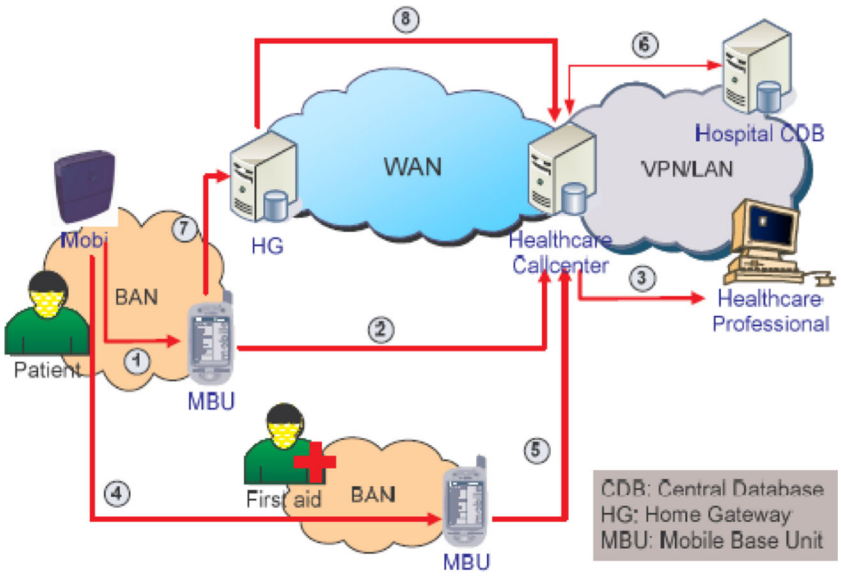

Fig. 5 Transmission of vital signs - MobiHealth system

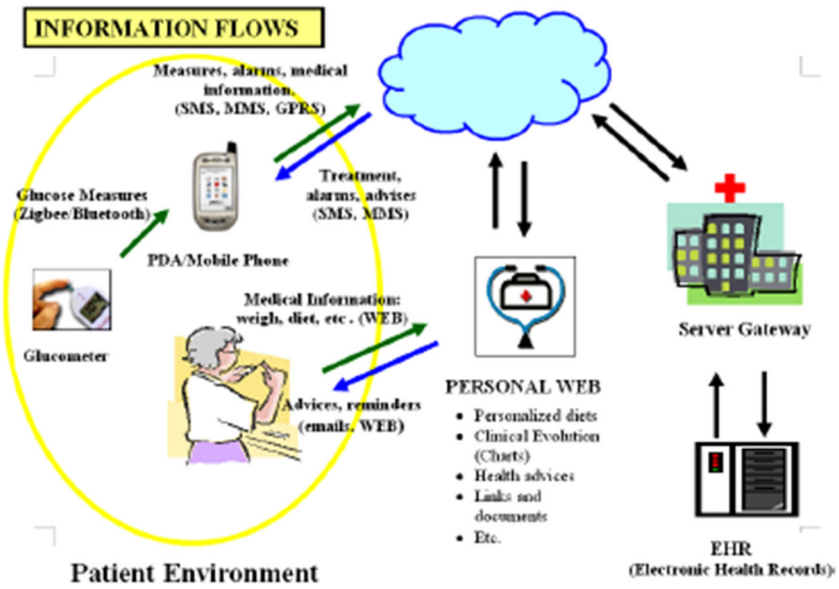

Fig. 6 Information flow in eDiab

synchronize with this service via Bluetooth, allowing it to detect whether we have introduced records recently and, through a set of questions (Yes or No), make sure see if our blood levels are correct. It will suggest the next recommended action to take, or in extreme cases, will send a SMS to the contact that we have previously selected for emergencies, with the option of sending another message to go home as a confirmation (see Fig. 3).

METABO [5]: This is a system for the monitoring and management of diabetes that aims at recording and interpreting the context of the patient, as well as supporting decisions for the patient and the physician. The METABO system consists of (a) a mobile device of the patient (PMD), (b) different types of discrete biosensors, (c) a central subsystem (CS) located remotely in the hospital and (d) the control panel (CP), from which doctors can monitor their patient and also access the CS. METABO provides a surveillance system that facilitates effective and systematic recording of diet, physical activity, medication and medical information (continuous and discontinuous glucose measurements).

Ambulation [6]: This is an important tool for assessing the health of patients suffering from chronic diseases that affect mobility, such as multiple sclerosis (MS), Parkinson's and muscular dystrophy, through the assessment of the way in which they walk. **Ambulation**

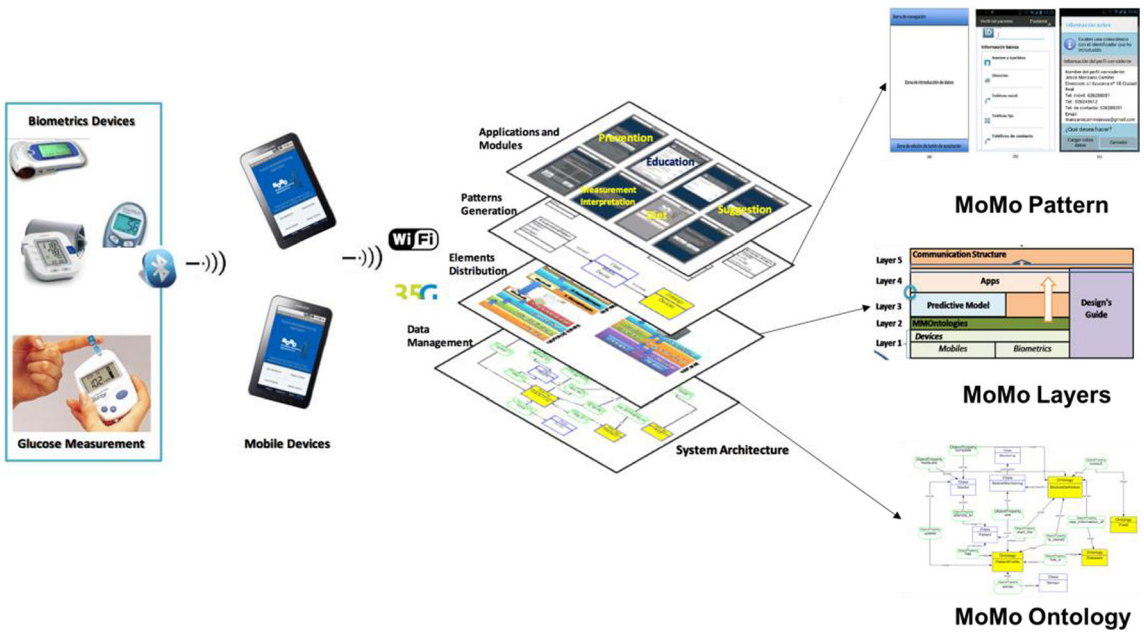

Fig. 7 MoMo architecture and the relation between each element designed

Table 1 Descriptive comparative all related work of section 3 with MoMo

Related work of section 3	Comparative with MoMo
Health buddy system	Aiming for minimal interaction with the mobile device, all processing is performed using the initial capture of vital signs. It requires minimal interaction in order to help the patient, providing the user with replies and messages automatically.
AirStrip patient monitoring	This avoids relying on a platform in particular and includes additional information of the patient as a result of tests and examinations in general. Initially, we developed software for an Operating System in particular, the most widespread Android, allowing others to adapt it to another with minimum changes.
WellDoc	This application, implemented regardless of the disease to control, has been developed to interact with a wide range of diseases that can be monitored using vital signs. We will implement specific case studies to meet the desired functionality.
METABO	An architecture software that enables the monitoring and control of patients independent of the type of disease being treated is developed, respecting each of the elements of the software architecture developed using the functional requirements initially raised.
Ambulation	The patient monitoring application runs without interfering with the activities of the patient and the interaction with the mobile device. This makes functionality transparent for the user and minimizes the interaction.
SenSAVE	It proposes communication between multiple mobile and biometric devices based on a specific patient profile and the disease being treated. This vital signals control information is generated for patients.
U-Health	It facilities continuous monitoring of the patient; it offers control whenever the values of the measurements of vital signs are obtained. The user can generate recommendations associated with this measurement by offering an environment of continuous monitoring.
Healthwear	Avoiding the use of equipment in the body, it is only necessary to have a biometric device to obtain vital signs. The use of the equipment in the body is very intrusive. We want to minimize the alteration to the daily lives of patients, minimizing the intrusion.
MobiHealth	This system proposes only a representation of vital signals received by mobile devices, creating data files of the representations of vital signs resulting from the mobility of users (patients) in heterogeneous environments. Our proposal is not based on a representation of vital signs but rather on the control and interpretation of these.
eDiab	This includes aspects of the control of patients, with the difference being that our proposal is based on the definition of the profile of the patient, This patient profile, associated with measurements obtained from an illness, governs the behavior of the final application.
LATIS Pervasive Framework (LAPERF)	This is based on a description of the activities associated with the location of the patient; communication is established between the patient and the medical specialist. The structure of the LATIS Pervasive framework is in the lower level of the Access Device Manager, where all devices that access the framework (Smartphone, PDA, computers desktop, etc.) are located. The security and Privacy Manager is responsible for unauthorized access by defining the system security policies.
MAHI	This does not intend to create a website but contains information in the mobile device of the patient, transmitting data to and from a remote server. This information is generated based on the activities of the patient and the measures obtained from biometric devices. The mobile device can be used in two roles: the patient role, specifically for the control and use by each patient, and the medical role, where doctors have access to the information of all patients assigned to them.

Android and Nokia N95 is a monitoring system of mobility that uses mobile phones to automatically detect the mobility of the user mode. The interaction required by the user with the phone involves turning it on and keeping it with him throughout the day, with the intention that it could be used as the patient's everyday mobile phone

Table 2 Comparison of defined criteria for evaluating the developed applications

Propouses	Desing						Adaptability								Communication		Security		Costs			
	Cohesion		Coupling		Usability		Change and Adaptive Capacity		Migration and Domain Application		Technological Migration				External communication or data transmission		In data treatment		In data transfer		Implementation		Maintenance	
Health Buddy System	MD	2	AT	1	MD	2	AT	3	AT	3	MD	2			MD	2	MD	2	MD	2	AT	1	AT	1
AirStrip Patient Monitoring	MD	2	AT	1	AT	3	MD	2	AT	3	MD	2			AT	3	MD	2	MD	2	AT	1	AT	1
METABO	MD	2	AT	1	MD	2	BJ	1	BJ	1	MD	2			MD	2	BJ	1	MD	2	AT	1	AT	1
Ambulation	AT	3	MD	2	MD	2	AT	3	MD	2	MD	2			AT	3	BJ	1	AT	3	MD	2	MD	2
SenSave	MD	2	AT	1	MD	2	MD	2	MD	2	MD	2			BJ	1	BJ	1	BJ	1	MD	2	MD	2
U-Health Healthwear	MD	2	AT	1	MD	2	MD	2	AT	3	MD	2			AT	3	BJ	1	MD	2	MD	2	MD	2
MobiHealth	MD	2	MD	2	AT	3	AT	3	MD	2	MD	2			AT	3	BJ	1	MD	3	MD	2	MD	2
eDiab	MD	2	MD	2	MD	2	BJ	1	BJ	1	BJ	1			MD	2	BJ	1	MD	2	MD	2	MD	2
LAPERF	AT	3	MD	2	MD	2	AT	3	MD	2	AT	3			AT	3	BJ	1	AT	3	MD	2	MD	2
MAHI	MD	2	MD	2	MD	2	BJ	1	BJ	1	BJ	1			MD	2	BJ	1	MD	2	MD	2	AT	1
MoMo	AT	3	MD	2	AT	3	AT	3	AT	3	MD	2			AT	3	AT	3	AT	3	MD	2	MD	2

for voice, data and other applications while Ambulation is running in the background. The phone loads the information gathered from the mobility and location onto a server. Then, it displays data through an intuitive and secure Web-based service, which is available to the user and any family, friends or caregivers.

SenSAVE [7]: A system developed for the mobile monitoring of the parameters of vital signs. It measures the blood pressure and pulse of people with cardiovascular problems in real time. In summary, this system studies the way that information, dialogue windows and the alarm function are presented, proving the usability of mobile devices (see Fig. 4).

U-Health [8]: A mobile system of health care designed and developed with the capacity to measure several physiological signs in real time. This system performs an analysis of data from vital signs via a mobile phone and transmits these data through a network of wireless sensors. The mobile phone performs some simple data analysis first and then immediately transmits these signals to a server for diagnosis at a doctor's hospital. The application of wireless technology in a diagnostic system allows the patient to be monitored anywhere and at any time and cannot be hampered by the physical constraints imposed by cables.

Healthwear [9]: This application addresses research that allows for the monitoring of health conditions through electrocardiograms, heart rate, the saturation of oxygen, impedance pneumography and activity patterns. A new design was made to increase the patient's comfort during daily activities. Fabric is connected to a portable electronic unit of the patient (PPU) that acquires and develops the signals from the sensors. The PPU transmits the signal to a central site for processing through the use of GPRS wireless technology. This service applies to three different clinical settings: rehabilitation of cardiac patients after an acute event, the program of early discharge of patients with chronic breathing and the promotion of physical activity for cardio-respiratory stable outpatients.

MobiHealth [10, 11] : The development of a framework that represents the vital signs of patients was proposed; see Fig. 5. This framework facilitates the storage of existing different notations to represent vital signs (FDA, CEN, HL7, DICOM). For this purpose, the designers proposed an XML schema to define the framework of the representation of vital signs by specifying a large number of these representations.

eDiab: Fernández-Luque [12] developed a system for monitoring, assisting and educating people with diabetes called eDiab. A central node (PDA or cellphone) provides health information, health tips, alarms and reminders. A glucose sensor is connected to a central node wirelessly (via Bluetooth/ZigBee) and the communication between the central node and the server is established via a GPRS/GSM connection. Finally, a subsystem for health education sends medical information and advice, such as reminders of treatments. As shown in Fig. 6, the eDiab project is designed with a multidisciplinary view: assistive technology, telemedicine and diabetes education. It is divided into two subsystems, one for the monitoring and control of diabetes and one for health education.

LATIS Pervasive *Framework* (LAPERF): Tadj [13] with LATIS Pervasive Framework (LAPERF) provides a framework of base and automatic tools for the development and implementation of applications of pervasive computing. Its main application has been used for health care applications. With it, we sought for better integrity in pervasive systems.

MAHI: Mamykina [14] developed MAHI (Mobile Access to Health Information), an application that monitors patients diagnosed with diabetes using acquired skills of reflective thinking via social interaction with diabetes educators. MAHI is a distributed mobile application that includes a conventional meter (LifeScan - OneTouch Ultra), Java (Nokia N80)-enabled mobile phone, and a Bluetooth adapter that connects to the phone and the glucometer. Through this, levels of glucose in the blood and changes related to diabetes, such as questions, problems and activities of interest, are recorded using images and sounds captured by the mobile phone.

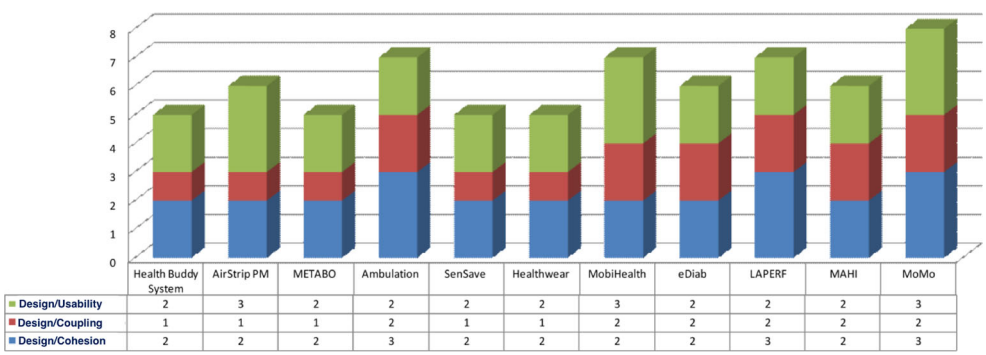

Fig. 8 Level design of the analyzed applications

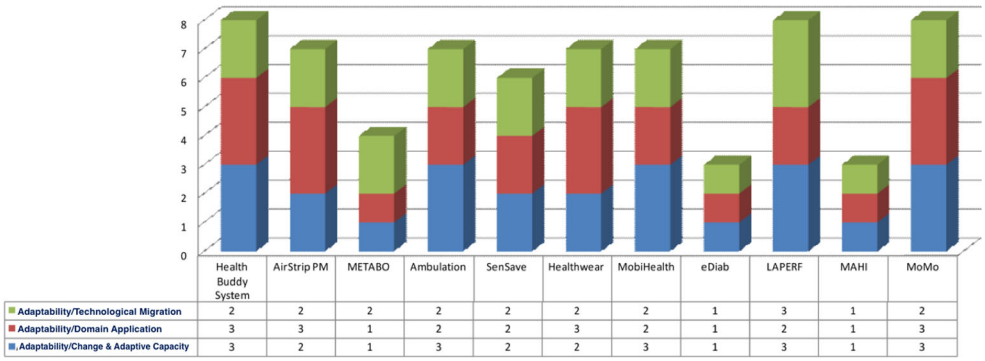

Fig. 9 Adaptability of the analyzed applications' levels

MoMo framework: Solution for the development of mobile monitoring applications

We have designed a guideline-based solution that allow the development of mobile software architectures through a Mobile Monitoring Framework called MoMo [15]. MoMo offers a solution to facilitate the development and implementation of software architectures and it will facilitate the performance of the activities of people. MoMo implements a solution for devices as mobile phones, PDAs, tablets and any mobile device. The main objective of the framework is to allow the classification, processing and data recovery from generated data of patients to observe fluctuations of normal values of vital signs in accordance with the disease suffered. These values come from mobile devices and biometric measurement devices, which enable the gathering, processing, and storage of data, to be used by other applications, for example, to create educational material, and for prevention and patient monitoring.

The framework defines a complete communication structure (MoMO Layers), a specific ontological classification (MoMo Ontology) [16, 17], and a structured pattern definition (MoMo Patterns). Each of these elements allows the integration and creation of different components necessary for the generation of final applications as is shown in Fig. 7.

With this solution, doctors could examine patients only by consulting their profiles, including the measurements history, generation of statistics (charts) with the patient data [18]. After checking, the application sends the results to the mobile device and the treatment is updated. The treatment can be specific information regarding the disease, generation of diets, intake of medicines and self-control services among others.

We can educate these people about their disease; therefore, an educational component being developed to allow knowing more about the disease and how to make their daily routines more comfortable. We have a system architecture that allows the patient mobile monitoring through mobile devices. This software architecture is developed through the definition of specific modules; these modules have been developed with a set of patterns that define the users interfaces and the module functionality. We have a layer distribution to send and receive data through mobile devices.

Analysis of evaluated applications based on the criteria

Some applications presented have any problems with aspect related to the design, content and communication technologies. In Table 1 we descriptive comparative all related work of section 3 with MoMo.

To analyze the studied applications, we will rely on the description and weight of the criteria and sub-criteria defined previously. These criteria allow us to analyze this block of related works, which have been classified as applications developed by companies or private developers. In Table 2, we

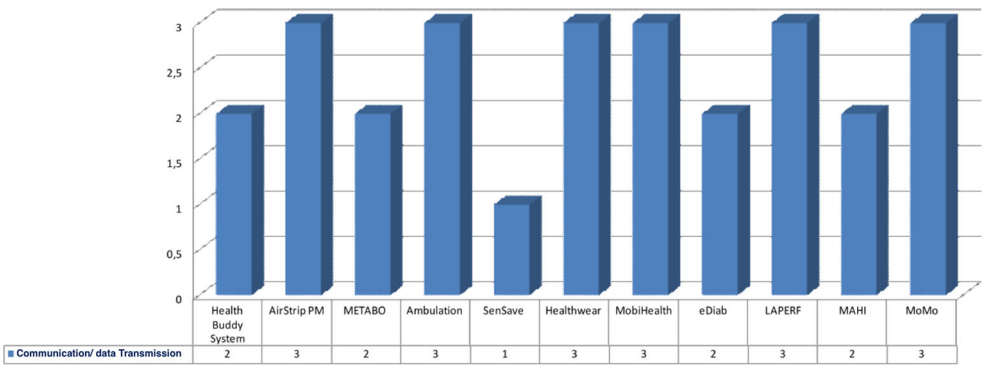

Fig. 10 Level of communication of the analyzed applications

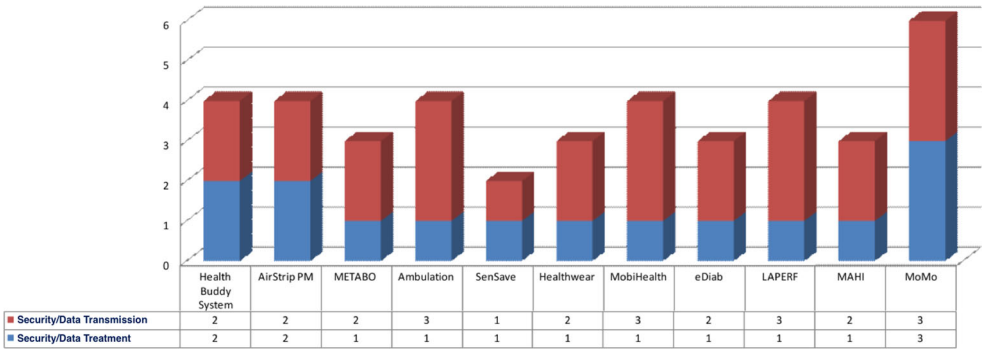

Fig. 11 Security level of the analyzed applications

show the comparison of defined criteria for the evaluation of applications previously analyzed.

Design: In Fig. 8, these criteria have been tested according to the functions specified in the documentation presented in each developed application. Evaluated applications possess a mid-grade according to the design criteria. The link sub-criteria have long been valued as the lowest criteria in the design, giving more importance to usability. MoMo offers design results in accordance with the criteria of cohesion, coupling, and usability. A generalized definition of software architecture that minimizes coupling but maximizes cohesion is found. With regard to usability, our software architecture is easily usable because it tries to minimize unnecessary interactions with the user.

Adaptability: Regarding the degree of the adaptability criteria and their sub-criteria, Fig. 9 shows the evaluation of each application analyzed in this article. The adaptability of the analyzed applications goes hand in hand with the design criteria; note that it values these criteria with a mid-grade. Most of the applications can be adapted to cover other existing technological aspects and other application domains. MAHI is the application with the lowest known degree of adaptability, while the Health Buddy System has greater adaptability. MoMo offers a high level of adaptability regarding both hardware and software technologies.

- **Communication:** In Fig. 10, we evaluated applications using any communication technology. These include those offered by the networks of mobile telephony, Ethernet, WiFi and others. SenSAVE is the application with the lowest degree of communication (data transmission) presented; it did not use existing communication technology at the time of the analysis. MoMo still offers a high level of communication and data transmission.
- **Security:** Another aspect of the applications discussed is that of security, as shown in Fig. 11. Only two of the applications define the treatment of patient data. They specify any protocol or guidelines followed to maintain the privacy of these data. On the other hand, the safety in data transfer is an aspect that has been moderately referred to, as some applications leave this aspect to communication technology if they use this technology while others do not consider it necessary. MoMo offers greater safety compared with other proposals.
- **Costs**: Deploying the applications mostly presents both an average maintenance and implementation cost, as shown in Fig. 12. This is because they are very dependent on the technologies for which they were developed. It is difficult to decouple these criteria because most applications are developed for specific platforms and technologies. A mid-grade weighting further minimizes the costs of changes that a person would want to perform in the future.

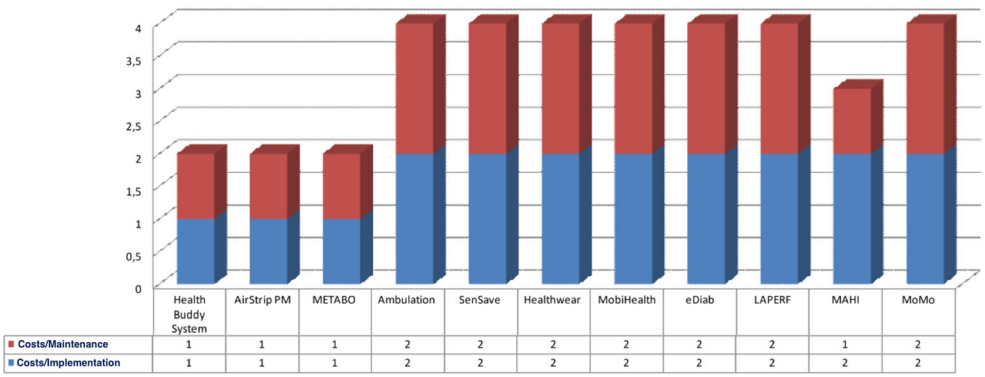

Fig. 12 Costs of the analyzed applications

Conclusions

This paper presented the different contributions made by various researchers in the field of patient monitoring, which were either mobile or similar to this type. A number of evaluation criteria have been defined to determine the level of integration, composition and functioning of each proposal to find deficiencies and to better understand the scope of development. The criteria were assessed objectively, based on the specifications of each study. Some of the documented proposals did not explain the retail distribution of their elements, which makes us think that they were developmental.

We note that although a significant amount of research has been developed, all of it was developed while focusing on particular settings to solve particular situations. This can be observed by some studies having an imperative to lifetime, which limits the concept of "multi-monitoring" that we are seeking in this article. This leads us to develop a software architecture based on the framework that is not dependent on a field of study in particular but can be adapted to different areas.

We seek to facilitate multiple monitoring systems, the integration of different types of diseases or conditions, and monitoring using various mobile devices and biometrics.

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