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Mobile context awareness for managing context healthcare data: a survey

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ABSTRACT

Context awareness was introduced in several fields in routine human activities. Healthcare systems are the most important ones among context-aware applications. The existence and awareness of the context made mobile device users conscious of physical environments or situations. Smart devices, armed with multiple sensors, can sense and react based on their environment, and become context-aware agents. Smart devices are ideal assistants that provide accurate solutions for the critical aspects of healthcare, and medical staff works as well as the closer up to date state of the patient. In addition, hospital's staff members can communicate with the patients reliably and suitably by using smart devices offers. But the applications of healthcare have lack of standardization in handling the context and the perceived sensors data. To perceive the context, we can rely on sensors, which may be physical or virtual. More generally, our research will concern on contextual applications of healthcare that aroused increasingly important interest. To improve the user experience, the advantage of contextual data is aimed to take by context-aware applications. A useful tool to reason about context is proved by using case-based reasoning (CBR) and fuzzy techniques to deal with lack of standardization in handling the context and uncertainty of data. On the other side, it could be interesting to analyse how context reasoning relates to CBR. To assess how CBR can be integrated with contextual information is the primary concern of our research study. So, in this paper, we concrete on the mobile application of healthcare that deals with contextual data by using CBR techniques to analyse the context data. It gives a perfect situation in a right way or prediction for providing accurate solutions for the critical aspect of healthcare and medical staff work. It can overcome the problem of the standardization for dealing with context data.

Keywords: case-based reasoning (CBR), nearest neighbor algorithm (NNA), geographical positioning system (GPS), context data management (CDM), profile translation based proactive adaption using context management (PTPACM)

1. INTRODUCTION

Context-aware computing is a rapidly growing field of ubiquitous computing, which is concerning the adaptation of mobile application to the changes of surrounding environment and situations. Context-aware is a rich field of research involving communication engineering, computer science, information technology, and more precisely mobile communication. Also, the context-aware computing has significant uses in human-computer interaction (HCI), wearable computing, augmented reality, data management, feature extraction, artificial intelligence (AI), and decision-making. For many years the notion of context has been important in the conceptualization of computer systems. However, providing its constructive and precise definition proves to be a non-trivial task. The situation of an entity can be characterized by using any information this known as context. The interaction between a user and application is an entity can be a person, place, or object, also involving the user and applications themselves [1].

For mobile handheld devices, there are different sources of contextual information that are presented, as shown in in Figure 1. The information sources include sensors [2], device applications, user's goals, and information gained via connecting infrastructure [3-5]. This is considered as one approach for categorizing context. Also, there are several other approaches have also been Presented for instance by Schilit et al. [6], Dix et al. [7], and Pascoe [8].

Context information has many possible ways to categorize [9-12]. Operational and conceptual categorizations are two kinds of categorization methods, which will be discussed in this paper. Based on how context is obtained. Operational categorization is the categorization that related to the way information is obtained, modeled, and treated. Contexts of different types differ substantially in their dynamic and reliable methods. Feng et al. [11] made another context categorization at a conceptual level, which differentiates user-centric context from environmental context [13].

Figure. 1 For mobile devices the contextual information sources [2]

After the in-depth analysis of literature, there are four main requirements (4R) for every mobile context-aware system that should be met to confirm its high quality and to cope with such drawbacks. These four requirements are as follows [1]. Frist, intelligibility is the operation of the user should be allowed to understand and modify. Second, robustness is the changing user Traditions, or environment conditions should be adaptable, and uncertain and incomplete data should be able to handle. Third, privacy means sensitive data should be assured that data are secured and not reachable to the third party for the user Privacy that his or her. Finally, efficiency should be efficient both regarding resource efficiency and high responsiveness.

There are many different approaches and frameworks resulted from research on context-aware systems. However, the diversity of the field, further development still need on the used hardware. This is especially true on the ubiquitous mobile devices that used for context-aware applications. New solutions need to be provided for today's mobile computing (e.g., smartphones or tablets) for all of the challenges to provide full support. Context modeling and classification not only the issue need to be addressed, but it is more important to create context-based reasoning layer**.** There are five most severe challenges. The first is the energy efficiency. The mobile device battery level decreases very rapidly when most of the sensors all the time are turned on. The usability of the system and ecological aspects have impacted regarding energy saving. The second is the data privacy. The reasoning of context should have performed by the mobile device itself. Because sending information like location, activities, and other private data to external servers, do not want by users. The third challenge is the resource limitations. The context-aware system should be transparent to the user and other applications, so it has to consume as low CPU and memory resources as possible, although mobile phones and tablets are becoming computationally powerful. Fourth, system responsiveness is considered as a challenge for the context-awareness. In processing contextual data, no delays are admissible because of changes very fast – in mobile environment context. Finally, context data distribution is the fifth challenge. The quality measures should be developed, and distribution methods designed for pervasive mobile environments to fit unstable and dynamic characteristics of the network, because a huge amount of contextual information has produced by many devices [1, 14].

To be aware of the context and assess situations is the ability of the core of the surrounding intelligent system**.** To assessing situations by being context-aware, we assume that CBR supported by a rich knowledge model is a favourable approach. A number of challenges are posed in an inherently dynamic environment for using CBR in an online fashion. There are four main challenges [15]. Frist, the initial cases should acquire. Second, the initial cases are coping with the enormous number of case being constructed during run-time. Third, is to know when to initiate a cycle of CBR. Finally, knowing cases whether if correctly classified of the case or not.

1.1 Life-cycle of Context

The context information delivers to a context-aware system by a context information provider. As show in Figure 2 the main steps of context information are in life-cycle of Context.

- **Discovery of context information:** In this step, available context information providers are discovered by a context-aware system. There are two modes of the discovery either in a push or a pull mode can be performed.
- **Acquisition of context information:** context information is collected by a context-aware system in this step from the discovered context information providers and a context information repository is used to store context information for further reasoning.
- **Reasoning about context information**: in this step, applications are enabled by reasoning mechanisms to take the available context information advantage. Based on a single piece of context information or on a collection of such information they can perform the reasoning.

Figure. 2 Context life cycle

1.2 Healthcare context information model

1.2.1 Context information classification

By using a ubiquitous network (USN) and radiofrequency identification (RFID) system the healthcare context data obtained that is classified into seven different groups, and then the context data are arranged by group. The seven groups that healthcare context data is classified as the following:

a) Individual data

- Like name, age, sex, injection history, disease, disease history, family disease history etc.

b) Medical data

- Disease Data: hypertension, diabetes, cancer etc.
- Symptom Data: physical, emotional etc.
- Examination Data: hemoglobin reading, AST etc.
- Health Data: blood pressure, pulse rate etc.

c) Auxiliary data

- Biological data analysis, biological data management etc.
- management services

d) Location data

- Indoor, outdoor

e) Device data

- PC, IPTV, smart phone, biological signal detector

f) Activity data

- Sedentary, running, walking

g) Environmental data

- Indoor temperature, outdoor temperature, indoor humidity etc. [16].

1.3 Analysis framework of context in health care applications

They proposed a simple framework to analyze the use of context in health care applications, choosing three main axes to characterize context.

- **Purpose of use of context**

According to Dey et al. context is used in three main purpose cases. The first purpose is the presentation of information and services to a user. The second purpose is the execution of a service. Finally, tagging of context to use information for later retrieval.

- **Items for context representation**

It is possible to describe the items of context used through of the health care context-awareness projects. They identified three main classes to split items of context into: people, environment and activities.

- **Organization of context features**

The features of context complexity are highlighted in recent literature. The organization of the context should be in more sophisticated ways because Context representation is not only splitted [17].

This chapter is organized into five sections as follows. Section 2 introduces the Context-aware Architecture system. Section 3 presents the current retreaters work of some different applications of context-aware systems. In Section 4, we present the discussion and analysis. In Section 5, Challenges and futures trends of a context-aware system for health care. Finally, we present the conclusion and the future work in Section 6.

2. CONTEXT-AWARE ARCHITECTURE

As showing in Fig. 3, a layered framework is represented for context-aware systems. It is composed of the bottom to top by sensors, raw data retrieval, pre-processing, storage or management, and an application layer. The responsibility of a context management system is abstracting and combining the sensed data or raw data from sensors into high-level context, and then for the context-aware applications making it available [18].

Sensors are the first layer that responsible for retrieving raw data from the user environment (e.g., user device, social network, or user access network) by a group of sensors. The second layer is the raw data retrieval, which is responsible for requesting data from the sensor layer by using specific application programming interfaces or protocols. These queries must implement in a general way as far as possible, making it possible to exchange sensors (e.g., exchanging a radio-frequency identification system with a geographical positioning system (GPS)).

Reasoning and interpreting contextual information is the responsibility of the third layer that is known as pre-processing layer. Also, it is responsible for transforming the information from the underlying layer to a higher.

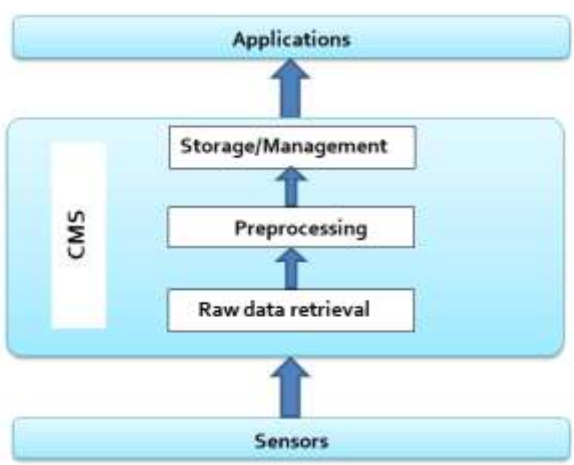

Figure. 3 A layered framework for context-aware systems

Abstraction level is responsible for transforming a GPS position to one such as at home or work. Not only sensed or deduced data have to be modeled, but also data describing them (e.g., accuracy and recall, or lifecycle information). Storage and management is the fourth layer that responsible for making the gathered data in an organized way that comes in two modes synchronously or asynchronously. It makes them obtainable to third parties' applications. In the first mode, remote method calls are used by the third-party applications to poll the server for changes. In the second mode, a specific event of interest and are notified by subscribing them to when the event occurs (e.g., by a call back). The fifth layer is the application that is responsible for implementation when the reactions to context changes (e.g., if illumination is bad showing text in a higher color contrast) [18].

2.1 The architecture of context awareness system

Furthermore, when designing context-aware systems, it is critical to determine the method of context-data acquisition because the architectural style of the system should be predefined at least to some extent. Baldauf and Chen [19, 20] presented how to acquire contextual information in three different approaches.

- **Direct sensor access**

  In the devices, the sensors locally built in. Thus, this approach is often used in this way. The desired information gathered and there is no need to add an additional layer for obtaining and processing sensor data because the client software directly gathered from these sensors. Due to its direct access nature, it cannot use for distributed systems because it is not suited, and it cannot manage multiple concurrent sensor accesses, which is considered as a lack of component capability.

- **Middleware infrastructure**

  Methods of encapsulation is used by Modern software design to separate business logic and graphical user interfaces. A layered architecture is introduced for context-aware systems by the middleware-based approach with the aim of hiding low-level sensing details. In this technique, the code of the client has not been modified anymore. So, it eases extensibility as compared to direct sensor access. Also, the reusability of hardware dependent sensing code it is simplified due to the strict encapsulation.

- **Context server**

  In this approach, remote data sources are permitted to multiple clients to access. An access managing remote component is presented as a distributed approach to extends the middleware-based architecture. To facilitate various concurrent access, data gathering by the sensor is moved to this so-called context server. Besides the reuse of sensors, the usage of a context server has the advantage of relieving clients of resource intensive operations [20].

During the last years, many layers have evolved for context-aware systems and frameworks. Most of them differ in functional range, location, layer naming's, the use of optional agents or other architectural concerns. Besides these adaptations and modifications, when analyzing the various design approaches a common architecture is identifiable in the modern context-aware applications. The low-level context is accepted as sensors context that is directly referred to raw data. The sensor is not only described as a physical device in context-aware applications, but also a data source for context representation that could be beneficial for it. Contextual information that collected may range in a broad sense regarding specification and representation of a phenomenon in real-world onto an entity in the cyber world. So, sensors can be categorized into three different types [21]. The first type is the physical sensors, which can capture physical activities, such as GPS to capture location and accelerometer for capture activity. The second type is the virtual sensors that imply a source from software applications and/or services. In addition, semantic data are obtained through cognitive inference (e.g., location info by manually entered place pinpoint through social network services or computation power of devices, etc.). The third type is logical sensors are defined as a hyped of physical and virtual sensors in addition to varied sources by user interactions (e.g., databases, log files, etc.) that we can obtain information.

The context has many forms we can deal with it. The context can be divided into the following:

- Device context: including net connectivity, communication cost, and resources, etc.
- User context: including profile, GP, neighbors, and social situation, etc.
- Physical context: including temperature, noise level, light intensity, traffic conditions, etc.

- Temporal context: including day, week, month, season, year, etc. [21].

2.2 Context-aware concept and case based reasoning

CBR is a technique that used to solve a new problem from user's past experiences. The cases are considered as those problems. The new case and older cases are performing similarities between them by the system which have happened or existed are defined as CBR completes a case. Four stages of CBR which are as shown in Figure 4 [22]:

- **Retrieve**

  The newer case is matched or similarities with an older case that taking in order.

- **Reuse**

  In the older case the reuse of information that is already existed to solve problems. Reuse will happen when the newer case has high similarity value to an older case. By that means, the similarity value calculation is needed to check which case has higher similarity with a new case.

- **Revise**

  If the older case does not have high similarity rate to the newer case Revise the suggested solution.

- **Retain**

  In another problem we keep the revised solution to be used [22].

The filtering the Enormous amount of contextual information that is available is the problem in most of the context-aware systems research, in such a way that the identification of important constellations of the contextual information is feasible, has not been thoroughly addressed. CBR is a favourable method for this. Adapting to new situations is performed by Case Based Reasoning [21-23] that remembering similar earlier experienced situations (cases). In large monolithic systems, CBR has historically been used. CBR has the capability of running on a small mobile device because it is a lightweight reasoning mechanism [21]. Two different parts of reasoning mechanism. Resides on the user's mobile device this is the online part and resides on the user's backbone system this is the off-line reasoning.

a) Online reasoning

In the context agent, The CBR mechanism is encapsulated. The dynamic structure of the contextual information available is maintained by the agent. There are much different and a very diffuse fashion from contextual information that can arrive, e.g., time is continually flowing into the system, whereas location might be pseudo-static. The values flowing into the system must be converted to discreet since CBR works on discreet cases. This is handled by the context agent, following the suggestion of Zimmermann [21, 22]. At certain time intervals, the contextual information is snapshot by the agent that takes, i.e., the state of the context structure, and stores them as cases.

b) Offline reasoning

The storage, indexing and searching for identifying situations are considered as the two main problems with the use of CBR. First and foremost is the problem of storing them, potentially vast, some cases constructed during run-time. The user will have personal persistence storage to solve this problem that available on the user's home network. For storing the cases, the storage will be used and will be synchronized when the user has an up-link. The large amount of data not only the problem it found another problem that is the indexing and matching algorithm used that arise from large amount of data

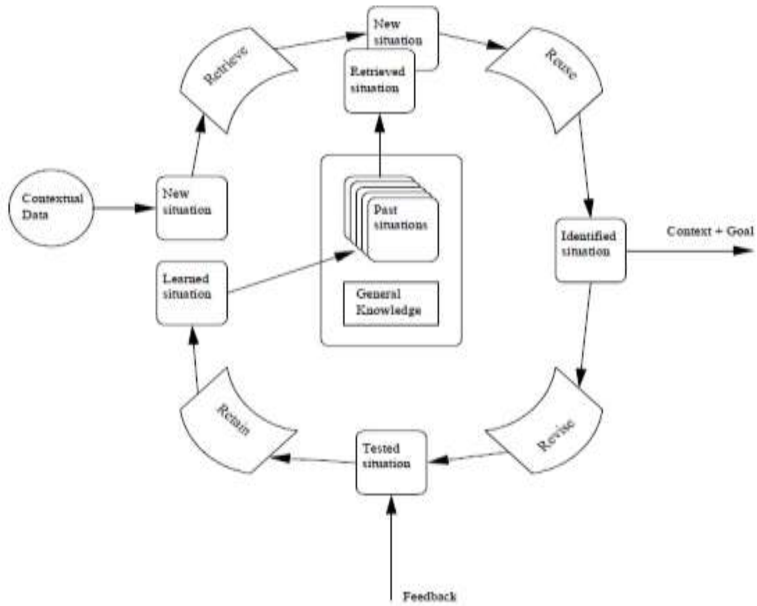

Figure. 4 The CBR cycle [22]

3. LITERATURE REVIEW

Two different categories of Context-aware sensing applications that classified as the following: personal/human-centric and urban including participatory/community/group or opportunistic. Device user is the point of interest in personal sensing applications. For instance, personal fitness log or healthcare reasons are considered an active research topic in this field for monitoring and recognition of user-related posture and patterns movement. On the other hand, multiple deployments of mobile devices are depended on participatory sensing to interactively and intentionally share, collect, and analyze of each local knowledge that is not solely based on human activity but also based on surrounding environment. The active participation is required by participatory sensing of each user into a gathering of sensory data to result in large-scale phenomena, which can be difficulty measured by a single participation. In this paper, we concentrate on personal/human-centric.

3.1 Application of context-aware of healthcare

Buttussi et al. [24] proposed for fitness training A context-aware and user-adaptive wearable system In the last years, with the aim of improving user's health for fitness applications, wearable devices have been increasingly investigating by researchers as well as companies, regarding cardiovascular benefits, loss of weight or muscle strength. User interaction and artificial intelligence capabilities are usually very restricted regarding some devices that are already commercially available such as dedicated GPS devices, accelerometers, step counters and heart rate monitors. They propose the mobile personal trainer (MOPET) system to better train and motivate users. In outdoor environments, MOPET is a wearable system that based on alternating jogging and fitness exercises to that monitors a physical fitness activity. Knowledge elicited from a sports physiologist and a professional trainer by using real-time data obtained from sensors, and a user model that is built and periodically updated through a guided autotest. MOPET also displays a 3D embodied agent that speaks to better interact with the user, suggests stretching or strengthening exercises according to user's current condition, and demonstrates how to practice exercises with interactive 3D animations correctly.

Lo et al. [25] proposed Ubiquitous Context-aware Healthcare Service System (UCHS) based on a decision support systems, to sense user's life vital signal they use micro sensors integrate RFID , such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), and blood sugar (BS). As shown in Figure 5, User's requirements inference and relevant services search are provided by UCHS which made semantic inference engine and found the most adaptive Nature Medicine Services (NMS). By combining Medical Stemming Mechanism (MSM), Medical Ontology (MO), Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic

Analysis (LSA), and k-Nearest Neighbor (kNN) the higher accuracy for NMS inference is discovered. Customized NMS and decision obtained by mobile users that are conveniently and use those services reaching the target ‘‘Eat, Drink, and Be Merry with Health” in advance by UCHS. MEAD is combined with UCHS, where MEAD is based on Linux. Also, it is a system that known as a public domain portable multi-document summarization. MEAD consists of multiple processes, and it is implemented by Perl programming language [26]. As the following the main procedures of MEAD is presented:

1. **Preprocess:** The contents of the Blog is retrieved d by the intelligent agent, to facilitate follow-up to the weight computing in original document it is used HTML format to segment the sentences [27, 28].
2. **Feature Selection:** MDS is designed in this paper to consider several features of each sentence by words and phrases to compute the weight. Centrality, sentence length, and position are considered as the main three features [29].
3. **Classifier:** For every sentence, the weight with each feature is mainly computed to obtain the scores of every sentence [30].
4. **Reranker:** Especially in multi-document summarization, there is a problem that arises from the high similarity between sentences because the score of sentence similarity calculation and sorting is only carried out by the classifier. So, the recalculate the sentence with the syntactic similarity is made by MEAD designs Reranker mechanism and to filter out important sentences to reduce the redundancy ratio the threshold is set. Finally, extracting the sentences is made for a summary that obtains from an original document by the compression ratio [31].
5. **Summarization:** In the original document, it can retrieve and recombine words and phrases by Summarization according to the Reranker sorting that made the order of the sentences.
6. **Evaluation:** Text summarization system performance is measured by HMGS system including the output effect of results as well as users’ satisfaction [32].

Kim et al. [16] established real u-healthcare environments to implement a ubiquitous climate that based on Ontology-based healthcare context information model; it is vital to receive from various platforms the context information at the suitable time in portable devices where the communication operate in two ways using both wired and wireless. Moreover, to reflect the information and characteristics needed a knowledge model is required for such services while remaining appropriate for medical reference. The context information model is used for extracting and classifying contextual information to implement the healthcare services. The ontology is used for defined the healthcare context information model, and a common model was developed for healthcare by taking into a consideration medical references and service environments. The sensed information in various environments can use by application and healthcare service developers by authoring device- and space-specific ontologies based on this common ontology.

Yuan et al. [33] proposed Fuzzy CARA – a Fuzzy-Based Context Reasoning System for Pervasive Healthcare. Healthcare is moved from care by professionals in the hospital to self-care, mobile care, and at-home care by using pervasive computing. The pervasive healthcare system, CARA (Context-Aware Real-time Assistant), is designed to provide personalized healthcare services for chronic patients in a timely and in a proper manner by adapting the healthcare technology to fit in with normal activities of the elderly and working practices of the caregivers. A personalized, flexible and extensible reasoning framework is presented by this paper for CARA by using a fuzzy-logic and a related context-aware reasoning middleware. Remote patient monitoring is supported by this paper also caregiver notification where based on data fusion and representation as well as inference mechanisms context-aware. The imperfections of the data are noteworthy about the work for dealing with it, also to control the application of rules in the context reasoning system they use of both structure and hierarchy based on fuzzy-logic. Results are presented for the evaluation of the fuzzy-logic-based context reasoning middleware under simulated but realistic scenarios of patient monitoring. The results point at-home monitoring is more feasible and effective.

Hadjioannou et al. [34] proposed application for people that are in need of services such the tracking purpose this application for smartphone present the steps that were taken for the development of a location-based Android application which can be used for this purpose. In case the owned device is located in an area where it is not expected to be in, it will be able to inform a number of the users chosen peers about their whereabouts. Sensing a few simplified movements is the capability of the application which the user performs with the device and fire particular events based on the user's gesture, giving this way a context awareness aspect to the application. The drawbacks of this application are the use of a few simplified movements the user performs with the device. We can replace with taking a photo by mobile camera and make on this photo pattern recognition.

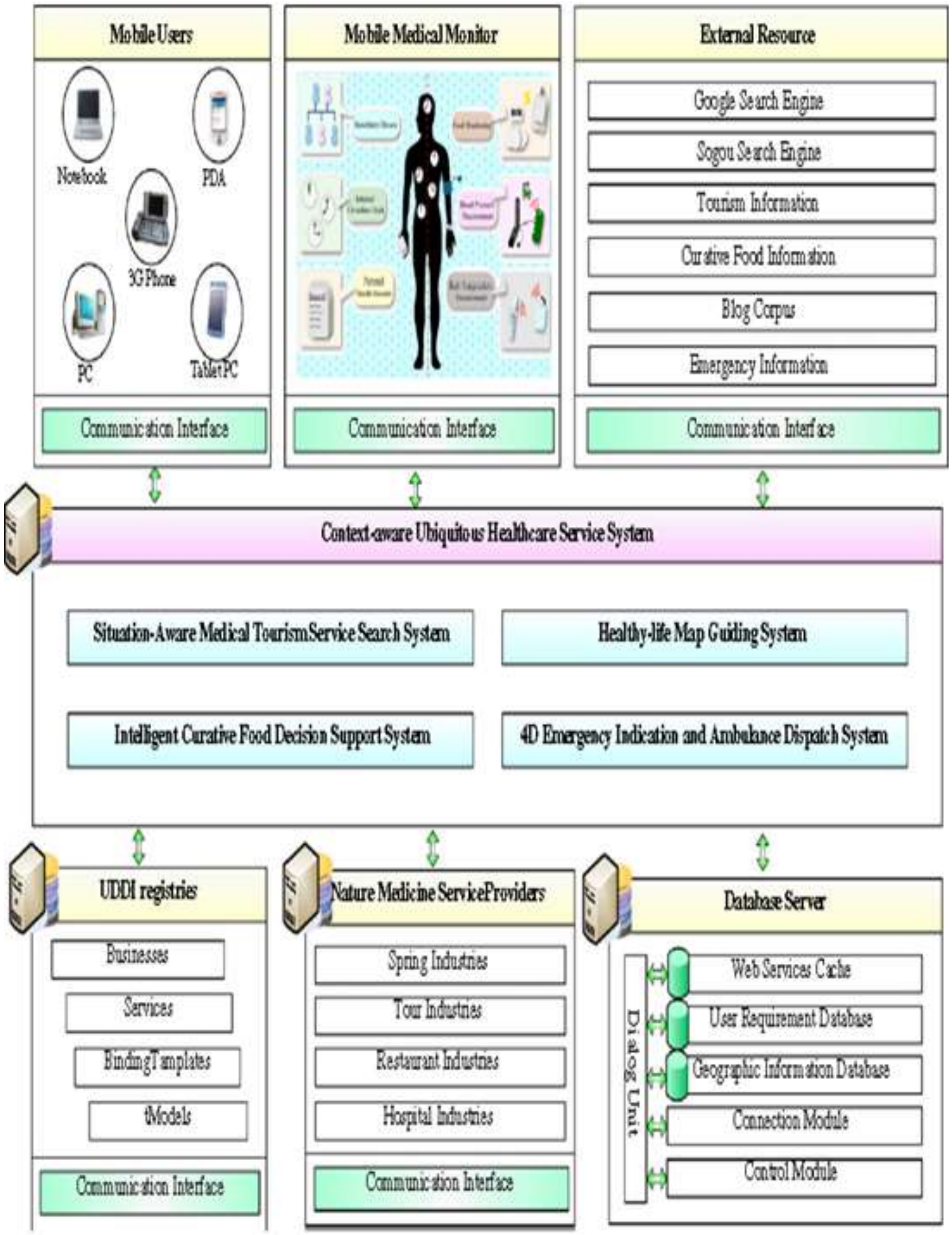

Figure. 5 The architecture of ubiquitous context-aware healthcare service system (UCHS) [25]

3.2 Application of context-aware of learning technology and general application of context-aware

Selviandro et al. [35] presented a paper for learners in a learning technology to build or develop a system that has the capability of giving a proper context that based on CBR and Nearest Neighbor algorithms by discussing the designing and testing plans of the context awareness system that is developed. The drawback of the proposed system is not implemented to verify that Nearest Neighbor Algorithm is an efficient way for making the similarity between new cases and old cases or is not proven whether the proposed system can give a proper or suitable context to the user based on user's situational conditions.

Alrammal et al. [36] presented a novel approach for Context Awareness in Mobile Commerce approach based on Regression Model, so-called RBCM, in modeling a domain to construct a context-aware model for mobile computing. RBCM is used to construct a probability density function for action schema in a domain by basing on a multivariate regression method. The mapping of the action schema with a context is applied by a machine learning algorithm. A benchmark dataset is used to evaluate RBCM. The start-of-the-art rivals of RBCM are used for comparing the results. Nayes bias, MOCART and Decision Tree with the latest variations where the main candidate rivals of RBCM are based on. Their model is compared with the rival techniques, and the results show that it is outperformed in accuracy and precision. Also, the rivals cannot predict the preferences of the users like RBCM that predicts with a higher accuracy. When the sample size greater than 50 perform of RBCM is better.

Fanelli [37] presented for efficient context data distribution their original solution, by stressing their principal design guidelines, and highlighting how the use of different wireless modes and distributed context caching can deeply improve the Context Data Management (CDM) efficiency. Their novel algorithm Adaptive Context-aware Data Caching (ACDC) have been proposed, replacement policy, specifically tailored for fast adaptation of cached context data in mobile environments, where context data access patterns can quickly change due to mobility. To assess performance improvements and total overhead introduced by their approach they extensively compared ACDC against traditional caching techniques (FIFO, LFU, and LRU). On their ACDC caching obtained results are stimulating further research activities. On the one side, according to mobility indicators, they are currently working on the dynamic sizing of H length to improve ACDC promptness further while roaming. On the other hand, since reactive replication does not properly work if all close MNs have their caches full, we are working on additional coordination protocols to decongest caches of highly replicated data, so to keep relevant ones that the neighborhood may completely remove them.

Bobek et al. [1] Building systems that gaining, process, and reason with context data are a major challenge. The mobile context-aware systems are required model updates and modifications. Additionally, the data required for the reasoning depended on the nature of the sensor-based systems that implies the data is not always available nor it is certain. Finally, context data can be significant and can grow quickly in the amount, constantly being processed and interpreted under soft real-time constraints. Such characteristics make it a case for a challenging big data application. In this paper, they require specific methods for mobile context-aware systems to process big data related to context. Also, they need to deal with uncertainty and dynamics of this data at the same time. For developing such systems they identify and define main requirements and challenges. Then they discuss how these challenges were addressed efficiently in the Know Me project. In their solution, the AWARE platform is used for the acquisition of context data. They extended the AWARE platform with techniques that can minimize the power consumption as well as conserve storage on a mobile device. To build rule models they use data that can express user preferences and habits. Some uncertainty management techniques they used to handle the missing or ambiguous data. A rule engine developed for mobile platforms provided for reasoning with rule models. Finally, they demonstrate how our tools can be used to visualize the stored data and simulate the operation of the system in a testing environment.

Railkar et al. [38] proposed for Smartphones a Profile Translation based Proactive Adaptation using Context Management (PTPACM)to manage information and applications on Smartphone, for the service provider with their details filled the user must supply with credentials or profiles by logging onto different websites. To this purpose, user's profile resides in control of multiple service providers. A data inconsistency is due to duplication of data occurs that obtained from different websites. In Smartphones to overcome these issues according to the scenarios, this paper proposes PTPACM which automatically generates user's profile. The proposed system let keeping user's full profile in user domain resulting into centralizing or exchanging the profile information with an increase in the consistency of profile information. For PTPACM with Context Awareness Layer, Proactive Analyzer Layer and Profile Translation in a system this paper present the layered architecture. A probabilistic representation also presented in this paper of PTPACM as well as pseudo codes for different operations in the functional blocks of presented architecture.

Miraoui et al. [39] proposed for context-aware services adaptation by using two machine learning methods approach for a smart living room. In learning/prediction process two algorithms are used the standard probabilistic Naïve Bayes classifiers and the multilayer perceptions neural network that considered as most famous and interesting algorithm. Their approach gave encouraging results, but the main drawback of this approach that it suffers from being a static adaptation. The dynamic aspect by anticipating the adaptation during the operation of the system put into consideration as the future work by making the learning incremental.

Kabir et al. [40] presented a system for context-aware based on machine learning which can provide service according to the trained model. Backpropagation Neural Network and Temporal Differential (TD) are the two effective learning algorithms that used for prediction and adaptation respectively as a class of reinforcement learning. For context-aware service, this approach indicates better adaptation due to the low error rate. In this paper, they focused on using machine learning technique and context-aware application layer for making an adaptable context-aware system. Several modules consist of the context-aware application layer for a particular task as shown in Figure 6. Different types of services are supplied by the context-aware application layer such as Morning call service, Dining service, Entertainment service, Sleeping service and Guarding service according to the current contexts. The main disadvantage of the use of rule-based not using CBR for solving new case not stated in the system.

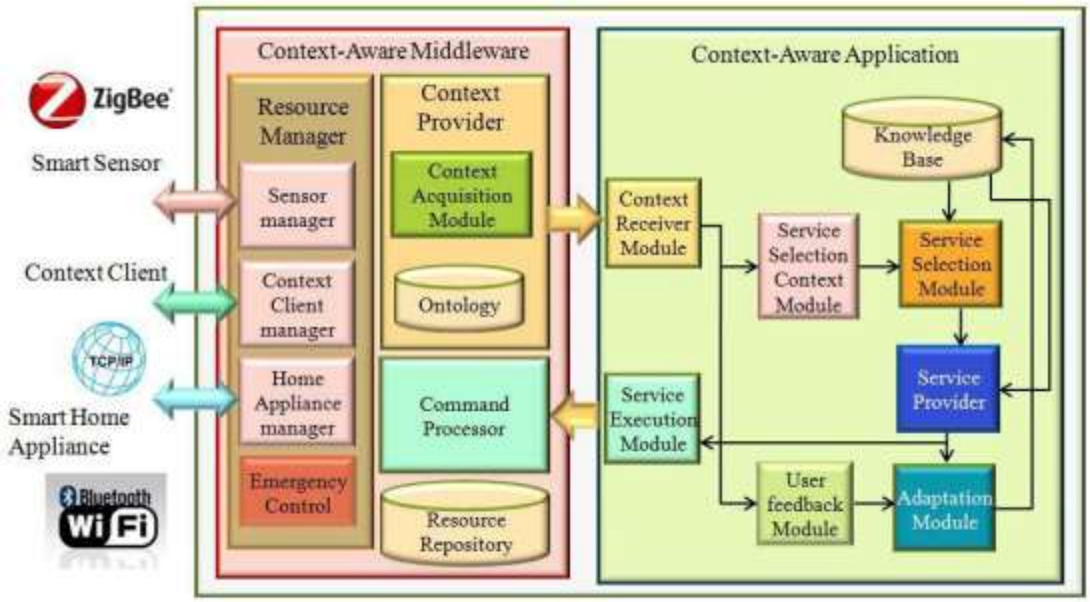

Figure. 6 The block diagram of machine learning based adaptive context-aware system [40]

Kumar [41] proposed for the management of context data an ontology-based model for mange m-Health application. In developing a context-aware m Health application, there are the most One of the major challenges is to store and process raw context data. The novice users can use this application so it should be simple and easy. For example, if there is someone X want to know the nearest medical clinic, public hospital, pharmacies from these current locations. Based on the user context any person can obtain the required result. Furthermore, details of the preliminary design are also provided for proposed m Health application. The drawback of this system that it does not carry out to implement the system using Android development toolkit for the mobile applications. Furthermore, the system does not evaluate and upgraded based on the feedback from the users.

Broens et al. [42] proposed for m-health an application framework for context-aware. For mobile healthcare (e.g., telemonitoring) there are several social issues, like aging, stimulate the use of mobile ICT applications. The consequences of developing these applications to support novel m-health applications should be considered in the scope of a comprehensive architecture. For such a framework this paper gives initial requirements, and it gives the first attempt at a functional decomposition. This work is based on the architecture proposed by the Freeband AWARENESS project, as shown in Figure 7 [42]. AWARENESS architecture is considered as a three-layered architecture. The network infrastructure layer is the bottom layer of the architecture, which offering seamless mobile connectivity (e.g., GPRS, UMTS, WiFi). The service infrastructure is the middle layer that provides an execution environment for nomadic mobile services. The application layer is the top layer where they position their application framework. An application container offered by a top layer that provides an execution environment for application components and additionally provides access to generic container functions, domain-specific functions and the service infrastructure in general. Generic functions like context management are offered by the generic container functions, which apply to all application domains. Furthermore, a domain-specific function also is applied.

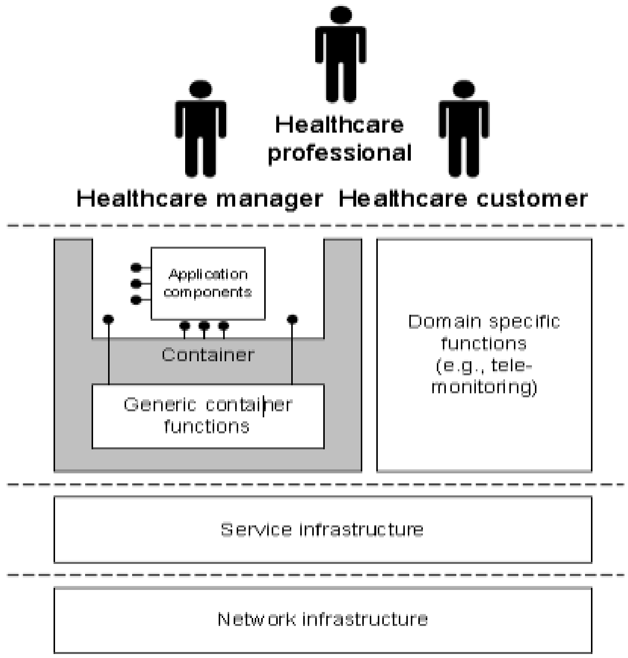

Figure. 7 The positioning of the application framework in the awareness architecture [42]

Mcheick et al. [43] proposed for health care systems context-aware mobile application architecture (CAMAA). From a wide range of sensors, data will be collected continuously. An Agent is responsible for the good organization of data, formatted, and structured before forwarding it to an upper layer, where in a later stage it should be processed. As shown in Figure 8, their new architecture is decomposed to three layers from bottom to top as follows: sensors, agents, and application layers.

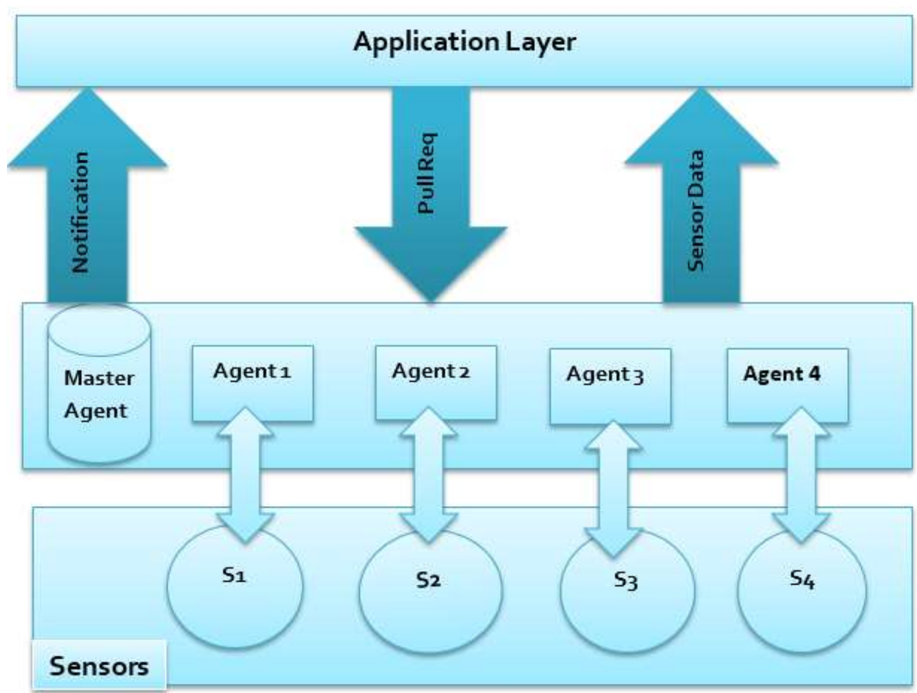

Figure. 8 The context architecture layers [43]

In the first Sensors Layer that available in the user context, it can be physical sensors like (GPS, temperature, etc...) or virtual sensors this means that the user's application it is not only the source to the sensors. Agents Layer is the second layer, where an agent associated with each sensor. The data collected from the sensor by the agent's role, data from the sensor are stored in XML format, and according to a certain threshold, it decides whether to forward it or not to upper layer. The difference between the last sent value and the new value is known as threshold measures. In case of a Pull request coming or scheduled from the upper layer Also, agents forward sensor data. Application Layer is the third layer where requests subscription by the client from the Agents layer, and when a notification is received the data is pulled, or by initiating a pull request, also he can discover the available.

4. ANALYSIS AND DISCUSSION

Sullivan et al. [44] for providing nomadic practitioners proposed Context-Aware Mobile Medical Devices (CAMMD) with efficient access to patient records at the point of care. Examines the storage is the first test that required by a CAMMD enabled handhelddevice. Storage costs for the Remote Method Invocation (RMI) implementation also obtained. At each ward the data storage on the PDA is constant due to the retrieval of every patient record for the medical practitioner by using the RMI implementation. In comparison, by retrieving patient records the CAMMD implementation requires on average 80% less storage only associated with the practitioner's active context. the network bandwidth usage is examined as the second test of a CAMMD enabled handheld device. RMI enabled device also obtained bandwidth usage. The results of this test case are shown in Figure 9b. The network usage of the RMI enabled device is again constant and is calculated by determining the cost of invoking a remote retrieval of patient records. In comparison, the bandwidth usage of a CAMMD device fluctuates according to number of patient records transmitted and the frequency of location updates.

To evaluate the performance of CAMMD four individual tests were executed and these are outlined in Table 1. Both the CAMMD framework and a Remote Method Invocation (RMI) medical-based implementation was used to conducted each test.

Table. 1 Overview of performance evaluation tests

Type	Test Name	Description
Physical Constraint Test	Handheld Device Storage	**CAMMD** On the handheld device Determine the storage cost resulting from the propagation of patient records. The storage cost is determined by Remote Method Invocation on the handheld device resulting from a retrieval of patient records.
	Network Bandwidth Usage	**CAMMD** The network bandwidth consumed is determined by a CAMMD handheld device. By the RMI implementation the network bandwidth consumed is determined.
Usability and Interaction Test	Data Transmission Time	**CAMMD** To perform a data management operation the time taken is determined. The time required is determined by Remote Method Invocation for a retrieval of patient records from a provisioning server.
	User Navigation	**CAMMD** The average user time to navigate is determined to a patient medical record. The average user time to navigate is determined by Remote Method Invocation to a patient medical record.

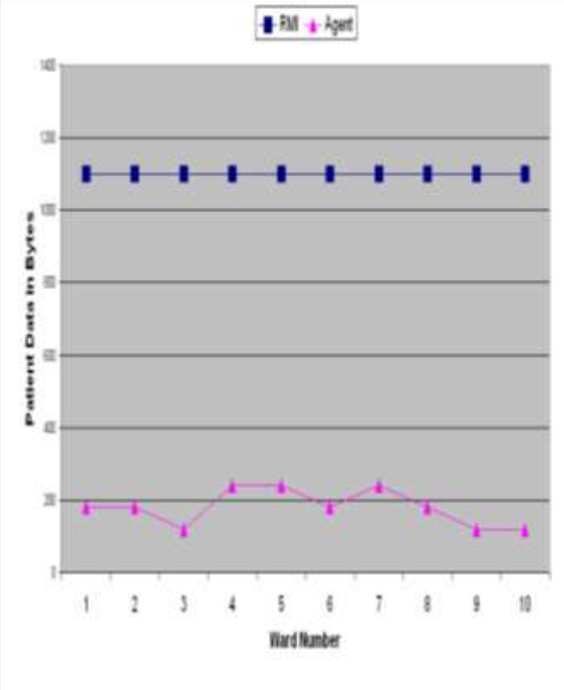

Figure. 9a Handheld device storage

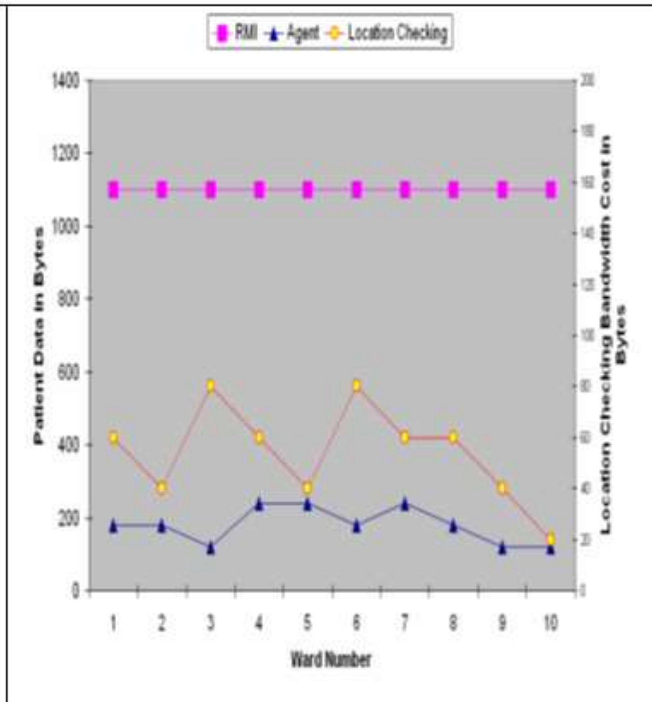

Figure. 9b Network bandwidth usage

Liu et al. [45] proposed mobile-health applications for iOS devices. In this section, top two hundred apps in related categories from Apple's App Store were examined to find out features shared by these most popular applications. To demonstrate the current status of m-health applications several representative apps were analyzed on iOS and to identify implications from a developer's perspective. Apple's App Store classified the applications into twenty categories for example: Healthcare & Fitness, Lifestyle, Medical, Navigation etc. M-Health applications were distributed in the categories of Medical or Healthcare & Fitness.

Apps in these two categories were chosen for detailed analysis based on three criteria:

- Popularity. The sort of the applications is by "Most Popular" instead of "Release Data.
- Rating. Applications with higher customer ratings (three or more stars out of five) were selected.
- Relevance. The goal was to identify the current status of the m-health applications. So only those applications relevant to healthcare were selected.

By popularity out of the top 100 apps, In the Medical category eighteen had two or fewer stars in customer ratings as showing in table 2 also in Fig. 10. The subtotals of the numbers of applications in these classes are shown in Table 2. Table 2 shows the largest class is the Medical information reference was followed by Educational tools and others. It was obvious that medical information reference apps dramatically decreased in the percentage, and the percentage of track tools dramatically increased.

Table. 2 Distribution of apps among different classes of the 80 relevant apps in the medical category

No.	Class	Number of apps	Percentage
1	Drug or medical information database	8	10
2	Medical information reference	27	33.75
3	Decision support	3	3.75
4	Educational tools	19	23.75
5	Tracking tools	7	8.75
6	Medical calculator	3	3.75
7	Others	13	16.25

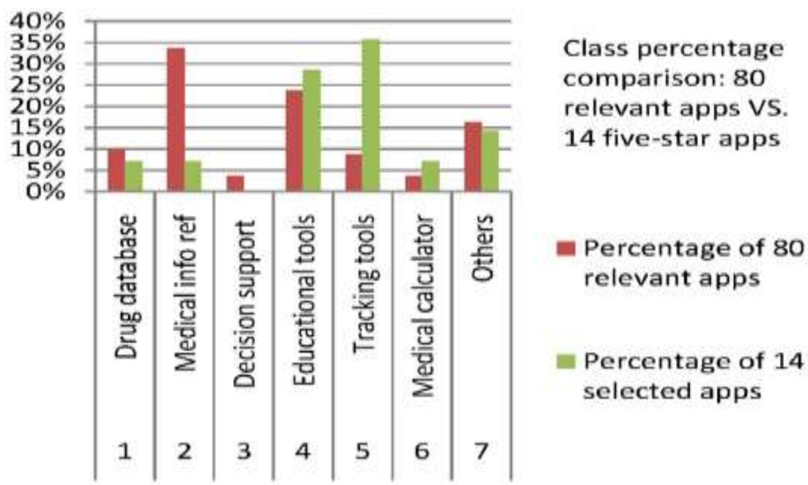

Figure. 10 Class percentage comparison between 80 relevant apps and 14 five-star apps.

As discussed above, for mobile electronic-health applications sufficient computing power and offer media-rich and context-aware features that are suitable that is provided by modern smart mobile devices. For m- health applications these devices have gained acceptance as target devices. First, the majority of developers chose to port existing web based or standalone desktop apps to mobile devices. Second, for m-health apps typically have multi-touch interfaces and include context-aware hardware sensors so mobile devices are suitable for this purpose. It is critical for m-health developers to innovate and integrate support for these features in m-health apps.

5. CHALLENGES AND FUTURES TRENDS

Mobile devices are becoming increasingly popular such as smartphones, IPAD and tablets, and price it is becoming affordable to many because there is a massive reduction in price. Also currently mobile applications have a huge demand that can meet people daily needs in providing services, such as finding shops, medical facilities, and restaurants. One of the most widely researched areas currently in mobile computing is that of context awareness. There are many limitations in context awareness that we need deal with in the current future direction. For example, Bobek et al. [1] several directions for future work are considered, like uncertain context data management included in more applications epically in dynamic mobile environments. One of them is the scope of contextual data that usually in extension they process with effective context acquired from physiological devices [46, 47]. So, our approach can be applied in the affective computing paradigm. Big social data is considered as another direction concerns. In these applications, event detection with the combination of user localization can be applied based on their rule-based descriptions. In such a case they are planning to use AWARE to acquire context data from social networks, but also possibly for social applications on mobile devices. The secure context awareness and context-aware security are currently a field of active research in both academic and industrial community [48]. Security challenges in context-aware systems include integrity, confidentiality, and availability of context information, as well as end user's privacy. Another important issue is trustworthiness of context information.

In designing of context-awareness also there are many awaiting challenges in mobile Sensing. Dynamic sensor selection, adaptive sampling, opportunistic workload division, and optimal sensing are the first challenge all of them known as Sensing Management. Second challenge Data Acquisition like data calibration, orientation change in device, distortion, noise, and device placement. Learning paradigm, computational complexity, online processing, and redundancy check are considered as the third all of them under name context Inference. Fourth Framework Design like a generalization, inhomogeneous physical world, adaptability, tradeoff handling estimation/prediction,time-variant sensing, robust processing, optimization in sensor senses. Finally, limited power, bandwidth, and storage, richness in context sources, complex device architectures, security, privacy and trust issues are considered as a general challenge[21].

6. CONCLUSION

New opportunities for application developers and end users are offered entirely by context-aware systems that gathering context data and adapting systems behavior accordingly. To increase usability tremendously especially in combination with mobile devices these mechanisms are of high value and are used. In this paper, we described different design principles and context awareness models for the mobile application. Context-Aware has many fields that can apply to it such as communication engineering, computer science, information technology. In addition to aid, the user for many purposes the context-aware computing has important uses in human-computer interaction, wearable computing, augmented reality, data management, feature extraction, artificial intelligence, and decision making. Especially, Smart devices are ideal assistants that provide accurate solutions for the critical aspects of healthcare, and medical staff works as well as the closer up-to-date state of the patient. Also, hospital's staff members can communicate with the patients reliably and suitably by using smart devices offers. In the future work, to improve the user experience, the advantage of contextual data is aimed to take by context-aware applications. A useful tool to reason about context is proved by using case-based reasoning (CBR) and fuzzy techniques to deal with lack standardization in handling the context and uncertainty of data. On the other side, it could be interesting to analyze how context reasoning relates to CBR. To assess how CBR can be integrated with contextual information is the primary concern of our research study.

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