Context-Aware Middleware Architecture for IoT-Based Smart Healthcare Applications

R. Venkateswara Reddy, D. Murali and J. Rajeshwar

Abstract In recent years, Internet of things (IoT) has become an intelligent computer model in which various things and resources are connected to a range of intelligent solutions such as Bluetooth and Wi-Fi, ZigBee, and GSM. These communication technologies offer connectivity between different IoT devices that can help control and operate devices with the user interface. The development and implementation of these applications are ideas for the next era: IoT has enabled the user to define and design a large number of middlewares to connect the IoT application levels, and one of them is a contextual middleware. Contextual applications are more adaptable to their dynamic changes in the environment, with behavior that attracts more attention from users. Contextual applications are in fact three principles of context-awareness, modeling, and reasoning. The existing approaches are technically focused on the style of architecture, abstraction, the expandability of reasoning, fault tolerance, the identification of services, privacy, security, archiving, the level of awareness of the context, and Big Data analysis. In this article, we focus on improving the security and privacy of middleware and data visualization with cloud-based Big Data analysis. At the end of the document, we discussed the challenges of open research at work.

Keywords Internet of things (IoT) · Middleware · Cloud computing · Big data analytics

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1 Introduction

IoT's Internet-based smart house (IoT) is a wireless network that collects, interchanges, and displays data that is connected to many things (HVAC devices), devices, buildings, sensors, and many electronic devices [1]. Kelly has been researching how smart devices can be managed and controlled without human interaction and success [2]. Heterogeneity, row/argument vulnerability, and characteristic inheritance are considered as issues that Zhang has opened with security-oriented IoT [3]. Nisha Single describes the Linux version of Raspberry Pi, a trilevel model for context modeling and system architecture for smart devices [4]. IoT's intelligent home-based equipment is able to dynamically track things and the environment by changing context-sensitive middleware applications. In general, all context-dependent applications are implemented using three approaches, namely, Owner Mode, Library/Toolkit, and context management [5]. Context management performs better than the other two approaches. The design and development of contextual middleware applications emerged and much architecture have been proposed by previous researchers [1, 6–8]. Zhang and Baosheng [3] and his team only produced a publication of a context-sensitive middleware architecture and presented evaluations and comparisons without overlapping the existing approach.

The rest of this article is organized in different sections. Section 2 offers work related to the conscious principle of the context and its architectures. In Sect. 2, we analyze the system model that is the architecture models based on the cloud and the context and the new architecture with an improved approach to security, the visualization of data. In Sect. 3, the techniques for displaying data and their results were presented. Section 4 opens the research challenges. Section 5 summarizes the conclusion of the work.

2 System Study

2.1 Framework for the Cloud-Based Context-Aware Internet of Things Services

From the perspective of our home research to smart home applications, we have noticed the lack of precise definitions of the technologies and models involved in smart home applications after reviewing our existing tasks and reviewing existing tasks. Therefore, we have considered the successful adoption of a "smart" view, with a complete perspective reflecting our view of the integration of many technologies and techniques in this segment. Smart-x offers a framework that contains items from different enabled elements to strengthen their ability to build and improve applications and services (e.g., Smart Health, Smart Agriculture, Smart Grid, Smart Mobility, etc.). Our policy is based on contextual and context-awareness to solve the consensus referred to above. From linguistics to computing, the context is a key element.

The Cambridge dictionary defines “context” as “the situation within which something exists or happens, and that can help explain it”; adding to that Abowd and Dey’s definition of context stated in our introduction. We believe that in any case context and contextual understanding will play an important role in the understanding and interpretation of the situation. Context-aware computing is defined by Gartner 3. “Communication and environmental information about people, places and things in the computing genre can be used to predict immediate needs and provide useful, useful and intuitive content, functions and experiences.” The life cycle of contextual operating systems is usually four stages: (1) collection and integration phase, (2) modeling and storage phase, (3) reasoning and processing phase, and (4) expansion and integration phase. The first phase refers to ways to integrate contextual data around an entity and to provide accurate data. The second stage deals with the collected data (key–value, anatomy, etc.) and how to store it (relation databases, nosclick databases (This is repository from noslick.com), XML files, etc.). The third step is responsible for processing data to improve better knowledge and more meaningful information (Fig. 1), in the context of collecting the fourth task, interested parties (e.g., services, programs, reactions, etc.) .

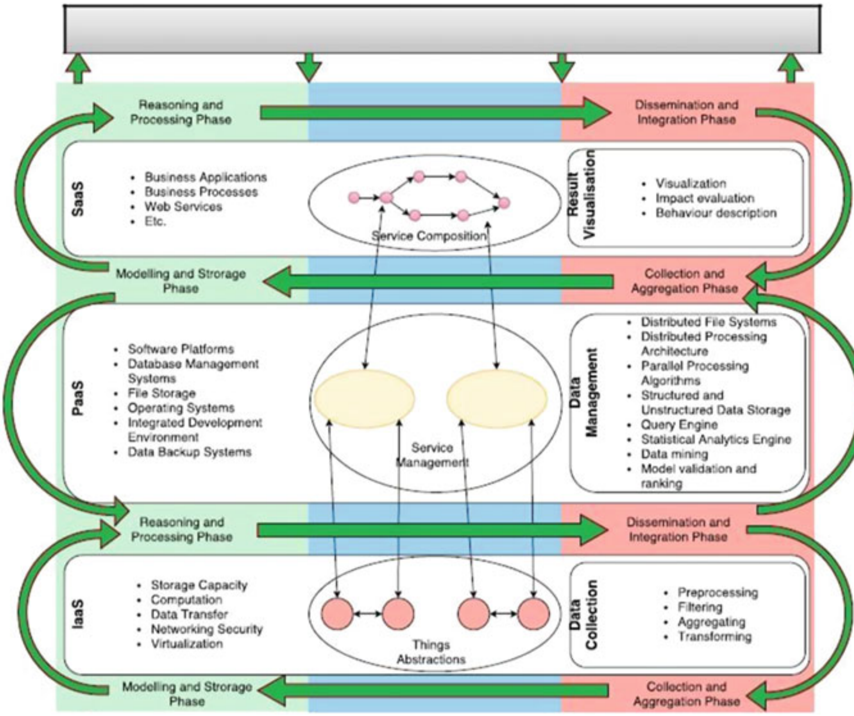

Fig. 1 Cloud-based context-aware internet of things services architecture

In the context of our work on "Smart Home Applications," we believe that we can be firmly credible to IoT data in the IoT, cloud service and Big Data decision-making. From this perspective, we will assign the context.

Management lifecycle to essential subjects provides other cloud computing facilities, IoT and Big Data computing.

Earlier in the movie, we provide service models based on cloud computing, such as service (IaaS), platform (PaaS), and software (SaaS). Smart home applications challenges (e.g., Scalability, Heterogeneity, etc.) provide all the flexibility and effectiveness needed to provide a service that provides challenges.

Infrastructure level
Through IaaS, cloud provides the necessary infrastructure and tools (e.g., processing, storing, networking, etc.) necessary to collect data from physical objects. Cloud is generally referred to as centralized technology, fog, or edge computing [6].

Platform level
Tools that help developers and data professionals in data and services are collected during stage, development, processing, testing, and development level (IaaS). Services are related to services, supervision of services, supervision of services, mapping services of contents, service configuration, service composition, etc. In the Big Data perspective, data management is the way the data is stored (structured or structured), restored, and processed (e.g., data mining, statistical analysis, etc.) (see Fig. 2).

Software level
At this stage, cloud software provides the product regularly to the user (for example, business application, business processes, APIs, etc.). This is usually done by using the tools and techniques provided by the platform at the underlying (platform level) level. From an IoT perspective, the process of software service composition (orchestra or choreography), which serves as a service, call range for the underlying layers and mapped to physical objects.

For example, showing each lego four-out processing, path coordination, and multiple objects and payment details provided for each legend can be interpreted as the time of departure. Visualization of data is processed in graphs to a considerable data perspective, to assist in decision-making, to identify new patterns in data, or to assess the effect of new data.

2.2 Proposed Structure to Improve Security and Privacy

Transmission and data operation is done by a lot of security in the middleware security which is an important issue. To have a safe system, we need to take into consideration, integrity, and availability. Therefore, ubiquitous different security measures must be provided for ubiquitous applications and pervasive environments, such as evidence and evidence, authority modifications, and proof of access control policy and accountability obligations. Confidentiality means that all parts of the IoT healthcare system that access the personal information of the patient must ensure the protection of information specified by unauthorized access.

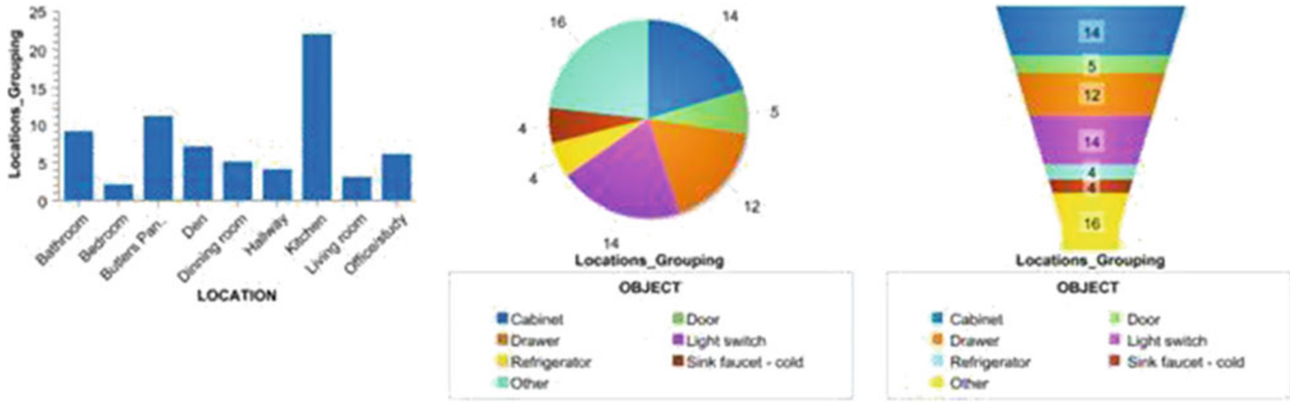

Fig. 2 Data visualization/forecasting of sensor information based on location

2.3 Context Data Security Algorithm (CDSA)

The proposed CDSA guarantees security and privacy of context-aware application data over the cloud repository. We used box to store context data in ECM. CDSA allows the cloud users based on the user id to access, visualize, and search context data. The core context-aware SAAS application algorithm has implemented on Force.com platform using an APEX programming.

3 Data Visualization Techniques for Context-Aware Applications

Context-aware application data forecasting was done with modern analytics such as standard salesforce report and dashboards, wave analytics, and Tableau. To visualize the context, we used two types of reports, namely, summary and matrix-related reports. Figure 2 represents the sensor data gathering based on the location presence. Figure 3 illustrates the data forecasting by grouping sensor ID, heading, category, and subcategory.

4 Open Research Challenges

This section discusses the remaining challenges to address the corresponding IoT device. The purpose of the section is to provide research guidelines to the new investigator in the domain.

4.1 Interoperability

The IoT has three main types of interoperability challenges, in particular, technical, semantic, and pragmatic. The technical challenges are related to the functionality of relevant devices, protocols, and standards to coexist and interoperate in the same computational paradigm, while semantics deals with the capabilities of various IoT components that are responsible for the processing and interpretation of the data exchanged. However, the pragmatic concern is about the capabilities of the components of the system to observe the intentions of the parties. Achieving technical interoperability can be achieved by providing agent-based mediation between devices and IoT standards. Semantic interoperability is a requirement for the computable logic of the machine, the discovery of knowledge, and the federation of data between information systems. Pragmatic interoperability can be achieved through the creative design of predefined specifications of component behavior. In the future, interlayer interoperability solutions are required.

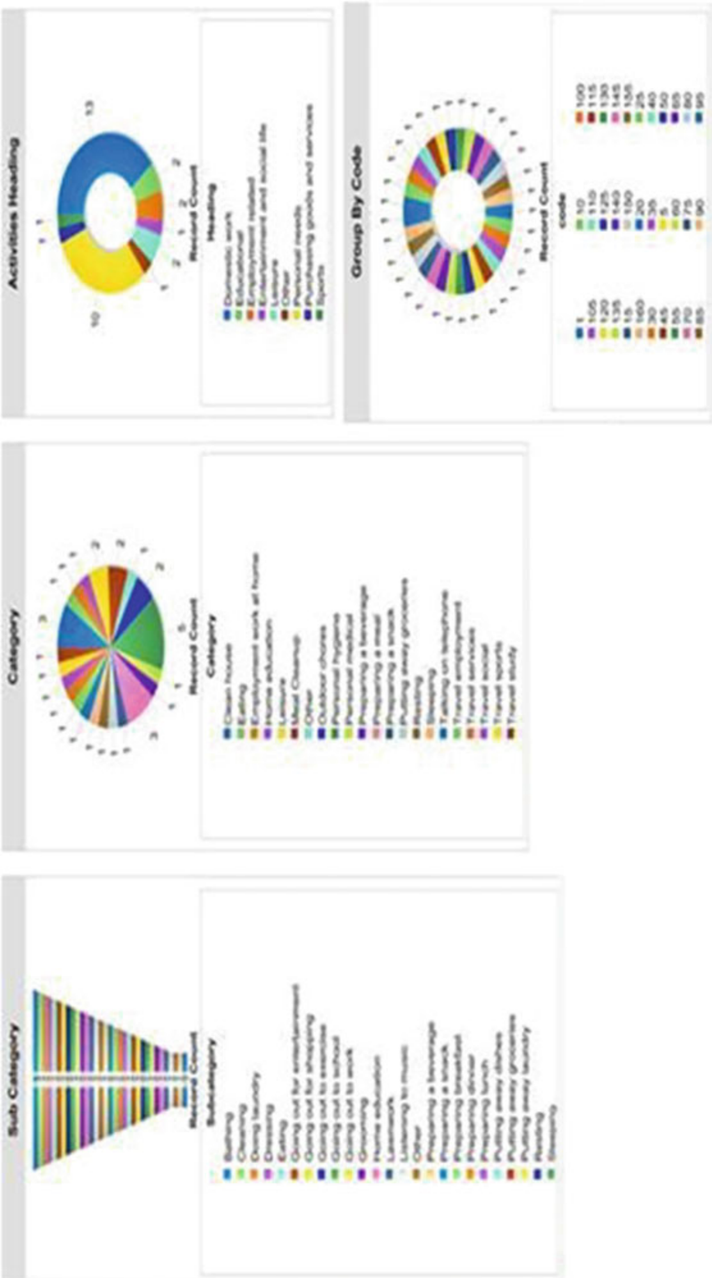

Fig. 3 Data visualization/forecasting of sensor information based on location

4.2 Scalability

The IoT treats many challenges related to significant differences in interacting entities and interaction differences and behaviors. The existing IoT healthcare device formats should be changed to fit billions of smart devices. The scope ownership of IoT healthcare systems will be compiled in two subjects. Initially, IoT devices were developed rapidly. However, the current management protocols do not suit the needs of the IoT device due to its limited capabilities. Second, social connections between equipment owners need to take into consideration, in which some of the IoT systems are individual portable devices. In the future, scalability management protocols are expected to follow social relationships between devices enabling computer services based on specific functions by providing some motivations.

4.3 Flexibility

Since there are many IoT applications, it is a great challenge to provide different IoT applications according to their demands. IoT users usually require dynamic configuration, personalized, value-based services on the fly. In addition, personal, autonomous, and dynamic services can be supported by the construction and use of compatible, sensitive, and reconstructive multiservice network structures. In the future, declaratory service specification models are required to build a future network service structure.

4.4 Energy Efficiency

Tiny devices are the backbone of IoT. However, these devices have limited processing, memory, and battery capacity. As a result, computational-intensive applications and routing processes cannot be implemented on IoT devices because these devices are lightweight. Energy awareness observation in routing protocols does not exist yet. Although some protocols support low-power communication, these protocols are in development. In the future, IoT energy systems will have good solutions to meet the energy requirements.

4.5 Mobility Management

The mobility of the nodes can create several challenges for IoT networks and protocol capabilities. Current mobility protocols of VANET, MANET, and sensor networks do not work well with simple IoT devices due to intense power and processing restrictions. Mobility management is one of the key programs and has two stages: First, the identity of the movement (the movement of the device that connects to the network's new area). Second, signaling and control messages should be merged to help them understand the nodes in a network. Motion recognition can be achieved through persistent scanning, through passive protocols or passive messages from the movements of the movement protocol. Mobility management is one of the most complex issues in the IO example. Consequently, it should take into account the future IoT structure.

4.6 Security

The diversity of IoT applications and the varied IoT communication infrastructure have many kinds of security challenges. In IoT, security can be ordered. In an ascending manner, the system must follow the safe boot process, access control rules, device authentication procedures, firewalling, and security software. If security is a critical concern in IoT, the appropriate security mechanisms cannot be used for the device and network level (physically and physically). IoT devices have some kind of intelligence to identify and counter possible threats. Fortunately, this does not require a revolutionary approach. Instead, the successful evolution of standards in other networks should be taken into consideration the processing capabilities of intelligent devices in the IoT model.

5 Conclusion

This article focused on the design and implementation of important applications based on the context through the cloud. This document highlights some of the open problems of existing approaches/platforms in the field of security and privacy, and aspects of data visualization. We design and implement the panorama for the security and privacy of the data that are sensitive to the context, taking into account the authentication, authorization, accessibility, and ownership of the data. We have designed and modified reports and panels to show the data of the application plus the graphic representation. The analysis of the presented data is more useful to analyze the IoT healthcare applications related to supervision.

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