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Study of IOT Systems To Create A Low-Cost Smart Medicine System

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Abstract

BACKGROUND: The Internet of Things (IoT) is a paradigm that has improved society's day-to-day operations. This model has been used in a variety of fields, including AAL, energy, transportation, environmental, urban monitoring, and healthcare. IoT also have many benefits in the healthcare sector, including continuous health monitoring, improved quality of life, and comfort, to name a few. Smart medicine boxes, a system that provides users with medication care tracking, are one form of IoT application in this domain. It enables health providers to confirm that users are adhering to their treatment regimens and aids in decision-making. The majority of smart medicine box projects in the literature are still costly and do not fix certain IoT device characteristics like scalability, latency, and time to answer, among others. Taking this scenario into account, this paper proposes a low-cost IoT device prototype to assist users with medication manipulation. The proposal uses the idea of edge computing to introduce an intermediate layer that improves connectivity between devices and services. KEYWORDS: IoT, AAL, ICT, e-health

INTRODUCTION:

The Internet of Things (IoT) is a paradigm that has improved society's day-to-day operations. This model has been used in a variety of fields, including AAL, energy, transportation, environmental, urban monitoring, and healthcare.

New paradigms emerged as a result of technological advancements, such as the IoT. The IoT has been dubbed a revolution in information and communication technology (ICT), and its adoption presents opportunities for a wide range of industries and businesses. Any object can be identified, addressed, managed, and monitored through the internet in the IoT paradigm. These objects can interact and work together to complete tasks that benefit end-users. In this context, IoT enables smart objects such as sensors, actuators, and other devices to be connected to the internet, having a significant effect on human society. This model has been used in a variety of fields and healthcare is one of the technology domains that benefits from IoT. (or e-health). Body monitors, mobile devices, and information and communication technology are used in IoT systems in e-health to track patients' vital signs. These services provide remote assistance to physicians, patients, families, and healthcare facilities.They can also collect and organize related healthcare information. Furthermore, there are many benefits of using e-health systems, including improved consistency of treatments

and diagnostics, decision-making support, tracking of patients' symptoms and vital signs, improved health and well-being, and quicker diagnosis of emergency situations, among others.2

The smart medicine box is one example of an e-health application.

They concentrate on issues relating to the administration of medications. In certain cases, they may assist in determining if the patient is adhering to the treatment plan or whether the drug has been abused. The medicine box approach seeks to address this issue by reminding patients of their prescription medications. It reminds patients to take their medicine at the correct time and in the correct amount.3

Smartphone alerts, a warning tone, and a visual indication (LEDs) are some of the ways that smart medicine boxes notify users about their medications. Treatment tracking, noncompliance management, wellbeing monitoring, and diagnostics are only a few of the features included in these boxes. internet remote control on a regular basis.4

Prescriptions, medical assistance, and pharmacist notifications about prescription refills are only a few of the services available. Furthermore, healthcare practitioners and pharmacists may observe how patients are being treated and monitor whether the recommended medication is being carried out correctly.5

Furthermore, certain services are required for the operation of IoT systems, such as interoperability, scalability, performance data processing 1, and protection. These solutions are also prohibitively costly, preventing widespread adoption of this technology. As a result, this research proposes the development of a low-cost smart medicine box prototype.6,7

Related work

In this section, we'll go over some of the smart box solutions that have been proposed in the literature.

To increase the autonomy of introvert patients, **Rosli and Husaini** suggested a smart medicine package. When the number of patients in hospitals grows, so does the workload of nurses. The authors created an IoT system and applications to assist nurses in their daily practices based on this scenario. This device aids nurses in providing medication guidance and supervision for introvert patients. A proof of concept was carried out, which included device and app creation. The authors emphasized the device's utility in assisting nurses in their work and providing comfort to patients**.**

Pang et al. and Yang et al. suggested an advanced framework for a health-IoT solution made up of sensors and facilities. This device assists physicians in prescribing medications and monitoring patients' recovery progress. It can send warning messages, play an audio clip, and trigger vibrations, among other things. In addition, this approach involves the use of a tracking tracker to monitor users' vital signs. The data can be obtained locally and on the LCD of the smart medicine box. To define the user's permission, only one authentication is used.

The method was evaluated in terms of performance assessment and feedback that showed the system's feasibility, according to the researchers. **Srinivas et al.** proposed a smart medication box-based IoT healthcare platform for monitoring patients' welfare. The unit sends out reminders

(mobile notifications, warning lights (LEDs), and an audible warning - buzzer) to remind patients to take their medications on time, and it also updates the patient's smartphone with medication information. Doctors may use a website to keep track of their patients' schedule specifics and administer drugs.

Proposed solution

The research outlined in this paper suggests a low-cost smart medicine box that would alert consumers when to take their medications. An ad-hoc literature review was conducted to identify the framework specifications. The functionalities were then defined and converted to IoT scenarios. In addition, non-functional specifications were discovered that satisfy the characteristics of IoT systems.

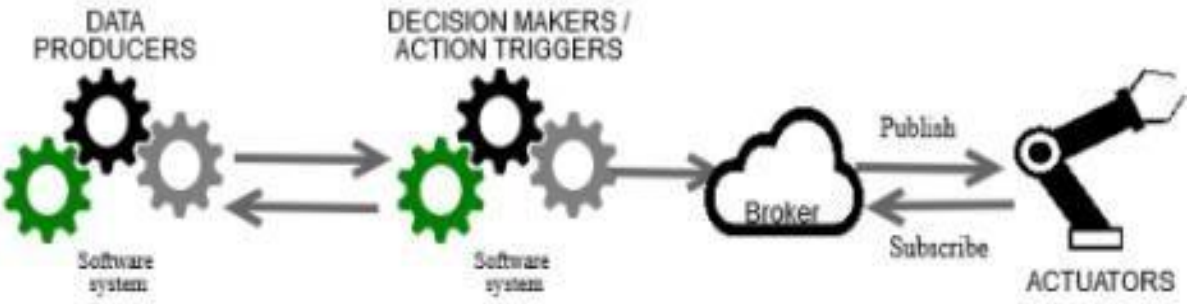

Figure 1: ScenarIoT

In the case of IoT scenarios, we used ScenarIoT, a scenario-based strategy. The scenario can be described as a series of events or an ordered collection of interactions between components. ScenarIoT was used because it can be used for design specification, design description, documentation, and idealization of device features. This approach aids analysts during the early stages of growth by suggesting a compilation of IoT arrangements and their associated information catalogs. The IoT configurations are graphical representations of the components of the IoT structure that show how they interact. We include a summary of the specifications that our solution created. They're divided into two groups: IoT scenarios and non-functional specifications.

IoT scenarios

1. Schedule reminders to alert users to take their medications - use a web interface to set the dates when certain users would take their medications. The smart medicine box will then sound an alarm at the predetermined time. This scenario's arrangement is IIA-6: Actuation caused by a software device, based on non-IoT results (see Figure 1).

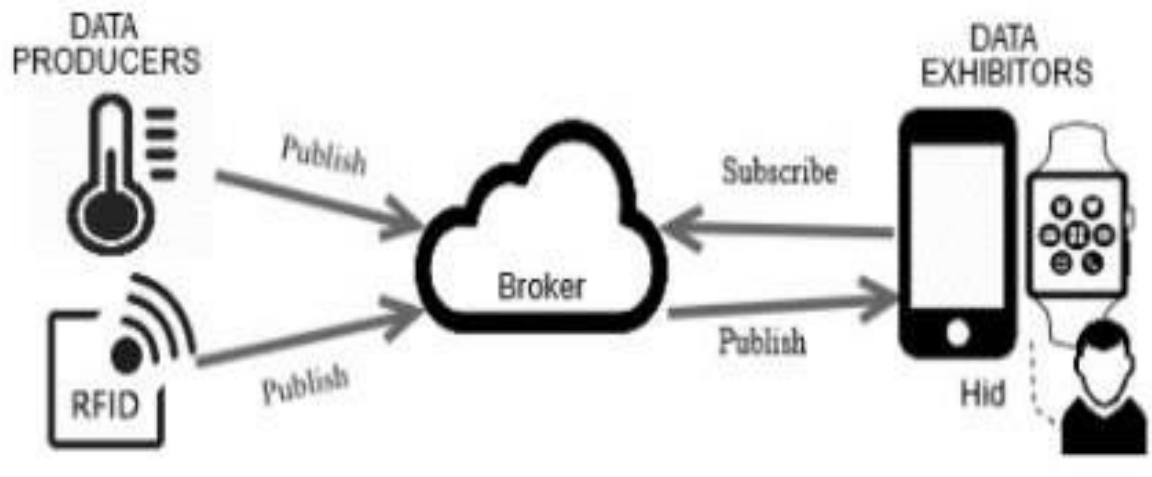

Figure 2. Visualize medicine box state and data - through a web interface, users can visualize alarms configuration, box state, and slots status. This function enables health professionals

2. Visualize the state and data of medicine boxes - users can view warning setup, box status, and slot status through a web interface. This feature allows health providers, caregivers, and family members, among others, to monitor and control medication use. This scenario's corresponding structure is the IIA-1: Data exhibition (see Figure 2).

3.Non-functional requirements

a) **Scalability** - Implement an interface that allows for a large range of devices and software to be added without disrupting existing operations.
b) **Decoupling among devices and applications -**enable interface and application interactions without prior knowledge of each other [7].
c) **Data processing -**For improved resource use, provide local data compression, data fusion, and data filtering.
d) **4. Data storage** - For data collection, have a cloud architecture
e) **Performance -**allow for low-latency communication and faster response times between device components
f) **Security -**enable computer and data access control management
g) **Interoperability -**allow computers, protocols, and data to communicate with one another. This feature facilitates connectivity between devices from various vendors that use different communication interfaces.8

4. Architecture of a smart medicine kit

Who dealt with a vast number of devices necessitates modern technical technologies in terms of interoperability, scalability, and latency, among other IoT characteristics. The fog-computing principle can be used to address any of these characteristics.

Fog computing, also known as edge computing, is a system architecture built on a hierarchical system architecture that has a layer between the cloud and end-devices. By incorporating a portal, the fog layer enhances cloud storage services. As a result, additional services like energy consumption, consistency, stability, interoperability, mobility, load balancing, effective scalability, and low-latency response are offered. This layer also aids coordination between the sensors and the cloud layers.9

The edge/fog layer consists of distributed gateways that provide data processing, filtering, and dimensionality, among other services. Finally, the cloud layer provides a cloud-computing interface for IoT systems that is extremely flexible and reliable. Broadcasting, data warehouse, data analytics, and user interfaces are only a few of the utilities provided by the cloud layer.10

The architecture introduced in this work uses a fog-based IoT architecture to provide a stable and scalable approach to accomplish the desired objective. The smart devices network, distributed gateways, cloud service, and online clients are all part of the infrastructure.11

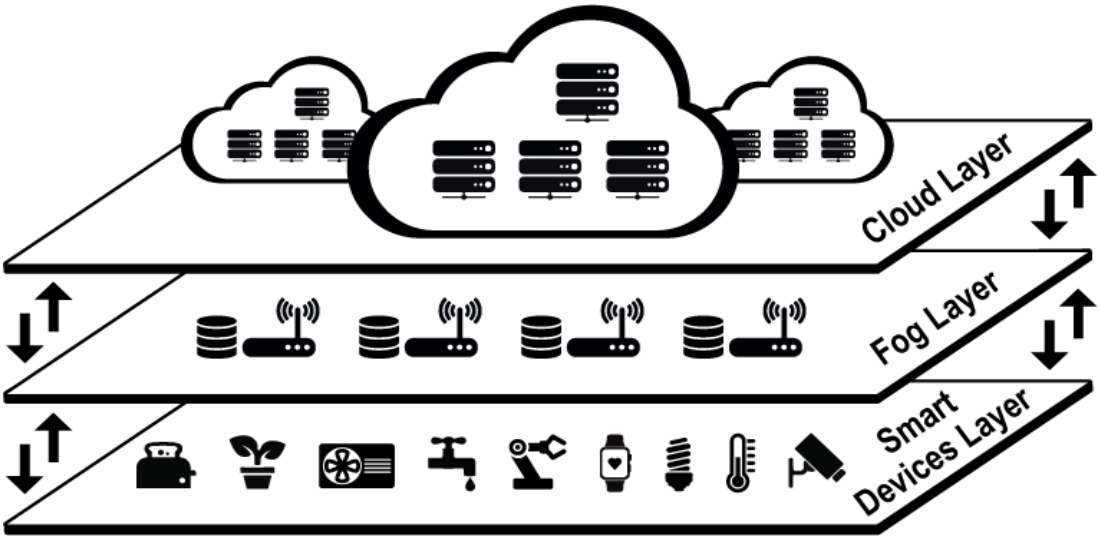

Figure 3: IoT architecture based on fog

a) Smart devices network

Local networks of sensors are formed by smart devices in consumers' homes or hospitals. These instruments have detection, sensing, and networking capabilities, allowing them to deliver valuable services to consumers. The suggested solution consists of only one unit, the smart medicine box, which serves as the system's brain and is in charge of updating consumers about their medications. The IoT scenarios 2 and 3 are addressed in this component. It shows the state of the package and the available medication slots. This system also has warnings and visual indicators to alert people to take their medications.12

Each of the four slots in the box reflects a different day of the week. The smart drug box flips on the appropriate Lead and the buzzer beeps to alert the patient to take their pills when it is time (scheduled time). To make this unit (see Figure 4), the following materials were used: 1 esp8266 microcontroller, 1 multi-purpose case, 4 LEDs (different colors), 1 buzzer, and 1 tilt sensor13

Figure 4: Smart medicine box prototype

Conclusion Final thoughts and plans for the future:

IoT devices have a number of benefits in our daily lives, including increased convenience and improved life satisfaction. This paradigm has been implemented in a number of fields, including healthcare. A common issue in this domain is user medication enforcement, which is discussed by some authors. To solve this challenge, these solutions make use of Internet of Things (IoT) technologies.

This research suggested a low-cost smart medicine box device with a comprehensive infrastructure to assist users and health providers during the administration of medications. The approach is already a proof-of-concept developed as part of a master's degree program at COPPE/UFRJ that needs to be refined and tested. The original plan was to put the cutting-edge technology taught in this course to use. As a result, we determined that this approach has the potential to enhance convenience and quality of life.

Other kinds of equipment, such as wearables, electronic devices, and home appliances, may be incorporated into the proposed architecture, providing an unlimited number of implementations and features. This system could be strengthened by allowing users to plan medication intake alarms on a more customizable basis, such as twice a week, three times a week, or every other day, among other options. Another disadvantage is the detection of users' behaviour related to medication use. Only if the box is tilted is the Tilt sensor enabled.

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