A SURVEY ON IoT RELATED PATTERNS

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Abstract: Internet of Things (IoT) makes the things in the integrated smart pervasive environment. Massive number of devices connected, communicated and collaborated with one another to achieve the common goals. Due to more number of devices and applications like Healthcare, Logistics, Smart environments and Personal and Social, different procedures adopted to manage different work. In this paper we surveyed different patterns used in the IoT devices and applications. This will give the clear idea about patterns used in IoT applications.

Keywords: Internet of Things, Patterns

1. Introduction

The Internet of Things (IoT) is a modern technology that connect set of anyone, anything, anytime, anyplace, any service, and any network. The IoT uses objects like Radio Frequency Identification (RFID) tags, smart phones, sensors, etc. will be capable of communicating and functioning in collaboration with one another and achieve the common goals. [1] [2] [3] [4] By the introduction of IoT automation is implemented in our daily life. The emerging IoT applications are health care, transportation and logistics, traffic congestion, smart cities, waste management, structural, security, emergency services, industrial control, retail, personal and social.

Patterns are quality improving techniques. A design pattern is a common reusable solution to a generally occurring problem within a given context in software design. Patterns help us to construct the common understanding of capable software engineers. They apprehend present, well understanding in software development and support to encourage effective design practice. Entire pattern deals with a explicit, recurring problem in the design or implementation of a software system. To develop software architecture with fixed properties the Patterns can be used. (Frank Buschmann et al.,2001)

There are numerous amount of IoT applications available and utilized by the end users for their day to day activities. This service increases the sophistication of the end users. Many studies (Wen-Tin Lee,2017, S Aljawarneh,2016) were reviewed to know how IoT is involved and utilized by the people in the day-to-day activities as well as to standardize the past experience of the software architecture.

2. Literature Survey

Wen-Tin Lee et al [6], proposed five security design patterns for IoT software system, which are secure logger pattern, input validation pattern, secure directory pattern, secure adapter pattern and exception manager pattern. Secure logger pattern encrypts the server events in the log files. Input validation pattern validates the mobile user’s input. The security directory pattern is applied in server validate user’s right for accessing file in server. Exception manager pattern secures exception and limits of exposure of sensitive data. The adapter pattern applied between Arduino and Server for interfacing.

Shadi A.Aljawarneh et al [7], proposed a pattern for temporal data. In IoT most of the information are temporal information which is under the categories of broadest type of information. Information are collected from different devices like sensors, smart mobiles, smart homes and smart vehicles, these information are classified as temporal nature and huge data are collected and recorded at different timestamps. Here main objective is to segregate the temporal data pattern and identify their recorded values at different timestamps. These incidence values helps us to determine our parameter such as time interval of the data pattern recorded and to classify the temporal pattern. In order to increase the level of security, the stamped fleeting information are used in the IoT.

Soheil Qanbari et al 2016 [8], proposed four design patterns for Edge applications. Edge provisioning pattern deals with the provisioning of all the edge devices automatically. Edge code deployment pattern deals with deployment of code to all devices connected with IoT. Edge orchestration pattern deals with automating the creation, monitoring, and deployment of resources in the IoT environment. Edge diameter of things (DoT) pattern deals with the metering usage of all edge devices.

Marco Brambilla et al [9], proposed a set of design patterns for the common user interaction for the IoT
applications. These patterns are One to one Device operations, One to many Device Operations, many to one Devices Operation, a program driven Device, many operation under One Category and collect the device detail, current state of the device, and collected information from the device, Application Launch, Device for searching, and locality Devices and pull information.

Lukas Reinfurt et al [10], proposed five patterns for the IoT devices. Device gateway pattern used to connect devices to the network. Device shadow pattern deals with interaction of off line devices. With the use of Rule engine pattern user can define rules without program. Device wakeup trigger is used to send message to the devices that not currently connected to the server but they listen the message. Remote lock and wipe pattern is used to control the device when it was stolen or missing.

Gullena Satish Chandra [11], classify design patterns based on the IoT architectural layers- patterns on edge device, communication, security, local network, integration, IoT cloud, infrastructure, monitoring, application and information model.

Michael Koster [12], briefly states the design patterns of connected things, IoT use cases, information models, interaction, application programming, infrastructure and IoT security. These design patterns are useful to provide a better solution for constructing architectural model for IoT.

Table 1. Different Patterns in IoT

<table>
<thead>
<tr>
<th>Publications</th>
<th>Parameters or Attributes</th>
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</thead>
<tbody>
<tr>
<td>“IoT Design Patterns: Computational Constructs to Design, Build and Engineer Edge Applications”, Soheil Qanbari et al, IEEE, 2016</td>
<td>Four different design patterns are used to develop homogeneous applications.</td>
</tr>
<tr>
<td>“Model-driven development of User Interfaces for IoT Systems via Domain-specific Components and Patterns”, Marco Brambilla, ICEIS, Volume 2, 2017</td>
<td>UI design pattern is identified and its merits and demerits are reported in the development of IoT applications.</td>
</tr>
<tr>
<td>“Design Patterns for an Internet of Things” Michael Koster, ARM community, 2014</td>
<td>Set design patterns of connected things, use case, information model, interaction, application programming, infrastructure and Security for IoT architecture.</td>
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</table>
3. Timeline Of IoT And Patterns

Internet of Things

From the above timeline chart, we observed the development of network, Internet, Ubiquitous computing, Smart devices, Cloud and IoT. The term IoT was coined by Kevin Ashton in 2009. In the past decade, IoT has been dramatically used in various applications.

In the future years, IoT will play a vital and eminent role in the modern technological world. We can absolutely say that the IoT will conquer the world soon.

Patterns:

From the above chart, we infer that the Patterns were originated by Christopher Alexander in 1977. In 1995 Gamma et al, published a book “Design patterns: elements of reusable object oriented software”, this popularized the design patterns to all. Then the researchers turned their vision on the importance of patterns. Later on, researchers create patterns for website, health, business applications, internet shops, navigation, building interfaces, infrastructure, personalized web applications, Enterprise Application Architecture, online share trading, Software Health Monitoring, fundamental banking, component retrieval system, browsing and purchasing behavior of web users, business integration, composite, building secure systems. Internet banking etc. These patterns gave the clear idea about the particular application. Patterns for these applications are very useful for reusing, time saving to rebuild and create standard for that application.

Patterns in IoT

Internet of things used variety of massive devices to communicate with each other. Devices with different vendors of different policies give more complication to synchronize. So the integration and unique policy is needed for the IoT applications.

Implementation of patterns are needed for this purpose. So, researchers started slowly to implement patterns in IoT. From the given timeline chart, we found that most of the design patterns are device based and some patterns are with User Interface, Communication, security and Data utilization. But there is only a limited patterns in applications.

4. Understanding From The Survey

Wen-Tin Lee and Po-Jen Law proposed the five security design patterns for the development IoT software system. Shadi A.Aljawarneh et al discussed temporal pattern with data from several sources shall be of temporal nature with engendered information recorded at different timestamps. Soheil Qanbari et al proposed four design patterns facilitating IoT architects to make edge applications. Marco Brambilla offered a set of design patterns for the common user interaction for the IoT applications. Lukas Reinfurt et al suggested five patterns, Device gateway, Device shadow, Rule Engine, Device wakeup trigger and Remote lock and wipe for IoT devices. Gullena Satish Chandra classify patterns based on IoT architectural layers. Michael Koster set design patterns of connected things, use case, information model, interaction, application programming, infrastructure and Security for IoT architecture.

5. Conclusion And Future Work

From the study, we clearly analyzed the patterns used in the IoT applications. We found that most of the patterns are specific to their applications, where it has its own merits and demerits. By the detail survey, we found there is lot of scope for developing a generic pattern for the IoT applications.
References


