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Internet of Things based system for Smart Kitchen

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Abstract

This paper provides insight to the dynamics that come with the emergence of IoT in the furniture and kitchen manufacturing industry. By implementing the concept of IoT companies are currently evaluating how internal knowledge and skillsets correspond to the new technical requirements that the emerging digital setting outlines and by directing internal research they are learning more about IoT and connected products as they proceed. One current major problem is that there are no open protocols that can connect all products regardless of supplier. Nevertheless, implementation of IoT does not solely involve technical aspects and companies are also faced with the dilemma on how to design and develop corresponding commercial processes. To this point early product implementations have arrived on the consumer markets and the future vision is to achieve full integration that imbeds connectivity and interaction among all products in the home.

Index Terms: Internet of Things, Blue ocean strategy, Dynamic capabilities, Changing environments, Business model, Kitchen and furniture industry.

1. Introduction

IoT has changed the life of human beings. Enormous increase in users of Internet and modifications on the internetworking technologies enable networking of everyday objects [1]. Each thing is uniquely identifiable through its embedded computing system within the internet infrastructure [2]. If the settings of the environment can be made to respond to human behavior automatically, then there are several advantages. Ambient

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intelligence responds to the behavior of inhabitants in home and provides them with various facilities [3]. Internet of Thing is all about physical items talking to each other, machine-to-machine communications and person-to-computer communications will be extended to things [4]. The ultimate goal is to create a better world for human beings, where objects around us know what we like, what we want, and what we need, and hence act accordingly without explicit instructions [5]. Natural gas is an energy source that is commonly used in homes for cooking, and heating. Financial loss as well as human injuries is happened due to accident cause by gas leakage. To detects gas leakage and alerts the subscriber through alerts and status stored in database and display on android device is the work aims of the designing a system [6]. The system is an intelligent system, as it does not create a noise nuisance by continuously sounding alarm but gives the alerts to the users. Explosions due to gas leakages are avoided by this technology and improve safety of life and property while using domestic cooking gas.

Digital transformation is an ongoing development process of digitalization in society that has received a lot of attention in academia as well as in business. The development has gone through many phases and in the last decade Internet was recognized for its empowering role to change economic and social systems [7]. Internet has since then continued to spread and is nowadays considered to be one of the most disruptive technologies in modern history [8]. In 2015, 3, 2 billion people worldwide used Internet (ITU, 2015) and in today's modern society people are constantly surrounded by Internet. Not only does Internet allow people to occasionally surf the web, it has radically transformed the modern world. It has changed the way business is conducted, it has revolutionized educational systems and human learning methods but perhaps more importantly; it has changed the way of human interaction [9, 10]. By the use of Internet, it has become possible to transfer knowledge in ways no one could foresee and society is today full with information and the flows are growing faster and faster. Every day in every waken hour people are surrounded by *things* that are able to collect, track and store all sort of information on their lives and persons [11-13]. This ultimately raises a lot of unanswered questions and concerns. But if one merely focuses on the positive side, people have recently started to think about and explore how these information flows can become valuable. E.g. how can all this available information be used? What opportunities does it bring? What if *things* are to connect to one another, what value can be created and extracted from that?

This is where the concept of Internet of Things (IoT) enters the picture. The conceptual idea of IoT is to enable *things* or *objects* with connectivity through e.g. RFID tags, sensors, actuators, big data analysis, cloud computing, mobile phones etc. The *objects* or *things* can with the above mention features collect information, understand their environment, communicate and report current status. Ultimately, this means that all sorts of *things*, including goods and appliances can become equipped with small built-in sensors and computers which leave it up to the creative mind to bring new services and applications to the market [14, 15]. In relation to the above mentioned, the definition of IoT is understood as to include all devices and objects whose state can be altered via the Internet, with or without the active involvement of humans. Different forecasts predict that there will be around 26 billion connected devices in the world by the year 2020 [16, 17]. The potential economic benefits and the possibilities IoT brings should be clear, not least as processes will become autonomous or require very little human interaction. Most applications and techniques in IoT will be in the manufacturing and industrial settings and in the consumer-facing subset smartphones will be vital bringing the technology to consumers. Even though IoT still is emerging, the potential of it promises to enable companies to achieve objectives in new and innovative ways [18, 19].

When it comes to economic growth and structural transformation in society, technological change is regarded to be the strongest fundamental driver [20]. But even if economic growth is desirable, transformation and adjustment of social and institutional environments in line with technological change can also be painful. Technological and societal changes possess a threat to all companies as it challenges established routines, processes and competences which all are invaluable to current operations. Therefore, in order for companies to successfully respond and adapt to change, they should do so by continuously evaluating their internal capabilities as well as existing business models [21, 22]. The major aspect with regards to IoT is that products in a connected world no longer should be seen as "*one-and-done*". Whereas the previous business logic was

simple; you make a product, sell it and get the money, final! The business logic of IoT is proposed to be different. In the emerging digital setting, a physical product can be the beginning of a long relationship and a *thing* may in many cases refer just as much to a service as a physical product. Through software updates and big data analytics it has become possible to reach customers with new features and functionality on a regular basis and with the ability to track objects it becomes possible to respond instantly to customer behavior. Not to mention, as products potentially will become connected with other products this will give rise to services that more efficiently can optimize processes and improve customer experiences. Therefore, in order for companies to successfully enter this new phase, [23] that firms not only must focus their efforts of developing internal core capabilities but also state the importance of growing partnerships. Understanding how others in the business ecosystem make money will be vital for long-term success [33, 34, 35].

The above stated issues and the proposed challenges that circumstance IoT diffusion becomes more evident looking at the results from an IoT survey that was conducted by Telenor in Sweden in 2014. Around one third out of 100 manufacturing companies responded that transformation of existing business models possess the biggest challenge in implementing IoT as part of their business. At the same time, the vast majority of companies think that IoT will be important and over half of them believe the area to become critical for their organization in five years' time. And finally, as many as six out of ten companies think that IoT will change their whole industry in the same time period. Despite [24, 25] the great potential of IoT and the many challenges it possesses, the impact it has on incumbent companies has, as far as I am aware, received little attention in the literature. Point out some barriers that prevent companies from moving ahead with IoT, e.g. the challenge of identifying horizontal needs and opportunities to overcome the market immaturity problem and problems related to managerial challenges to achieve internal team alignment. In other words how the existing organization can match the new technology with the ongoing objectives of its internal business developers. It extended [26] this view by explicitly point out three contemporary challenges; the diversity of objects, the immaturity of the technology and the unstructured ecosystems. The authors further argue that in order to overcome the associated problems, managers must shift their focus from the business model of the firm to ecosystem business models (Ibid). With this background, it is interesting to investigate how IoT affects incumbent companies in traditional manufacturing industries and in particular focus on companies in the kitchen and furniture industry [32]. The kitchen and furniture industry is interesting because there are plenty of areas in the home where one easily can see how household appliances and furniture together with connectivity and autonomous solutions can help to facilitate everyday life. For instance, just think about an kitchen that autonomously monitor the use of kitchen appliances so that energy consumption levels doesn't go beyond the threshold or ovens that can turn on Spotify for you when you are about to start cooking. Implementation of IoT products in the household will not only help to spread the technology, the home is potentially one of the places where a large number of end consumers will encounter the technology [27].

A final factor that makes it even more interesting to focus on firms in the kitchen and furniture industry is that most of the companies have rooted experience and competences in working with non-digital materials such as wood, plastic and textiles etc. [28, 29]. This makes it worth investigating how they orientate themselves in a business ecosystem that moves in a direction towards a bigger emphasis on digital and software capabilities. Altogether, this provides the study with a strong argument and a clear goal to investigate the development further. The purpose of this paper is to investigate how incumbent companies in the kitchen and furniture manufacturing sector adapt to the emergence of IoT and work to implement the technology in products. The study is explorative and aim to shed light on how implementing IoT in consumer products may transform current practices. The aim is also to map what aspects that are important in order to introduce IoT consumer products on the market and to highlight associated challenges. To be able to fulfil the purpose a theoretical literature review will be presented and semi-structured interviews with representatives for six companies in the kitchen and furniture manufacturing industry will be conducted [30, 31].

The rest of the paper is organized as follows. In Section 2 the background concepts are discussed. Section 3 presents the survey of different comparative analysis on the basis of parameters and advantages/disadvantages and Section 4 discussed about the proposed architecture. Finally, Section 5 concludes the article.

2. Related Works

In the year 2009, Kiritsis proposed a new definition of intelligent product based on what happened with us as human being. It suggests closed loop product life cycle management to develop more enhanced product data technologies, which can be used in future to develop smart or intelligent product and also to deal not only with static but of dynamic product data as well. In the year 2009 Eisenhauer et. Al., was published which proposed a platform to create an intelligent application for wireless devices and sensors. This will work as a middleware for the developer to create intelligent application for the embedded systems. It used unique combination of Service-oriented Architecture (SoA) and a semantic-based Model Driven Architecture to build this platform.

In year 2010 Rolf focuses on new security measures and various privacy challenges in the IoT. It focuses on different parameters like attacks, data authentication, access control and client privacy to study the privacy challenges and to build new security model. This paper also describes the importance of establishment of a task force doing research on the legal challenges of the IoT. It also suggests to build a legal framework which will be more flexible and easy to adjust according to specific needs.

In 2010 Haller, focuses on describing all the important terminologies used in the internet of things in detail. This paper tries to bring clarity by describing the most important terms like things, devices, and entities of interest, resources, addressing, identity and more importantly, the relationships between them. In 2010 HONG et. al, it proposed wireless sensor network technologies on the basis of various standard protocols, internet protocols to facilitate internet of things. It focuses on how to adapt the IP to the space of things. This article introduces the Sensor Networks for an All-IP World (SNAIL) approach to the IoT. It also includes four significant network protocols: mobility, web enablement, time synchronization, and security.

In the year 2013 Tsado et. Al proposed to detect the gas leakage with the help of GSM cell phones. They used two gas sensors; used to detect gas leakages in a particular location. They have also used 8051 microcontrollers programmed in assembly language and a GSM phone. The GSM phone is configured to send gas leakage alerts in the form of a short message service (SMS) message which indicates the exact location to another GSM phone to enable prompt necessary action. This whole system will lead to a faster detection when the gas leakage occurs. In 2013 Guo et. al, suggest to create an IoT based on the ad hoc, opportunistic networking of devices (e.g., mobile phones and smart vehicles) using short-range radio techniques (e.g., Bluetooth and Wi-Fi). This will create a close relationship between human and opportunistic connection of smart things because it deals with information forwarding and dissemination within and among the opportunistic communities formed based on the movement and opportunistic contact nature of human. This paper suggests a method to create IoT in a different manner so that it can be created whenever needed with the help of radio frequencies. In the year 2014 Apeh et. Al proposed a system that detects gas leakage and alerts the subscriber through alarm and status display and also turning off the gas supply valve automatically. It automatically uses a normally closed solenoid valve for the shutting off of the gas valve before calling for help via visual display and alarm. It automatically opens the valve again for normal operations once the leakage goes below the set point.

In 2014 Bello and Zeadally, focuses on how two devices in any IOT should communicate intelligently because the quality of the information gathered depends on how smart the devices are. In IoT, different devices work on different network standard, so this can lead to several networks challenges & this cannot be solved by traditional routing protocols. So this paper proposed state-of-the-art routing algorithms, which can help to achieve an intelligent D2D communication in the IoT. In the year 2016 Sun et. Al proposed that one can use IoT to make a network of various connected devise and smart sensors, so that this network can able to remember the past & plan for the future. They also argued that to use big data analytics to get the desired SCC. It suggested that one can use mobile crowd sensing and cloud computing to build SCC and suggested that SCC will help to improve livability, preservation and attainability.

3. Comparative Studies

Here in this section, we study about the different comparative analysis on the basis of techniques and parameters (See Table 1) as well as their advantages and disadvantages (See Table 2).

Table 1. Comparative Analysis using Different Parameters and Techniques

No.	Year	Authors	Parameters/Techniques
1	2011	Li and Yu	IOT (Internet of Things); Component; Sea Computing; Smart Home; Web Service
2	2014	Jing et. al.	Internet of Things, Security, Heterogeneous Wireless sensor networks, RFID sensor networks
3	2014	Singh et. al.	Internet-of-Things; Architecture; Internet Services; Semantic Web; 6lowpan; Sensor Networks
4	2011	Bandyopadhyay et. al.	Internet of Things, middleware, semantic model, context-awareness, ubiquitous computing.
5	2010	Kranz et. al.	Internet of Things(IoT), human-computer interaction (HCI),
6	2013	Guo et. al.	Opportunistic IoT, Opportunistic mobile social networking, Heterogeneous community orchestration, Information dissemination, Human-centric sensing
7	2013	Ning et. al.	Internet of Things (IoT), authentication, cyber-entity, physical-object, security.
8	2015	Soldatos et. al.	Internet-of-Things, Open source, Semantic interoperability
9	2009	Dohr et. al.	eHealth; Pervasive Healthcare; Telemedicine; Near Field Communication (NFC); RFID
10	2014	Perera et. al.	Internet of Things (IoT), Internet Connected Objects (ICO), cloud, sensor data, Mobile Sensor Data Processing Engine (MOSDEN), service model
11	2015	Li et. al.	IoT . Internet of Things, RFID. Wireless Sensors Network. Service Oriented Architecture
12	2013	Soliman et. al.	Smart home, Internet of Things, Cloud Computing, Arduino, Zigbee, JSON
13	2010	Atzori et. al.	Internet of Things, Pervasive computing RFID systems
14	2012	Tozlu et. al.	Internet of Things, low power wi-fi technology, IP connectivity of battery powered devices.
15	2015	Puustjärvi and Puustjärvi	Smart data; RDF; Ontologies; Health monitoring; Semantic interoperability; Internet of things
16	2013	Yashiro et. al.	Internet of Things (IoT), constrained application protocol (CoAP), ubiquitous ID (uID) architecture, RESTful services

Table 2. Comparative Analysis using Different Advantages and Disadvantages

No.	Year	Advantages	Limitations
1	2011	Presented the outline of a smart home framework in view of Internet of Things (IOT) and administration segment innovations.	As there are various scopes in IoT resulting in various privacy and security issues
2	2014	Breaks down the cross-layer heterogeneous joining issues and security issues in detail and talks about the security issues of IoT in general and tries to discover answers for them.	IoT framework lives in a more hazardous condition with restricted assets and less system monitors, consequently lightweight arrangements would dependably be the principal decisions for IoT security
3	2014	Presents a novel engineering model for IoT with the assistance of Semantic Fusion Model (SFM). This engineering presents the utilization of Smart Semantic structure to epitomize the handled data from sensor systems.	Improvement of space particular cosmology or a free philosophy arrange is required
4	2011	The part of middleware framework in IoT is displayed	Support for setting identification and preparing have not been accomplished completely. Support of semantic modelling and overseeing of information volumes likewise fall in the open issues, especially taking care of the group sourcing of differing space.
5	2010	Showed the hidden ideas of installed cooperation, the mechanical and calculated wonders of	Having privacy and security issues

No.	Year	Advantages	Limitations
		flawlessly incorporating the methods for collaboration into regular ancient rarities.	
6	2013	Displayed shrewd IoT, another examination zone that tends to data dispersal and sharing inside and among crafty groups that are shaped in light of the artful contact nature of human.	Many of the challenges and issues need to be worked out
7	2013	Considered the Unit and Ubiquitous IoT (U2IoT) to address the digital security issues, exhibit the prescribed security approaches as indicated by the digital substance action cycle, and further set up a safe communication answer for various cooperation situations with both security and protection contemplations.	Having privacy issues
8	2015	The OpenIoT extend, which has created and given a first-of-kind open source.	IoT stage empowering the semantic interoperability of IoT benefits in the cloud.
9	2009	Proposed a closed circle social insurance process, mix of both KIT innovation and Closed Loop Healthcare Services for elderly individuals can be used to understand the focal AAL worldview through the IoT	Data privacy and security issues
10	2014	Proposed an IoT middleware arrangement that can take a shot at asset obliged cell phones enabling them to gather and process information from sensors effortlessly	Mechanized sensor disclosure and arrangement functionalities can be added to the MOSDEN where it will have the capacity to look and find any sort of sensors around a given area and consequently introduced the required modules.
11	2015	Overviewed late advances on IoT from the point of view of empowering advances. Specifically, the part of SoA in IoT has been acquainted and related empowering advances with execute SoA have been talked about	Need potential solution of various discussed problems
12	2013	Presented a way to deal with the advancement of Smart Home applications by coordinating Internet of Things (IoT) with Web administrations and Cloud registering.	Having privacy and security issues
13	2010	Studied the most essential as-1650 pects of the IoT with accentuation on what is being done and 1651 what are the issues that require additionally examine.	Current advances make the IoT idea achievable yet 1653 try not to fit well with the versatility and proficiency require-1654 ments they will confront.
14	2012	Utilized financially accessible chips, they demonstrated the achievability of low-control Wi-Fi innovation to empower IP network of battery fueled gadgets.	Under overwhelming in-organize movement, the AP turns into a bottleneck and influences the dormancy and dependability impressively.
15	2014	Keeping in mind the end goal to accomplish semantic interoperability in brilliant homes they have created Smart Home Ontology.	Semantics for the information that are traded by the frameworks and gadgets in a savvy home.
16	2013	The uID-CoAP model, another model intended to have IoT benefits on basic inserted frameworks	Regular customer apparatuses.

4. Proposed Work

We proposed the design and construction of an IoT based Smart Kitchen System are indicated in Fig.1. Here different types of sensors were used to detect gas leakages, water tank overflow and bucket management system in a kitchen; its outputs are then interfaced with an ATmega32 microcontroller programmed in assembly language. The GSM phone is configured to send alerts in the form of a short message service (SMS). We can get this and much more safety feature that can be integrated with the automation system includes temperature sensor, weight sensor. Continues monitoring of services in kitchen is performed by this system.

The system is proposed of Android Smartphone user's mobile app will be developed in android. MySQL will be used for maintaining database. In this system, the main concept used is atomization of home appliances using the domain of Internet of Things. For this purpose, a gas cylinder, water tank and bucket are used which is provided with different kind of sensors as mentioned above. The variation in parameters will be observed with the help of the different sensors and the values will be taken according to the variations. For example, reduction in the weight of the gas, water tank and buckets below the threshold value will be sensed by the weight sensor and accordingly message will be sent to the user and also the value will be stored in the database accordingly. Thus, the working of all sensors takes place in same manner.

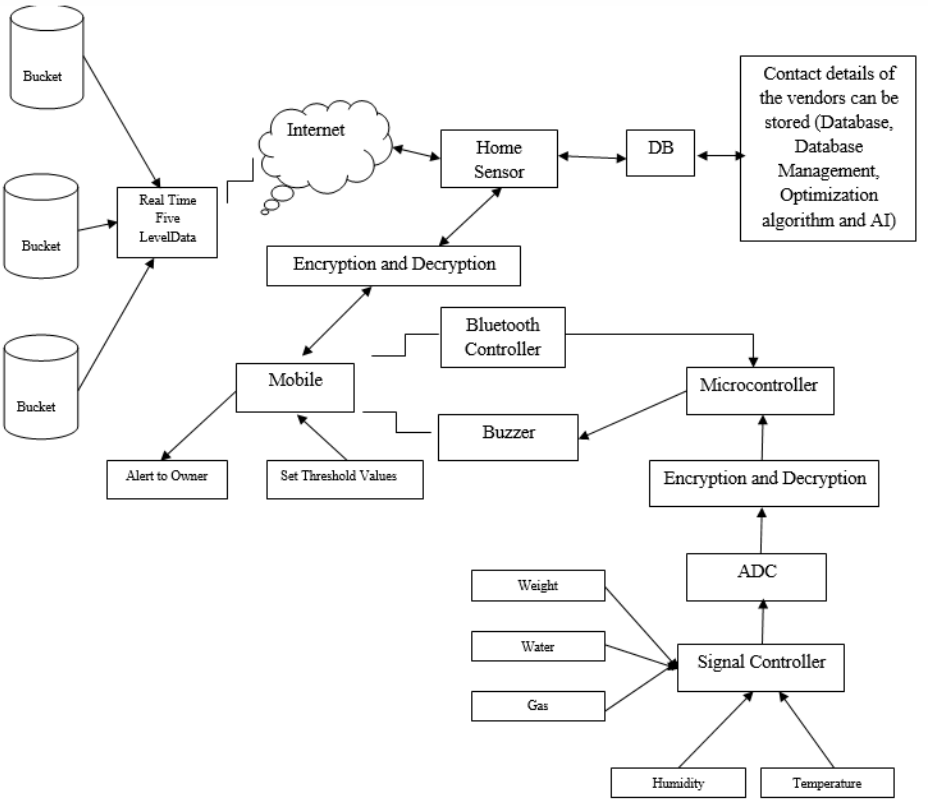

Fig.1. Architecture of IoT based Smart Kitchen System

5. Conclusion

Our Smart Kitchen using IoT system with multiregional sensors has been designed, constructed and tested. The result obtained from the tests carried out shows that the system is capable of sending SMS alerts whenever there is gas concentration at the inputs of the gas sensors. Hence this system can be used in homes and public buildings such as hotels and restaurants. Smart kitchen provides you all the automation features that include safety features over gas leakage detection system. For this we are using gas sensors, temperature sensors, weight sensors. Gas sensors are used to detect the leakage of a gas in the system, weight sensors are used to detect the weight of the gas cylinder. Temperature sensors are used to detect the current room temperature. Server stores information and related data are stored in it; it also stores the information about the hardware, sensors, and also maintains the logs and status of system, also stores the room temperature and information

about the users. Threshold values are set into the room, when it crosses that values it will send a notification to the user, about the leakage of a gas cylinder and leakage of a gas. Server can communicate with the user through android device. Through email and SMS server can sends a notification to the user which will display on the android devices. It can prevent the accident and hazards. The only way to access the information is if the user is far from the home. It is a cost effective and time-consuming solution. We can use this in various applications like home automation, Hospital management, Military management, industrial applications. One of the modifications is to provide the system with a dual power supply i.e. include a battery power supply source in addition to the utility power supply. Design the sensors that can be used for more kitchen parameters. Apply various techniques to make the system more secure.

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