Home Health Hub Internet of Things (H^3IoT): An Architectural Framework for Monitoring Health of Elderly People

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Abstract— Internet of Things (IoT) has paved a path towards the digitization of everyday things connecting each other through internet. Due to the huge advent of IoT in recent years, researches have stared to accomplish the long cherished will of human being to make life simpler and better in many ways.Health being the most valuable wealth of human,should be given most priority. Though health related research implyingIoT has been neglected due to heterogeneity and interoperability issues. This literature presentsH3IoT a novel architectural framework for Home Health Hub Internet of Things for monitoring health of elderly people at home.The frameworkis promising in terms ofits design and future envision ofusage of real lifeimplementation H3IoT.

Index Terms—Internet of Things, architecture framework,health care.

I. INTRODUCTION

THE Internet of Things (IoT) has gained rapid attention as a comprehensive paradigm that isdriven by an expansion of the Internet. The phrase "Internet of Things" is believed to haveoriginated at the beginnings of the century in correspondence to the work done at the MIT Auto-ID Center [1] to develop industry-oriented identification technologies to automate, reduce errorsand increase efficiency [2]. However, the IoT model has grown since to accommodate any objectcapable of interacting directly with its local neighbor. In this context, the Internet can beviewed as a backbone network that interconnects a huge number of smaller (peripheral) networks,each of which would regroup objects according to its neighborhood relationships and physicalproperties. Examples of such smaller networks include sensor networks, vehicular networks andMobile Ad-hoc Networks (MANETs) in general.The IoT will have a tremendous effect on all aspects of everyday life, promising to eventuallyprovide identification, tracking and communication abilities to virtually every object on theplanet [3]. The IoT will revolutionize networking over a myriad of applications, includingparticipatory sensing, enhanced learning, e-health and automotive applications. Similarly, IoT'sinfluence will reform numerous business disciplines such as intelligent manufacturing, retail,supply chains and product lifecycle management, in addition to reliable and safe transportation of people and goods [2], [4], [5], [6], [7], [8].It is broadly accepted [3], [9] that the technologies and applications of IoT are both in earlystage and distant from mature.Few attempts such as telemedicine [10], mHealth [11] etc.have been made to cover the health related problems till now but they lack in common infrastructural design hence rely only on the specific way of communication and delivery systems which are sometimes costly, otherwise immobile and invasive.

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This motivates to develop a framework implementing the concept of IoT in such a way that the whole architecture is almost mobile,cost effective, and delay tolerant.

Here H^3IoT is proposed to cater with theneeds of livelihood in a handy and easy to useway. This architecture is novel in its nature and promising in terms of envisaged successful applicability for wellness is populations there by reducing the strain points of today's healthcare system. Some of the most promising use cases of H^3IoT are connected e-health including preventive health, proactive monitoring, follow-up care and chronic care disease management.

The rest of the paper is organized as follows. Section II provides some related works. Section III describes H^3IoT. Section IV presents the discussions and conclusion remarks.

II. RELATED WORK

In [12], Eisenman et al. developeda mobile sensor network framework for collectingand processing sensory data from a human body and thendelivering and visualizing it in remote locations in real time.

There has been extensive research about designing anddeveloping framework or prototype collaboration environments.A very few [13], [14] have worked out preliminary frameworks. [13]hasconducted a literature survey of state-of-the-art Ambient Assisted Living (AAL) frameworks, systems and platforms to identify the essential aspects of AAL systems and investigate the critical issues from the design, technology, quality-of-service, and user experience perspectives. In addition, we conducted an email-based survey for collecting usage data and current status of contemporary AAL systems.[14] hasshown the relation of IoT with healthcare and some health monitoring architectures. [15], [16] have presented abstraction to Model Driven Tree Reference Model(MDTRM) and General Domain Model Architecture (GDMA) respectively.

III. H^3IoT

Home Health Hub Internet of Things (H^3IoT) is a 5–layered framework architecture developed for home based monitoring for elderly people. H^3IoT is a novel IoT based layered based model which comprises the dependency and interconnectivity of biosensors, communication channels, microcontroller, gateway, internet, and applications. This architecture is designed while keeping in mind the mobility, cheap, and easy to use perspectives. The health condition of elderly people residing at home can easily be monitored by their relatives, doctors, near by hospitals, and care takers wherein staying at remote location. The detailed structure of H^3IoT framework is shown in Fig. 1. Details of the H^3IoT architecture are given below

A. Physiological Sensing Layer (PSL)

The PSL is the bottom most layer of H3IoT. The task of PSL is to sense various physiological activities by

sophisticated biosensors. Examples are Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG) cover the electrical activity of heart, scalp (brain), and muscle respectively. Among other sensors panic alarm (critical activity can happen anytime mainly at accident), weight scale (measures weight), tilt meter (records tilting), movement meter (captures movement of body), respiratory meter (lung activity measurement), pulse oxymeter (measures SpO2 in blood along with pulse of heart), blood pressure (calculates blood pressure), blood glucose (measures dissolved glucose in blood), thermometer (measures temperature of body). Few more sensors could also be added later on if necessary. Sensed raw data are then sent to upper layers for further processing.

B. Local Communication Layer (LCL)

LCL is 2nd bottom most layer which plays vital role by transferring the sensed data at PSL to upper layers. The communication technologies reside in PSL basically act in low geographical range (10 – 900 meter). This is because elderly people should be benefited with minimum physical intervention while getting connected to the whole system. USB PHDC (Personal Healthcare Device Class), Infra Red (IR), Zig BEE, XBEE, BTLE (Blue Tooth Low Energy), BT HDP (Blue Tooth Health Device Profile), BT SSP (Blue Tooth Secure Simple Paring), 868 MHz RF (Radio Frequency) are various technologies which perform best in such scenarios.

C. Information Processing Layer (IPL)

IPL is the soul of H^{3}IoT. Microcontroller or open source hardware platforms might be in place in order to process the data obtained from LCL to information for further actions in higher layers.Proprietary platforms such as MicaZ [17], Libelium[18] etc. and open source initiatives as Arduino [19], Raspberry Pi[20] are now being used plenty in similar type of researches. Gateway (a network point that acts as an entrance to another network) links its information at IPL to upper layers implying 2G, 3G, 4G or WiFiconnectivity.

D. Internet Application Layer (IAL)

IAL consists the backbone of the system– Internet. Information received from IPL is conveyed to Andriod [29], IOS [30], or Cloud [31] (xively [21]Ayla [22],Axeda [23], Exosite [24], Open Source IoT Cloud [25] etc.) platforms for visualization and or storage and analyze at later stage. API (Application Programming Interface) [26], APP (Mobile App) (A mobile app is a computer program designed to run on smartphones, tablet computers and other mobile devices.) [27], Plugin (a software component that adds a specific feature to an existing software application) [28] are various software which increases accessibility of internet in Andriod, IOS devices as well as Clouds.

E. User Application Layer (UAL)

UAL is the top most ingredient of H^{3}IoT. UAL can be said as the reaching end of H^{3}IoT to the doctor, relative, hospital, and care taker who get the real time information about health of elderly people as their counter part. Mostly visualization of received and processed information from IAL is done in UAL. Otherwise, stored information at cloud (IAL) might be analyzed for detailed health history of the particular elderly person.

IV. CONCLUSION

IoThas brought a lot of opportunities in application domain. Out of many, health care is one of most crucial area where more research effort should be given. In this paper Home Health Hub Internet of Things (H^{3}IoT)frame work is proposed. The architectural concept of H^{3}IoT is effective in terms of homely environment for monitoring health status of our near and dear elderly people around.

H^{3}IoThas many advantages as it is mobility, cheap, easy to use, simple layered design, and delay tolerant. Though,H^{3}IoTlacks in support for emergency health care for critical elderly people. This could be done with few modifications in layers.Also, H^{3}IoT is made for homely

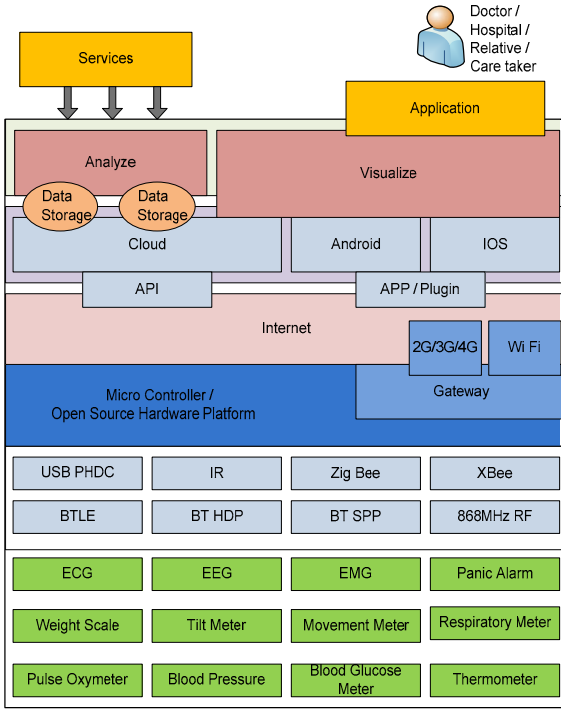

Fig. 1. H^{3}IoT framework architecture for monitoring elderly health.

support hence it has beet keptsimple but need to be changed rigorously if to be capable to act in clinical environment such as hospital, diagnosis center.

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