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WEARABLE DEVICES FOR HEALTH CARE APPLICATIONS USING BIG DATA

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Abstract— *The Internet of Things(IoT) is an emerging paradigm for the range of new capabilities brought about by pervasive connectivity. The concept involves situations where network connectivity and computing capability expand to objects, sensors, and everyday items that exchange data with little to no human involvement. The premise of the IoT is to build, operate, and manage the physical world by means of pervasive smart networking, data collection, predictive analytics, deep optimization, machine-to-machine methods, and other solutions. Its potential benefits can impact how individuals live and work. In the near future, corporate and government organizations, may be challenged by the inevitable addition of IoT devices to their networks and connected systems. This notion will serve as a source of innovative decision making.*

Keywords— *Big data, smart cities, smarthomes, health care applications, Behavioral Analytics, Frequent Pattern, Cluster Analysis, Incremental Data-Mining, Association Rules, Prediction.*

I INTRODUCTION

The US health care system faces daunting challenges. With the improvements in health care in the last few decades, residents of industrialized countries are now living longer, but with multiple, often complex, health conditions . Survival from acute trauma has also improved, but this is associated with an increase in the number of individuals with severe disabilities . Finally, recent health care reform efforts may add 32 million newly insured patients to the health care system in the next few years . These altered demographics raise some fundamental questions. How do we care for an increasing number of individuals with complex medical conditions? How do we provide quality care to those in areas with reduced access to providers?How do we maximize the independence and participation of an increasing number of individuals with disabilities? Cleary, answers to these questions will be complex and will require changes into how we organize and pay for health care. However, part of the solution may lie in how and to what extent we take advantage of recent advances in information technology and related fields. Currently, there exist technologies that hold great promise to expand the capabilities of the health care system, extending its range into the community, improving diagnostics and monitoring, and maximizing the independence and participation of individuals. This paper will discuss these technologies in depth, with a focus on remote monitoring systems based on wearable technology. We chose to focus on these technologies because recent developments in wearable sensor systems have led to a number of exciting clinical applications. Wearable sensors have diagnostic, as well as monitoring applications. Their current capabilities include physiological and biochemical sensing, as well as motion sensing . It is hard to overstate the magnitude of the problems that these technologies might help solve. Physiological monitoring could help in both diagnosis and ongoing treatment of a vast number of individuals with neurological, cardiovascular and pulmonary diseases such as hypertension. Home based motion sensing might assist in falls prevention and help maximize an individual's independence and community participation. Remote monitoring systems have the potential to mitigate problematic patient access issues. Nearly 20% of those in the US live in rural areas, but only 9% of physicians work in rural areas. Access may get worse over time as many organizations are predicting a shortfall in primary care providers as health care reform provides insurance to millions of new patients . There is a large body of literature that describes the disparities in care faced by rural residents . Compared to those in urban areas, those in rural areas travel 2 to 3 times farther to see a physician, see fewer specialists, and have worse outcomes for such common conditions as diabetes, and heart attack . Wearable sensors and remote monitoring systems have the potential to extend the reach of specialists in urban areas to rural areas and decrease these disparities. A conceptual representation of a system for remote monitoring is shown in Figure 1. Wearable sensors are used to gather physiological and movement data thus enabling patient's status monitoring. Sensors are deployed according to the clinical application of interest. Sensors to monitor vital signs (e.g. heart rate and respiratory rate) would be deployed, for instance, when monitoring patients with congestive heart failure or patients with chronic obstructive pulmonary disease undergoing clinical intervention.

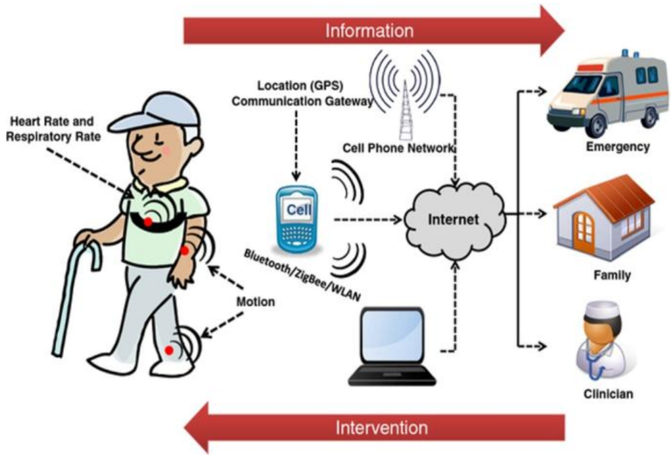


Figure:1 Illustration of a remote health monitoring system based on wearable sensors health related information is gathered via body worn wireless sensors and transmitted to the caregiver via an information gateway such as a mobile phone. Caregivers can use this information to implement interventions as needed.

II PROBLEM STATEMENT

Wearable technology has made significant progress in recent years, with millions of devices being sold to consumers and steady advances being made in technological capabilities. Although the form and function of contemporary wearables have changed from Shannon and Thorpe's 1961 experiment, many of the same conflicting design issues have to be taken into consideration when developing modern technologies that are intended to be worn. Al- though wearables have benefited from advances in mobile technologies, functionality remains limited compared to smartphones. Additional- ly, smartphones do not need to be comfortable to wear while in motion, are less restricted by weight and size requirements, and have more well-defined aesthetic requirements. However, wearables present a tremendous opportunity for capturing a continuous stream of data about our physiology and kinesiology, which can em- power consumers with self-knowledge.

III LITERATURE SURVEY

In our recent book *Health-e Everything: Wearables and the Internet of Things for Health*, we capture in an interactive e-book format some global thought-leader perspectives as well as early examples of case studies and novel innovations that are driving this emerging technology domain. Here, we provide a brief snapshot of key findings related to these novel technologies and use cases, which are driving both health care practitioners and health consumers (patients). As technologists, having a firm understanding of customer-driven innovation and the actual user benefits of interconnective devices for health will help us engineer better solutions that are more targeted to the triple aim of better, faster, and cheaper health solutions.

A progressive improvement in gait following knee arthroplasty surgery can be observed during walking and transitional activities such as sitting/standing. Accurate assessment of such changes traditionally requires the use of a gait lab, which is often impractical, expensive, and labour intensive. Quantifying gait impairment following knee arthroplasty by employing wearable sensors allows for continuous monitoring of recovery. This study employed a recognised protocol of activities both pre-operatively, and at regular intervals up to twenty-four weeks post-total knee arthroplasty. The results suggest that a wearable miniaturised ear-worn sensor is potentially useful in monitoring post-operative recovery, and in identifying patients who fail to improve as expected, thus facilitating early clinical review and intervention.

IV EXISTING SYSTEM

Existing system approach uses Semi-Markov-Model(SMM) for data training and detecting individual habits and the other approach introduces impulse based method to detect Activity in Daily Life(ADL) which focuses on temporal analysis of activities that happen simultaneously Existing. Similarly, the work proposes human activity for wellness monitoring of elderly people using classification of sensors related to the mainactivities in the smart home. Monitoring Smart meters data are also used for activity recognition using Non-intrusive Appliance Load (NALM) and Dempster-Shafer(D-S) theory of evidence. The study collects pre-processed data from homes to determine the electrical appliance usage pattern and then employs machine learning-based algorithm to isolate the major activities inside the home. If it is not easy to detect usage dependenciesamong various appliances when their operation overlap or occur at the same time. Deriving accurate prediction of human activity patterns is influenced by the probabilistic relationships of appliance usage events that have dynamic time intervals. The study does not consider appliance level usage details. This might notbe applicable for human activity recognition since specific activities required individual and multiple appliance to appliance and time associations.

V PROPSED SYSTEM

Wearable technology has made significant progress in recent years, with millions of devices being sold to consumers and steady advances being made in technological capabilities. Although the form and function of contemporary wearables have changed from Shannon and Thorpe's 1961 experiment, many of the same conflicting design issues have to be taken into consideration when developing modern technologies that are intended to be worn. Al- though wearables have benefited from advances in mobile technologies, functionality remains limited compared to smartphones. Additional- ly, smartphones do not need to be comfortable to wear while in motion, are less restricted by weight and size requirements, and have more well-defined aesthetic requirements. However, wearables present a tremendous opportunity for capturing a continuous stream of data about our physiology and kinesiology, which can em- power consumers with self-knowledge.

Human health and fitness are areas in which wearables can offer insights that smartphones cannot. This is evident from the immense popu- larity of fitness trackers (e.g., the Fitbit Blaze, Jawbone UP, and Nike+ FuelBand) and smartwatches (e.g., the Apple Watch and Samsung Gear) being used by consumers to self-monitor physical activity. Additionally, wearables are be- ing used for self-monitoring and preventing health conditions such as hypertension and stress. Donald Jones with the Scripps Translational Science Institute says, "My favorite wearables to-day are those that measure blood pressure and that can be used to impute stress. I think these are some of the most interesting areas of feedback that we have today. Hypertension is a cause of many illnesses, and stress is obviously a big contributor". Research continues to explore how wearables can help patients and physicians before, during, and after medical procedures, such as surgery. For example, telemedicine can be performed by on-site paramedics wearing Google Glass, a head-mounted display with a camera and mi- crophone, and communicating with off-site medical doctors to provide expert care during disaster relief efforts. Ad- ditionally, wearables can pro- vide a more expedient means of monitoring a patient's vital signs during surgical procedures by reducing the size of equipment and the number of wires leading to external de- vices. Such applications could improve the quality of medical.

Even so, many issues need to be taken into considera- tion when deploying wearables for general health care. For example, John Feland, chief executive officer of Argus In- sights, says, "People get tired of the fitness bands and throw them in the sock drawer. They stop being useful, people lose their fitness momentum. Furthermore, data security and privacy are primary concerns for both patients and hospitals. Therefore, new technologies need to be integrated with devices and systems already in place, and approval by regulatory agencies can take years and millions of dollars before benefits are realized.

VI The IoT and Wearables in Action

Wearables are steadily becoming the most prevalent personal devices, offering users the ability to interact with other tools and physical objects around them. Once the IoT becomes more widely adopted—creating a truly hyperconnected world—common interactions via the Internet and connected objects may shift to more active engagement of content and environment, specifically in health care. Let's take a look at a few case studies that showcase how wearables and other technologies integrate to form an IoT solution in different domains.

A) Augmented Reality Wearables for Medical Education

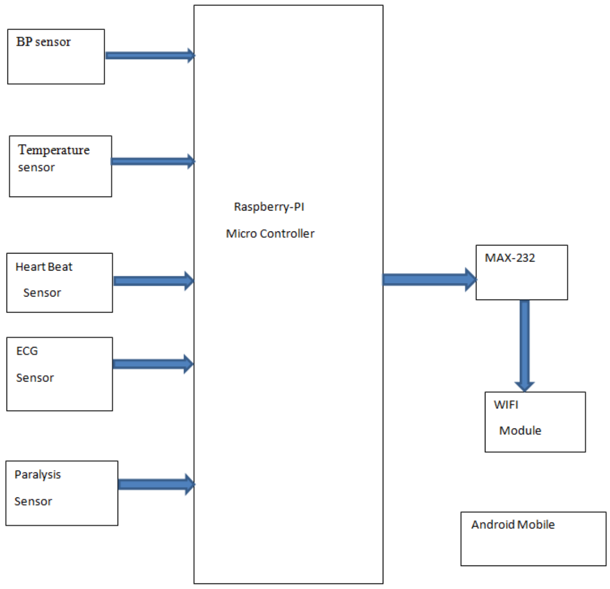
The IoT, augmented reality (AR), and wearables can create new paradigms that may potentially change the way people experience the world. In all aspects of life, AR is an emerging technology that can be implemented as a system of interactions to better serve human needs, especially in the field of health. For example, medical students from Case Western Reserve University and the Cleveland Clinic are using Microsoft Hololens, a holographic, head-worn computer that enables learners interacting with high-definition holograms to better understand the body's organs and systems. These students examine and become familiar with details of the heart and specific functions of the body through a three-dimensional projection instead of in traditional, cadaver-filled laboratories. Through the combination of AR, wearable technology, and the IoT, environments will become more responsive and digitally manipulable.

B) Humber River Hospital: An All-Digital Hospital

Humber River Hospital in Toronto, Canada, opened its doors in 2015 and is the first state-of-the-art, all-digital hospital in North America. Humber River uses the IoT to provide hightech patient-centered care in a manner that is more efficient with regard to costs and operations. The IoT has been integrated as a solution to provide faster care and consequently reduce patient stays, provide more accurate diagnoses, improve the link between medical records and medical practitioners, and automate more than three-fourths of its supply chain.
The all-digital hospital experience begins with online appointment scheduling and check-in. Patients are empowered with bedside access to their medical records via monitors, and they can communicate with doctors, nurses, and family members using video chat and instant messaging.

The hospital employs patient wristbands featuring real-time location technology for tracking wandering patients and improving security to prevent infant abduction. Additionally, Humber River has medical devices that automatically capture and store patient health metrics, which enables doctors and nurses to have a real-time view of a patient's health status from a distance.
The hospital uses robots to mix drugs and transport goods; machines also process blood samples in minutes, then transmit the results electronically.

VII BLOCK DIAGRAM



Raspberry-PI:
ARM virtual addresses (standard Linux kernel only)

As is standard practice, the standard BCM2835 Linux kernel provides a contiguous mapping over the whole of available RAM at the top of memory. The kernel is configured for a 1GB/3GB split between kernel and user-space memory.

The split between ARM and GPU memory is selected by installing one of the supplied start*.elf files as start.elf in the FAT32 boot partition of the SD card. The minimum amount of memory which can be given to the GPU is 32MB, but that will restrict the multimedia performance; for example, 32MB does not provide enough buffering for the GPU to do 1080p30 video decoding.

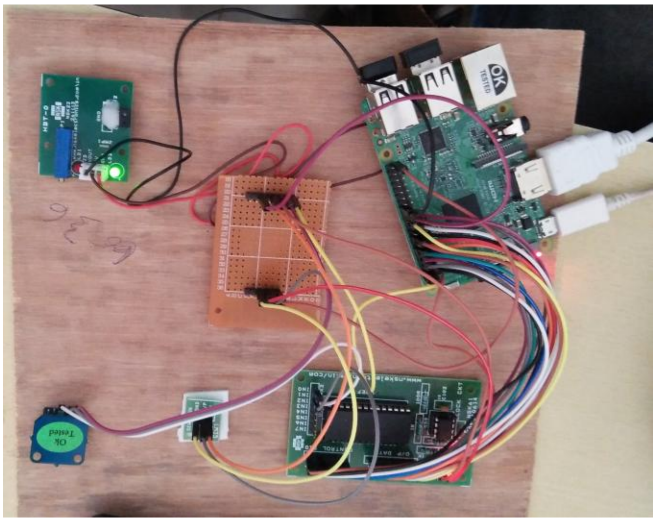
Virtual addresses in kernel mode will range between 0xC0000000 and 0xEFFFFFFF.

Virtual addresses in user mode (i.e. seen by processes running in ARM Linux) will range between 0x00000000 and 0xBFFFFFFF.

Peripherals (at physical address 0x20000000 on) are mapped into the kernel virtual address space starting at address 0xF2000000. Thus a peripheral advertised here at bus address 0x7Ennnnnn is available in the ARM kenel at virtual address 0xF2nnnnnn.

VIII EXPERIMENTATION RESULTS

The experiment results we have demonstrated the applicability of the proposed model to correctly detect multiple appliance usage and make short and long term prediction at high accuracy



XI CONCULSION

The IoT is a potential emerging solution that consists of interconnected devices. These networked devices offer better, faster, and cheaper customer-driven innovations in health care consumption as well as provision. Networked wearable devices and apps play an integral role, serving as the foundation to the ever-evolving practice of the IoT in health care.

Daniel Kraft of the Aspen Institute believes that apps and their IoT connections may begin supporting clinicians' workflow. He says, "As the incentives are aligning and value-based care comes together, the future will be the IoT that blends with wearable devices, apps, and smart analytics on top of data. This is so the clinician and care team can get the right insights from the data at the right time and not be overwhelmed. Smart preventative decisions can be made for a more proactive individualized care and therapy" [1]. With the wearables market still in its early phases of expansion and the IoT continuously changing, communications and electronic engineers will be at the forefront of building next-generation solutions.

There may be a substantial increase in things like embeddables— small and easily powered microchip implants that can be placed anywhere within a person's body. In terms of the health care sector, they may be able to measure vital signs without invasive surgery. Embeddables, such as electronic tattoos, for example, may be equipped with sensors that can transmit through wireless technology. Also, three-dimensional printed medical devices are very promising additions to the IoT, in that every object implanted in the human body may be scannable or trackable through networks.

Similar to what we see in science fiction movies, wearable devices that have electrostatic properties connected to various wireless systems could create new user experiences with the added capacity of artificial intelligence, making our future devices truly smart. With all of these looming innovations, the future seems to be very bright and electric.

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