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IoT Based Environment for Athlete's Supervision (IoT - Athletics)

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Abstract-

Athletics i.e; Track and Field Events are one of the most popular bunch of sports and games in the world. It has its wide popularity among millions of fans as well as another thousands and millions of player associated with Athletics. However, Athletes are prone to serious injuries and physical irregularities during their respective events and also during their training. Cramps, hypoglycemia, Muscle pull, swallowing the tongue, Hamstring, Concussion, and shortness of breath are commonly known threats that are related to the health problems of an Athlete when he/she is on the field be it for a professional event or for a routine workout or practice, and such problems in extreme cases may lead to death in few occasions. In addition to this, many athletics clubs and sport academies spend millions of rupees contracting new professional Athletes or even developing new professional Athletes.

The Internet of Things (IoT)is a cutting-edge technology that combines various other technologies and paradigm to make our lives better and more comfortable. Today the technology has evolved to a great extent that it can effectively and efficiently monitor as well as protect Athletes by diagnosing any health problems, which they encounter during the their events or during training and warm-up session, which, if detected at an early stage, may prevent and eliminate any adverse and harsh effects on their long term health and fitness which in one way or the other improves the overall performance of an Athlete. This paper proposes an IoT- based architecture for Track and Field Events i.e; Athletics, called IoT Athletics. The Proposed aim is to embed sensing devices (say sensors and RFID), telecommunication technologies (say ZigBee) and cloud computing in the field of Athletics in order precisely monitor the health of Athletes and reduce the occurrence of adverse health conditions. The Main aim is to integrate the IoT environment, in particular the IoT application, into the field of sport in the form of a new application that may subsequently benefit the game of Athletics and can further to the glory of the Sport.

Keywords—IoT Architecture;IoT Athletics; IoT application; RFID; WBANs; ZigBee.

I. INTRODUCTION

Athletics i.e; Track and Field Events, with more than 500 million Athletes around the globe, is one of the most popular sports in the world, if not the most popular. IAAF, the organization responsible for developing and improving the quality of Athletics in around the world, has recently introduced many innovations, which have improved the game. IAFF is also seeking to make Athletics a healthy sport (e.g. anti-doping regulations, and nutrition for Athletics). In addition, IAAF has published technical recommendations and requirements for building new multi-purpose Athletics Track in order to create safe and comfortable environments. Recent research has reported on the frequency and nature of injuries, which occur during different Athletes events and training sessions. Some of the injuries that Athletes face include Cramps, hypoglycemia, Muscle pull, swallowing the tongue, Hamstring, Concussion, and shortness of breath. These tend to occur when Athletes are fatigued or due to lack of inadequate and inappropriate warm-up before coming into action, and sometimes when they have face-to-face incidents with other Athletes. The proposed IoT Athletics system will help the coach and various instructors access and to make accurate decisions regarding the treatment of an injured or exhausted Athlete by sending information right away from the Athlete to the concern coach.

The Internet of Things (IoT) is a one of the most popular cutting-edge technology that incorporates new generation of Internet services which enables physical devices to communicate with each other by using the World Wide Web or Networks of Networks called The Internet. IoT can be elaborated as the most widely and extensively popular framework used to collect information from the perception devices be like sensors, Radio-frequency identification (RFID) or mobile devices. Then the information is forwarded to the network layer and finally to the application layer. The IoT nodes have to be effectively and efficiently identified managed and controlled and must have the ability to interact with human or other living or non living objects within the Machine to Machine (M2M) environment. IoT enhances an individual's characteristics or society's lifestyle, as it can be implemented in a wide range of applications such as Business, finance, marketing, health care, smart

cities, agriculture, smart grid, saving energy, home automation, smart building, Intelligent Traffic system and many more.

A number of studies and researches have been published to develop the IoT architecture standard. These studies are dependent on the hardware components, software compatibility, technologies bucket and classifications that are required in a specific domain. One of the most popular standards in IoT architecture is **ETSI's M2M**. This standard has many advantages in terms of hardware components, branches classification and layers structure. ESTSI's M2M is divided into two major layers.

We will be starting with Default Gateway that contain the vital components that gather information from the devices in the primary system. Then comes the second layer which is the network layer and its management. The Network Layer and Management Layer will be including the process and operations of accessing information securely, optimized routing, efficient storing information, effectively analyzing and application information. One of the game changer in the field of remote networks and key technologies that has been developed recently is Wireless Body Area Networks (WBANs). WBANs sensor can measure important physiological parameters such as blood pressure both Systolic and Diastolic, heart rate (Pulse Monitoring), and body motion which covers gestures and reflexes. Therefore, it is not only possible but also highly beneficial to build a monitoring health care system for a Athletes using this technology based on IoT technology, which has the caliber to potentially decrease the number of adverse and critical health conditions faced by Athletes on and off the ground. In addition to this, The advanced and updated version of new generation of Internet services (IoT) enables the sensing devices to connect to the Internet by using interconnection technologies (such as ZigBee). Moreover, LoPWAN6 (IPv6) can place an IPv6 on small devices to transmit data with low power consumption and with reliable and efficient packet transmission.

In this Research paper, the proposed idea is named as IoT-Athletics, which aims to carefully monitor Athletes while they play or perform their event, so that in the event of injuries, incidents and sport-related risks, these can be immediately accessed and analyzed and then the root cause of the injury can be subsequently and accurately resolved. This technique is based on placing sensing devices on the Athletes during the Events or in training and practice sessions to measure important parameters or say functions like Pulse rate, body temperature, sweat rate, heart rate, body motion and the respiration rate. Thereafter, it collects all the monitored information from the Athletics Ground such as the temperature of the particular area and the intensity of illumination of the place. And then finally, transmission of the data to the cloud for storing and processing purpose is done in a well managed and balanced manner, and finally the sending of the feedback to the coach or supervisor via the mobile application or any other relevant mode of application to inform them if anything abnormal happens to the Athletes or not. This architecture proposal uses the ETSI's M2M standard to build and develop a reliable, robust and agile system.

The flow of this research paper is organized as following manner: The 2nd Phase of the Paper provides the literature review of the technologies needed in IoT Athletics including the hardware components as well as the software requirements required to build a reliable IoT-based application, while 3rd Phase talks about the details of the architecture of IoT Athletics, which will also be including the case study that will be used in the development the IoT Athletics application to relate the cause with the real life events and live cases, and then describing the mentioned elements and technologies in the IoT Athletics application. The 4th Phase then illustrates some obstacles and the difficulties that could be faced during the implementation of this proposal in real life. Finally, The 5th Phase concludes the proposed Research paper and paves our way for the directions for future work.

II. LITERATURE REVIEW

Nowadays, technology provides a huge amount of services which are increasingly convenient, safe and reliable. Wearable monitoring devices such as fit band, strides for Running Shoes are capable of collecting important physiological parameters (e.g. pulse rate, blood pressure, blood oxygen level, daily activity and more) resulting in an improvement of the quality of life. The advancements are eventually lead to a change in the concept of the health care system and development of the sports and games in the near future, which is mainly focused on providing proactive and instantaneous wellness management that can detect and prevent a premature occurring injury or the disease at an early stage. One of the most crucial and innovative technologies that has been developed recently and has many implementations for health care sector in particular is the evolution of WBANs (Wireless Body Area Networks). Using WBANs in the health care system and also in development of players performances in various sports and games allows for the monitoring and recording of

physiological characteristics (such as blood pressure, heartbeat, body temperature, burned calories and Steps and total number of kilometers covered). Sensors gather this information and forward it to a default gateway such as a smart phone or even to an emergency primary center or headquarters via the Internet communication system. The action that is taken is dependent on this information.

As per the recent various survey conducted and reports issued WBANs will be the main technology used in the future to diagnose disease early as well as register any abnormal and unexpected events in the human body.In some cases, It can also suggest a suitable treatment by analyzing the data gathered. The most favorable news that comes is that the WBANs can work with IEEE 802.15.6 to lower power transmission, short range and efficiently and effectively reliable wireless communication. This kind of sensor supports a data transmission range from 75.9 Kbps and up to 15 Mbps depending upon the availability of the internet speed strength in that particular area. In addition, WBANs have the ability to communicate over the Internet and other popular wireless network technologies such as ZigBee, WSNs, Wireless Personal Area Network (WPAN) and Wireless Local Area Networks (WLAN).

A number of recent research efforts have focused on developing health care monitoring systems based on WBANs. Because of which these research contributes to developing completely a new health care framework that focuses to diagnose the health status of an individual before they suffer an adverse health attack. However, there is a huge negligence when it comes to the research that concentrates on developing a framework for the field of sports and games, which is one of the reason for the motivation to propose an IoT Athletics architecture. Numerous other paradigms have been investigated and work upon and proposed in different articles. In Otto etal; a health care system consisting of WBANs, and application software implemented on a personal digital assistant (PDA) or a personal computer is proposed. This system supports embedded sensor networks to monitor body activities and functions on the principles of an ECG sensor type to monitor heart activity. In addition, Yu et al. , another researcher proposed a monitoring system used for daily life and for the purpose of sport in particular. This system is particularly based on Bodynets, which is mainly dependent on the Body networks. It works by measuring multiple physiological parameters such as heart rate, blood pressure and the amount of oxygen (SpO2) that can be obtained by the photo physiography signal. After analyzing these parameters, the system can finally be able to make a decision to help those engaged in daily physical and professional sport such as Athletics.

However, even though these two systems show effective and noted results, but they are very limited to a specific environment. Sports players require an uncomplicated device while playing and training so that the level of comfort may not be compromised in anycase and also the level of performance can also not be compromised in anyway. Recent research expects that the fu health monitoring devices will be more light and further more will provide us with accurate results, and will be easy to wear on such as the bracelet). Lee et al. proposed a research paper in which he showed that the monitoring of physiological ECG signal activity in order to detect abnormal or unrecognized event experience. The proposed system also make use of IEEE power consumption. Sazonov et al. Also introduced a special type of shoe-based device, which has the ability to recognize and capture the postures and activities (like siting, standing, ascending stairs, descending stairs and cycling) can help people who suffer from obesity in the most positive way. Another Researcher proposed a pH monitoring system using pH in which the collecting of the pH takes place from the individuals body then the amount of sweat from the patient is analyzed and used for finding the odd one out. Since the IoT paradigm has been created, many scientific papers that focus on developing health care system based on IoT Architecture. Another notable Researcher developed a systems based on IoT architecture. In Chiu an alternative system for patients was developed. Using IoT technology integrated into a health care system allows patients to remain at home in what is environment' for an Intensive Care Unit.

III. IoT ATHLETICS ARCHITECTURE

A. Case Study:

It is very well known fact that Athletics is very popular among billions of fans as well as millions of Athletes across the World. It has its own Track and Field for various events that comes under Athletics. In this section, we will provide a case study to illustrate how IoT - Athletics can help and provide assistance to improve the Athletes when they encounter any accident, illness, fatigue or any adverse situation when they are on the field for competition or for training session. Here, we will encounter and describe the issue and then provide suitable measures to address that particular problem at real time.

Below are some following steps that will ensure how the various technologies will be installed and setup in the

Athletes Playing environment so that the worth of creating the application called IoT - Athletics can be utilized.

1. RFID will be used to identify different Athletes.

2. Thereafter, Sensing device will be installed to measure different physiological parameters such pulse rate, respiration rate etc.

3. Another set of sensing devices will be installed in the Athletes Playing Arena to detect and measure the weather temperature and illumination level.

4. After this, the data will be send to the base station for assessment.

5. Base station will further direct this mined data to the Default gateway for coach assessment.

6. Storing and processing of the mined data at the cloud is done for future references and then the data is deployed at the cloud service provider.

7. If any misconduct or abnormalities is found in the mined data or the data that is received by the coach from the Athletes end then An Alarm is notified at the Coach End.

8. A Message is displayed at the base station that is physician or the Coach itself stating the abnormalities encountered by the devices.

Take the Case Study of An Athlete X. The Name of Athlete X is Justin Gatlin. Gatlin is an international athlete for more than 10 years and is considered a professional in his track events. Throughout his career, his medical records shows no major illness till date. But suddenly one day while practicing on the track he suddenly fainted and felt concussed. Their is huge possibility like any other normal human being that something more than a normal dizziness and concussion had had happen to him. And due to this reason other related and possible illness and diseases are also monitored by this system. The diseases may include Cramps, hypoglycemia, Muscle pull, swallowing the tongue, Hamstring, Concussion, and shortness of breath. This is some of the main domain of interest that the technology will focus upon also has the ability to respond to the situations like sprained ankle or knee or many similar situation that an athlete might face when he is on the ground. Hence, Our system will help the coach or the trainer to monitor and control such ordeals during the big events and also during training session and importantly without any delay, as the technology enacts immediately at real time. In the next phase we will be discussing some crucial information that will be valuable for the purpose of responding and preventing these conditions when an athletes suffers from such ordeals.

Our proposed system means that the survival and the physical and mental health condition of an Athlete is monitored closely and precisely. The system can know the shortcoming or an unwanted situation even before athlete himself can understand anything unusual. The system can assess what an athlete is actually suffering from and how it can be prevent and fix that problem. Which ultimately means that their is reduced risk of injury or the occurrence of serious health issue for Athlete while he/she is concentrating on his/her game.

B. IoT Athletics Architecture

As we have discussed a case study and in order to support the aforementioned case study we require a IoT Architecture that will fulfill our desired requirements and needs. In order to deploy an IoT Athletics in reality, we require many functions and characteristics that the system must possess. We will be discussing the layers that will be required to fulfill the system characteristics and thereafter we will also be further discussing the functions that each layers should perform.

IoT - Athletics will perform with the help of three main layers which are as follows:

1. Perception Layer
2. Network Layer
3. Application in Cloud Layer.

We will now be discussing all the three layers in detail along with functions which they will be performing.

1. Perception Layer in IoT - Athletics Architecture: -

Perception layer will contain two networks of sensors. The Body Wireless Area Networks (WBANs) are the sensors that will be in direct contact with the Athletes body to measure various physiological parameters such as Cramps, hypoglycemia, Muscle pull, swallowing the tongue, Hamstring, Concussion, and shortness of breath. These types of sensors should not be heavy as they are wearable, like Wrist Band, Neck Band, Waist Band, Shoe Strides etc. To be able to communicate efficiently with the default gateway each sensor should have their own IPv6 which should be configured with Routing protocol for low power consumption. Our devices should also be able to meet the Quality of Service (QoS) and also the security capabilities.

Second types of sensors that will be required are those sensors which will be placed in Athletics Ground or the Stadium to measure the Atmospheric Parameters such as Temperature and also the Illumination levels. The sensors that will be installed in the Stadium or the grounds should not necessarily have the same capabilities as the body parameters sensors. On the other hand, both these sensors should be interoperable when it comes to dealing with the same cloud service as well as providing the accurate results with highest degree of precision and accuracy.

2. Network Layer in IoT - Athletics Architecture:-

In the netowork layer section we will be making use of ZigBee Technology. The ZigBee technology will be used for the base station in the system. It should also support IEEE 802.15.4 based network standard. In addition to this, it should have a standard protocol to send and receive to and fro the packets from sensor devices. And finally as already discussed above that it should have both security mechanism and QoS requirements.

3. Application Layer in IoT - Athletics Architecture: -

In order to successfully and effectively deploy our fully functioning application we should have a cost effective and an extremely strong cloud services for the smooth functioning of the application. The Main function of the cloud service is to deliver and analyze the complete data traffic to the coach or the prime location that comes form the devices to provide accurate and precise feedback to the trainer. At more advanced level, we can make use of the predictive analytic in the data mining or of deep learning algorithms for more precise and advanced prediction about the possible injuries and unusual conditions to the Athletes. The cloud services must also ensure the security capabilities and QoS. Also the data must be stored and kept in safe place for future reference. Lastly, the cloud services must be compatible with all the diverse software platforms so that the system may able to provide all the services to the coach or the trainer.

IV. DISCUSSION

We could face several obstacles while developing the framework for the Athletics ground and thus is important to discuss upon so they may be tackled in the coming future. The obstacles that may be faced are as follows:

1. The task of maintaining each and every equipment, devices, technology, and systems to the most highest level possible.

2. The interoperability between the devices and technologies play a vital role of providing steed fast and most accurate results to the users.

3. Regular update and advancement as per the recent technologies and sensing devices need to be done for better results and an updated systematic environment.

4. The Athletes may not agree to reveal or share their personal sport data due to privacy and security purpose. As the devices measure some crucial data that may prove to be harmful if that data reaches to the competitor or the rival team.

5. It may also be possible that the requirement specification of our application may change the infrastructure of the Athletics ground or the stadium which may prove to be an expensive budget.

V. CONCLUSION AND FUTURE WORK

We all are familiar with the wide popularity of the IoT and its wide scope in diverse domain of the society. IoT has also proved to be a game changer in the field of sports and games too, enabling physical devices to communicate with each other with the help of internet. It has also done a significant work in enhancing the lifestyle of a society and individuals and there are many applications for it, including health care, smart cities, saving energy, home automation, smart building, intelligent traffic systems and more.

This Research paper, we have proposed an IoT Athletics architecture, which aims to monitor Athletes so that in the event of injuries, incidents and sport-related risks, these can be analyzed and resolved. This technique is based on placing sensing devices on Athletes during a event or training session and transmits all the data that is collected from the sensors to the cloud for storing and processing, and finally sends notifications to the coach or supervisor via the mobile application to tell them if anything happens to the Athlete. This architecture proposal uses the ETSI's M2M standard that is an IEEE certified standard. This architecture can be implemented in different sports such as volleyball, basketball, football and more.
The next steps will be implementing this system using TinyOS simulation and addressing any issues and challenges that could arise. This will be documented in detail in a new paper.

REFERENCES

1. AIFF (2012) 270 million people active in Athletics. http://www.aiff.com/mm/document/affederation/administration/01/28/72/70/ hof-ee.pdf.

2. AIFF (2015). "Finishing Line Technology." 2015, from http://quality.fifa.com/en/finishing-Line-Technology/aiff-certified-GLTinstallations.

3. AIFF (2015). FIFA Anti-Doping Regulations, http://resources.fifa.com/mm/document/athleticsdevelopment/medical/01/17/17/09/anti-doping2015en_neutral.pdf

4.AIFF (2010). F-MARC Nutrition for Athletics. http://resources.aiff.com/mm/document/footballdevelopment/medical/51/55/15/nutritionbooklet_neue2010.pdf

5.AIFF (2007). AIFF Atheltics Ground and Stadiums - Technical recommendations and requirments. http://www.aiff.com/mm/document/tournament/competition/athletics_stadiums_technical_recommendations_and_requirements_en_8211.pdf

6.Ekstrand, J., et al. (2013). "Upper extremity injuries in male elite athletics players." Knee Surgery, Sports Traumatology, Arthroscopy 21(7): 1626-1632.

7.Rahnama, N. (2011). "Prevention of athletics Injuries." International Journal of Preventive Medicine 2(1).

8.Meyer, T., et al. (2015). Sports Medicine for Athletes: Insight from Professional Athletics for All Levels of Play, Meyer & Meyer Verlag.

9.Singh, D., et al. (2014). A survey of Internet-of-Things: Future vision, architecture, challenges and services. Internet of Things (WF-IoT), 2014 IEEE World Forum on.

10.Diogo, P., et al. (2014). Internet of Things: A system's architecture proposal. Information Systems and Technologies (CISTI), 2014 9th Iberian Conference on.