Internet of Things for Sports (IoTSport): An Architectural Framework for Sports and Recreational Activity

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Internet of Things for Sports (IoTSport): An Architectural Framework for Sports and Recreational Activity

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Abstract—**Internet of Things (IoT) is a new frontier where scientists are currently experimenting with fascinating new ideas and items. Along with health-care and wellness, sports and recreational activities constitutes one of the most rapidly growing areas of personal and consumer-oriented Internet of Things technologies. This area of research is in its nascent stage of development and has been investigated by none till date. Though few companies have started working in this area, the methodology while manufacturing their products lack in standard architectural framework. Despite of huge market expectations, this filed of research lags far behind than other sectors of IoT. This literature investigates how sports and recreational activities can be augmented through novel services based on standard architecture of emerging IoT infrastructures. This paper envisages the Internet of Things for Sports (IoTSport) as the novel and state of the art framework which is capable to cater the needs of persuasion of current sports culture in a smart and handy way. Moreover, IoT for sports and recreational activities provide a new domain of research that includes several of the critical challenges which need to be taken care of. It is skeptical to the fact that the research output from this work would surely affect other domains such as health and rehabilitation in near future.**

Keywords—Innetnet of Things; framework; architecture; sports

I. INTRODUCTION

Internet of Things (IoT) is defined as "the Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service" [1]. From the advent of IoT in Auto-ID center of MIT in the beginning 2000, the world has since been changed a lot in terms of scientific research and development in sensor technology and mobile communication domains. According to Gartner, 26 Billion of devices will be connected to the internet by 2020. Besides this, recent development in semiconductor technology has laid down the progressive inclusion of microcontroller in to human lives through mobile phones, smart hand held devices, smart television etc. Corporate world has always been in favor of carrying away the flavors of all these elements in a précised manner. The appropriate answer for the relevant question is IoT. IoT has the ability to disseminate all the aforesaid modules into a common platform.

Sports and recreational activities have always been the keen part of society. From the beginning of Marathon of the Greek to the latest Olympic Games, sports and recreation have covered up the bonding between human being and itself. Modern civilization has shown tremendous interest in these activities. Representations of both the elements have become viable to get changed rapidly, especially after the boom in Information and Communication Technology (ICT). Not only physical activities but also health parameters, predictive measures and contextual information of athletes and recreationalists have become crucial and important in present competitive scenario. In this situation, one can easily find out the necessity of accumulation of standardized, automated, intelligent, wireless, and sensory input based real time decision making solution that would pursue the long cherished desire of smart involvement. The true value of this moment is actually measurable by Metcalfe's Law,

$$V_N \propto u^2 \qquad (1)$$

where V_N = value of network; u = no. of user.

Equation 1 states that the value of a network increases proportionately to the square of the number of users. To move into this era of new possibilities, however, one must rely on a networking, computing, and storage platform that is distributed, virtualized, and application-centered [2].

Although the presented issues are critical enough to tackle with, no research article is available to counter with it. This has motivated to put down this literature so as the technical demands could be fulfilled. This paper presents Internet of Things for Sports (IoTSport), a novel standard architecture to statute the framework underneath the system to work. Further, few research challenges related to the summarized domain of sports and IoT have been discussed.

The paper is presented as follows. Section 2 presents related work. Section 3 presents concepts behind ITPD. Section 4 presents details of the IoTSport framework. Section 5 discusses major challenges of this area. Section 6 concludes the paper.

II. RELATED WORK

Although, the area of IoT based sports and recreational activities has many aspects of interest and challenges to cope up with, a handful of research articles are available till date. IoT based health monitoring has been materialized by frameworks like PAMIoT and H3IoT in [3][4]. These frameworks are basically based on sensory inputs received from the environment which is later on processed by open source hardware and fed to the internet by utilizing network protocols to visualize or comprehensive purposes. [5] clearly identifies a reference model in pursuit of the abstractions needed by IoT in modular way. Where as [6]. 2013 has generalized various domain models in to a compact structure which is backed up by the entity relationship (ER) diagram of relevance. Few companies have also produced while papers to enhance the development process keeping the conceptualization of IoT enabled sports culture in mind.

[2] is the most related one which clearly spreads out the massage of need of connection between athletes and IoT in respect to present time of duration. It has mobilized many issues such as technologies, interactions, processes, things and data to be taken in action so that the conventional mindset regarding sport can be changed.

Computer world has recently published that IoT dependent sport industry is very soon to get lifted off. It has clearly mentioned that sensors and ARM processors shall quickly get acquainted with the Baseball bat to monitor the swing, angle of impact and acceleration while in practice [7].

Swedish ICT [8] has started the Internet for Sports project to entangle the common requirements of juxtaposition between the games to internet technology through smart phones. This has already been visible through the early introductions of mobile sensor-based end-user products such as the Nike+, sensor equipped sports watches, apps like Runkeeper, and how these connect to social and broadcasting media. Further recently a cross country ski project has taken place in Sweden where movement analysis of the skier was performed. Smart phones helped the skier to develop his or her strategic ability to go faster.

P. P. Ray [9] has recently investigated an architectural framework for connecting Soccer with Internet as Internet of Things. The proposed work has identified many flaws along with new innovative mechanism to sort out the long cherished need of compact technology driven approach towards sports industry.

III. ITPD BEHIND IoTSPORT

Internet of Things for Sports and Recreational Activities is a framework envisaged to solve problems related to sports and recreations to through real world applications of IoT. It is a sensor-fueled analytics platform to cater the athletic performance for amateurs and professionals alike. Now athletes and recreationists can get real-time data on pace, power, drive, and more. The result is that the competitive athletes and performers can step up their activities (also game) with objective data and the analytics through network that are

critical to boosting performance. IoTSport framework collectively uses the concept behind ITPD ring which cumulates Interaction, Things, Processes, and Data. Fig. 1 presents the ring structure of ITPD around IoTSport.
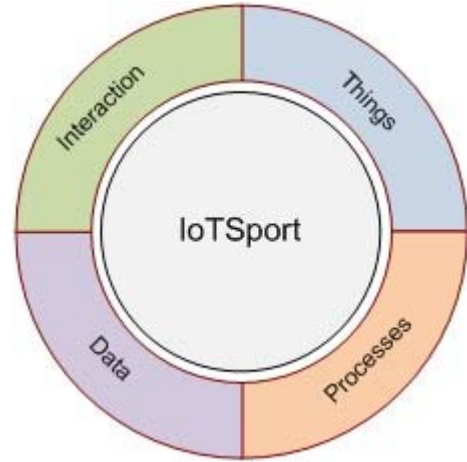

Fig. 1.   ITPD ring around IoTSport.

1) Interaction involves the athletes to get acquainted with sensors in and around. For example, it can become wearing of accelerometer to measure the speed of movement by athletes.
2) Things are sensors, actuators, meters, measuring device anything that can be connected with Internet any time. These things can be attached to any object available in environment, connecting that object to the network of distributed nodes and sharing information in social web or personal cloud.
3) Processes are business and/or technological processes which need to be changed in a meaningful way so as to automate rapid growth in connections. Accumulation, Communication, and Analysis are the main jobs to be processed by IoT.
4) Data can be collected from sensors attached to the body of athletes and processed later on by microcontrollers. It can be stored in cloud or could be analyzed in real-time. Today things can stream data online to the servers through Internet for further processing.

Hence, ITPD proves itself to be more powerful than any other options (if any) to get through the domain of sports in connection to IoT.

IV. ARCHITECTURAL CONCEPT OF IoTSPORT

IoTSport is a multi layered approach to best suit for the IoT enablement to sports and recreational activities. Fig. 2 illustrates seven slabs of frameworks in a vivid way. While discussing the layers in details it should be realized that the concept behind the structure presented here is purely theoretical.

1) Physical Sensing Layer (PSL): It is located at the bottom most slab of IoTSport. This is very crucial in terms of inclusion of various sensors to sport equipments and body of athlete or recreationalist. Ordinarily the sensors like EMG, ECG, Pulse Oxymeter, Movement Meter, Blood Pressure and Thermometer shall be attached to belt, armband or helmets of athletes where there is less possibility of getting ruined by harshness, during match time or practice period. Other sensors like Force Sensor, Accelerometer, Gyroscope, Impact Sensor, Tilt Sensor, and Strain Gauge will be placed over or in and around of the sport equipments such as Baseball bat, Tennis racket, Basket ball, Galf stick etc. Input signals (analog/digital based on sensors) obtained from the sensors from attached part of equipments and athlete body will then be passed to next layer.

2) Communication Protocol Layer (CPL): This layer is placed over PSL. It comprises of low power communication protocols like 6lowpan, Z-Wave, ZigBee, XBee, BTLE, BT HDP, BT SPP, RF to pass the sensory signal to the higher level of abstraction.

3) Data Processing Layer (DPL): Data achieved from CPL is directly fed into this layer where microcontroller (open source hardware platform) after processing let the information move towards higher slabs of framework. This is third bottom most layer of IoTSport.

4) Internet Layer (IL): Information gathered from DPL is routed to the cloud or servers through this layer. Internet acts as the backbone of the whole IoTSport. Hence, IL plays most needful jobs for IoTSport while taking network protocols like 3G/4G and Wi-Fi together.

5) Storage and Preview Layer (SPL): This fifth bottom most layer of IotSport which consists of cloud and apps or plugins. Application Programming Interface (API) designated for the particular cloud stores the information acquired from IL for further usage. Apps or plugins also plays a vital role in incumbent relationship between Internet Layer (IL) and smart phones based on Android and IOS. Information from DPL can be made available to this layer directly bypassing IL if needed. The result is much less operational distance between sensory devices and smart phones.

6) Visualization and Service Layer (VSL): Services like injury risk analysis, contextual awareness and compact analysis of sport equipments and athletes can greatly be furnished by this layer. Besides, 3D visualization is another process through which the overall standard of sports as a whole can be monitored.

7) User Application Layer (UAL): This is the top most layer of IotSport designed to cater the smartness of interactions between users like athletes, coach, and doctors and their playing.

IoTSport framework assumes the power of network intelligence, orchestration, and analytics with a dedicated connection between sport equipments and athletes to augment the exponential growth and power of Internet.
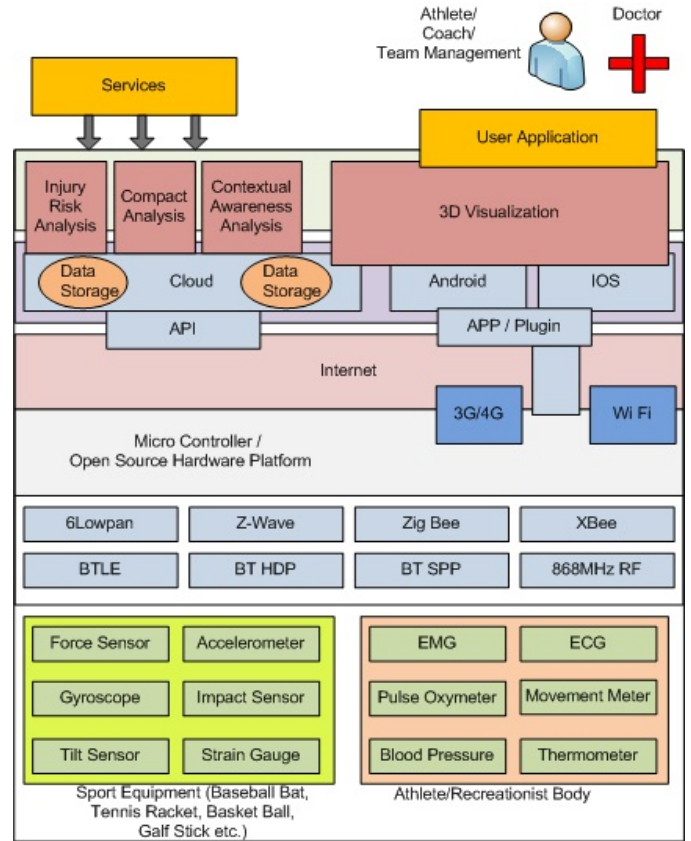

Fig. 2. Multi layer architectural framework of IoTSport.

V. CHALLENGES

Though, the area of Sports in conjugation to IoT is very flavorful, it is very much immature at present stage. Few challenges that are found obstructive in its way of development are discussed below.

A. Generalized approach

It is due to the lack of availability of expertise and technological nuisance. IoTSport hopes to cover it up. But many sports like Archery, Rugby, Shooting, High jump, Long jump etc. could not be addressed by. Researchers need to pay attention in this area which could result in a more compact and common platform to devise the needs of all sports under an umbrella of technology.

B. Energy consumption

This is another essential requirement which is indeed very important criteria for any technology to supersede than others. IoTSport includes many technologies in form of protocols and processor technology which consumes less power. But more effort should be put on so as to enable the sport more handy and green.

C. Fan interaction

IoTSport has mandated its functionality towards the vast users group like athletes, coaches, and medical practitioners. It lacks in approaches to the fans of the particular sport and the sport person altogether. Research work should be made to proceed in such direction so that fans can also be kept in touch with the doings of their favorite athlete even when no match is going on preferably through social web using the same platform.

D. Standardized technique

Being new area of research, sports and IoT together needs special consideration in standardization techniques. No framework has been standardized till date. Nor any related technology has been framed. This is a serious concern that the researchers would like to work upon.

E. Privacy and security

Recent technological boom has placed the privacy and security threats in front of IoT domain too. This area has not been touched at all when we talk about sports in IoT. Developments should be made in this regard to make the IoTSport like frameworks work authenticated.

F. Open source

IoTSport emphasizes on utilizing open source software as well as hardware. Arduino and Raspberry Pi are most promising in this field. This will reduce the licensing hazard also enable the sports industry to get spread world wide.

G. Big Data

Data characterizing big Volume, Velocity, and Variety is big data. IoTSport like architectures would surely increase the big data in near future. The present framework lacks to handle the big data problem. Efficient storage and data handling algorithms should be devised in the time being to cope up with the serious data related problems. Big data provides a huge scope in all the sectors including sports to enhance the decision making support system along with predictive analysis in a holistic way. Researchers need to put effort in this area to flourish the data analytical problems get solved for benefit of human.

VI. CONCLUSION

This paper discusses on the motivational aspects towards IoT in sports. In turn, IoTSport framework has been developed to smooth up the constant manual takeover to automated process. Sensors, microcontrollers, Internet, cloud api, smart phone apps and at large the athletes, recreationalists, coaches and medical teams as a whole could get connected together. Layered approach of IotSport has potential to upgrade the quality and standard of sports and related machineries to a new level of smartness. This paper also finds out few challenges to be sorted out so as to get good return from IoTSport. Privacy and security is the most concern of the list. Specialized knowledge and expertise would be applied to materialize all the problems and future threats, if any. Big data problem is another aspect of modern computing world. Tremendous effort should be placed together to overcome the unknown methodologies behind it. Physical implementation of IoTSport should be next phase of research.

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