

Application of IoT in Sports and Physical Education

Dr. Kishore Mukhopadhyay

Associate Professor

Department of Physical Education

Union Christian Training College, Berhampore, Murshidabad, India

Abstract— IoT has had a notable impact on gaming as well. Social distancing during quarantine has made it difficult for us to play outdoor sports. However, the second-best thing to playing outdoor games is playing indoor games, especially mobile and console games. IoT has made it possible for online and mobile games to be played solo or with a group of people from across the room or anywhere across the globe. By creating “smart sportsman,” i.e., network-connected players, it’s not just their coaches and team management who can get real-time insights into an athlete’s performance, but even fans can know how their favorite athlete is performing. With the evolution and development of Internet of Things into Internet of Everything, concepts such as Cloud Computing, Future Internet, Big Data, Robotics, and Semantics will be even more investigated and impact many more sectors and we hope that this is only the beginning. The present article deals with the various application and useage of Iot in the field of physical education and sports.

Keywords: Internet of Thing, Internet of Everything, Sports and Physical Education

I. INTRODUCTION

Duo to the invention and quickly development of the internet, the accumulated knowledge and information has violent development. And people have more varied methods to learn everything in everywhere at anytime. E-Learning is a trend of education, it can assistant teacher and reduces the loading of teaching. Students can develop the relative knowledge or skills through experience in virtual laboratories and simulated environments. The time is not far when athletes will open their phones and ask, “What do I need to do to improve my skills?” The human eye has limitations, but how about sensors? With sensors, it’s possible to record all the movements an athlete makes during an activity, which the human eye may miss. By applying machine learning techniques on these data, the athlete and his coach can learn exactly where to improve and how to improve. The output is an ‘instrumented athlete,’ which is becoming the new competitive advantage.

As an athlete, who doesn’t want to be trained? An AI-powered IoT-enabled solution not only tracks, essential metrics, such as speed, time, distance, cadence, calories burnt and much more, but also develops personalized training plans to improve fitness levels and endurance of an athlete. It also generates smart recommendations towards personalized nutrition, as to be fit is never about eating less but eating right. Nevertheless, leveling up to the audience experience is also another priority of this solution (1).

By creating “smart sportsman,” i.e., network-connected players, it’s not just their coaches and team management who can get real-time insights into an athlete’s performance, but even fans can know how their favorite athlete is performing. The solution allows visitors to watch the instant replay with slow motion, order food and drink, and

upgrade seats in the stadium. It also offers dynamic retail discounts to attract a large pool of audience and intelligent security monitoring to organizers (1).

II. INTERNET OF THINGS:

The Internet of things (IoT) describes the network of physical objects—“things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.^{[1][2][3][4]}

The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.[1] Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers-wikipedia (2).

III. HISTORY

The main concept of a network of smart devices was discussed as early as 1982, with a modified Coca-Cola vending machine at Carnegie Mellon University becoming the first Internet-connected appliance (3) able to report its inventory and whether newly loaded drinks were cold or not (4). Mark Weiser's 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of the IoT (5,6) In 1994, Reza Raji described the concept in IEEE Spectrum as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories"(7) Between 1993 and 1997, several companies proposed solutions like Microsoft's at Work or Novell's NEST. The field gained momentum when Bill Joy envisioned device-to-device communication as a part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999 (8).

The term "Internet of things" was coined by Kevin Ashton of Procter & Gamble, later MIT's Auto-ID Center, in 1999, (9) though he prefers the phrase "Internet for things" (10).At that point, he viewed radio-frequency identification (RFID) as essential to the Internet of things, (11) which would allow computers to manage all individual things (12-14).

IV. INTERNET OF EVERYTHING

Internet of Everything is the next step. In addition to connecting things, it also, connects people, places, companies, data, machines, and processes, producing billions or even trillions of connections in a massive network. Imagine a world connected at this level and where all data are analyzed and used intelligently, increasing processing power and efficiency, gaining context awareness and greater sensing abilities. Consequently, there will be created unprecedented opportunities, giving things that were silent a voice (Clarke, 2013) (Evans, 2012)

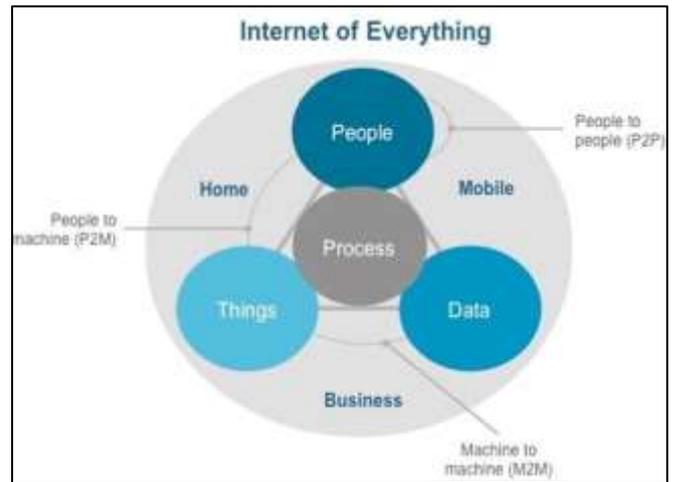


Fig. 1: Internet of Everything scheme (Evans, 2012)

With the evolution and development of Internet of Things into Internet of Everything, concepts such as Cloud Computing, Future Internet, Big Data, Robotics, and Semantics will be even more investigated and impact many more sectors and we hope that this is only the beginning (Vermesan & Friess, 2013).

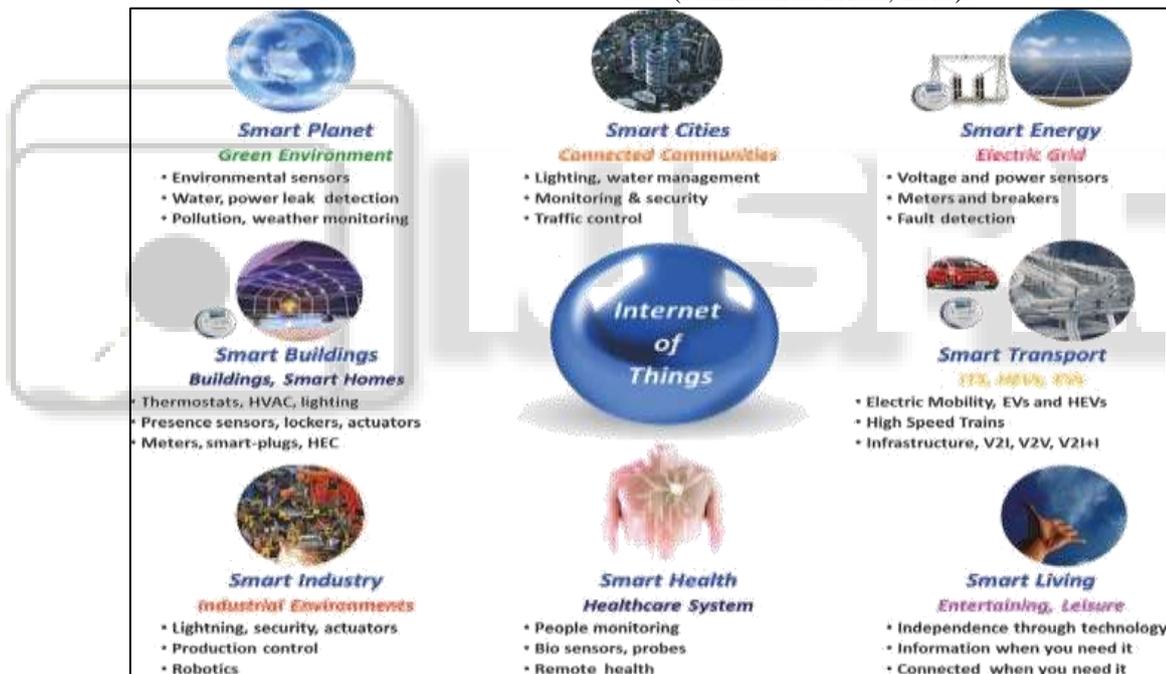


Fig. 2: Internet of Things Applications (Vermesan & Friess, 2013)

V. NEED OF IOT IN SPORTS & PHYSICAL EDUCATION:

The Internet of Things (IoT) allows organizations and individuals alike to harness the power of data to gain better understandings and insights into whatever problem, task or situation they face. Where exactly does IoT fit in the world of sports? Check out these IoT applications and how they're helping athletes and teams better experience the game.

- Athletes: IoT devices can help improve athletic performance, monitor progression and measure player efficiencies.
- Teams: Collecting data from wearables and connected devices can help teams understand how to improve in-game strategy, understand opponents' weaknesses and make better draft selections and trade decision.

- Fans: Sensors can drastically improve the fan experience and help make a trip to the stadium more about the game than waiting in lines for beer and popcorn.

A. IoT for Individual Athletes

Let's first dig into some ways that IoT applies for individual athletes. IoT devices can help individual athletes measure performance, efficiency and progression. By collecting this data over a long period of time, players can better understand their own strengths and weaknesses and use data-driven feedback to get to the next level (18).

Wearable devices are the primary medium for athletes to collect data on their performance and progression. Firstly, connected apparel unlocks performance metrics that have not been historically accessible for athletes. The

following technologies are at the crux of IoT and the athletic experience.

B. Connected Footwear

These shoes can track athlete speed and footwork. Pressure sensors in shoes can show where an individual tends to balance their weight and accelerometers unlock the ability to track max speed, stopping power and in-game stamina. Measuring these data points over time provides an insight-dashboard for any athlete to up their game.

C. Connected Apparel

Shirts, other clothing items and wearables with embedded sensors allow athletes to track their overall fitness. Heart rate, breathing rate and muscle usage can now be tracked throughout practices, scrimmages and in the game. Over time, athletes can iterate on energy expenditure throughout games and know when to take a rest or when to fuel up so they have enough fuel to close out a close game.

D. Connected Equipment

This is where it gets really interesting. Footballs and basketballs with embedded sensors can track all sorts of information about shot and pass accuracy and strength which allows athletes to get actionable insights regarding shot/pass mechanics and arm strength that can help players become better and track progress throughout the season.

E. IoT and Fitness

Consumer-facing items like the Fitbit, Apple Watch, and Peloton bike can have an equally great impact in the athletic world. Similar to connected apparel, these consumer devices can help athletes track vitals and performance metrics. Different types of connected fitness equipment may become an integral part of an athletic training regimen, as they can push individuals to work harder during a training session and monitor their progress and abilities over time. A concrete example here would be a competitive cyclist measuring their explosiveness on a connected bike and working to improve this metric in advance of race day (19).

VI. APPLICATION OF IOT

The sports industry is huge in Sweden and hence the Swedish ICT has initiated the Internet of Sports in a bid to bridge the gap between Sports and Technology. Mobile sensor-based products such as the Nike+, sports watches, and apps like Runkeeper have been introduced pretty early over there (20).

The technology which can enable IoT to be a part of Sports is similar to the technology that enables IoT to be part of any field. Sensors can measure anything from stress levels to temperature to altitude levels. The technology that connects all the various sensors and analyzes the data which it gathers has also become advanced (21).

- 1) Sensors can be used in various sporting equipment such as footballs, tennis racquets, shoes, watches, baseball bats, golf clubs etc.
- 2) These sensors can then relay all the important information such as a player's psyche, their heart rates, kick strength, stamina, mental health, golf swing etc. with the help of Bluetooth or any other wireless

mechanism such as WiFi to nearby smartphones or handheld devices.

- 3) IoT can also help monitor a player's practice sessions and determine which player is putting in more efforts. Accordingly, a coach or manager can be able to evaluate who is training more eagerly to perform.
- 4) IoT can also easily determine if a player is putting too much pressure on their body and can help prevent the player from getting injured.
- 5) IoT can also play an important role in enriching spectator experience. Spectators in the stadium can get real time information on their smartphone about the game they are witnessing. They will be able to access information about a recently performed move by the player. They can also get to know about the confidence of a player by being able to check upon the current mental state of the player. The information that the spectators can get with the help of IoT is vast. And it will definitely add to their entertainment.
- 6) Not just with the player's performance, spectators could also easily order for food sitting in their seats without moving an inch.
- 7) The records can be tracked accurately and displayed with interactive digital display. Healthcare-related tracking such as Blood Pressure, Heart rate, sleep, step count, etc. can be measured through a single wearable and consumers can share their results with their trainers or health professionals
- 8) Sometimes due to human errors, the conclusions taken in sports tournaments are not accurate. Hence if sensor-based instruments are supported wherever required, then the decisions conclude to be most accurate based upon the data gathered and is not just a randomly taken decision.
- 9) IoT integrated devices also have AI-based fitness advice which user can implement and get better results to achieve their goals. Devices are also coming up with Virtual Reality for engaging and immersive workout sessions.
- 10) Fitness freaks can set a type of exercise and can keep a count upon its completion and track the achievement ratio. This way they themselves motivated to do the workout and have the count of it without a trainer's interference. This way athlete's training can be conducted and tracked.
- 11) Fans are the pillars to promote the game and its popularity. Fans can be kept super entertained by displaying live analytics of sports players. Meanwhile, they can also interact and be a part of the polls and contests created for the application and other wearable devices.

A. Smart Stadiums

Investors are already making headway in IoT projects in sports like building smart stadiums. A couple of examples of smart stadiums include Golden 1 Center and Levi's stadium in the US.

A smart stadium integrates several sensors, digital signs, and cameras which are connected to both wireless and wired networks to collect and transmit data to IoT platforms.

The collected data is then analyzed and put to better use for enhanced fan engagement and stadium maintenance.

The stadium's ventilation, heating, and electronic systems can be monitored and maintained via IoT sensors.

It can also be used to conserve resources by tracking water and electricity consumption, locating empty parking spaces in the stadium, and asserting crowd control at the food and merchandise stands.

B. IoT Devices in Sports Equipment and Uniforms for Athletes

IoT devices in sports help ensure both athlete safety and enhanced training. For example, IoT sensors in smart insoles and smart fabrics of an athlete's shoes can collect data on his or her training regime, performance, health, and injuries for analytics purposes.

Player development is a key area of focus and data collected by sensors worn by players can be processed to derive insights on player efficiency. This, in turn, helps to formulate effective in-game strategies.

- Wearable IoT sensors provide the following types of insights:
- Effort exerted by players during a match
- Efficiency of the player and key areas to improve on
- Health of the player and recovery time needed
- Weaknesses in the body and prediction of injuries
- Patterns in player performance

The above data helps in the selection of players for each game in a strategic manner. IoT sports analytics helps trainers and coaches to customize and streamline training modules and game plans for athletes. This ensures enhanced athlete training and safety.

Moreover, sports manufacturers can use the data collected by IoT sensors to develop customized products to meet each athlete's specific needs.

IoT sensors also help in tracking the distance travelled, speed and position of a player in a real-time game scenario. These real-time insights help the coach in guiding players and making smarter decisions when it matters the most.

An example of IoT sports equipment is the smart cricket bat being developed by Microsoft. The IoT-powered bat has a sensor that will collect data like swing speed, impact, distance and angle which will then be analyzed to get an insight into a player's batting style.

C. IoT Sensors Sports Apps for Fans

IoT used in sports also benefits ardent fans around the world. Fans can use apps that will offer personalized experiences whether they are watching the game from their home or stadium.

Furthermore, collecting data on fans' preferences can enable advertisers and sports organizations to offer fans customized product packages, thus, giving them good value for their money. This also results in better fan engagement and more ticket sales (20).

VII. TODAY'S IOT PRESENCE IN SPORTS

Many organizations are utilizing IoT today in specific areas to address a particular need or challenge. Teams are focusing their IoT efforts on three main areas (19).

- 1) Player development: IoT is revolutionizing the way coaches facilitate training, manage players, and address key situations in each game. Combining advanced analytics with sensors and game video, coaches can easily process vast amounts of data to obtain metrics on player efficiency, player performance, and opponent weaknesses to better develop in-game strategy.
- 2) Player safety: IoT is shaping the way that sports physicians, physical therapists, and team doctors are reducing injuries and helping players heal faster. Embedded devices such as smart insoles and built-in chips offer real-time tracking that provides a holistic view of the athlete, allowing organizations to make the best decision for their longevity and health.
- 3) Fan engagement: IoT is being used in smart stadiums, improving digital engagement and ultimately the in-arena experience. The stadium of the future is here, allowing fans to engage with their favorite teams and athletes like never before. Many organizations are investing billions of dollars on new stadiums and stadium improvements to focus on the fan experience to get fans off the couch and into the venue.

VIII. OPPORTUNITIES AND CHALLENGES

A. Opportunities:

- 1) IoT Applications in Sport can increase a sport's viewership.
- 2) It can help improve a sportsperson's performance.
- 3) It can help the coach and other managing staff in devising strategies to combat rival teams' plans at real time.
- 4) It can enable sportsperson to push themselves to greater limits.
- 5) The biggest advantage of it is that it can curb down injuries and even fatalities. Imagine if a player gets hit pretty badly and needs immediate medical attention, the sensors on the sportsperson will be able to notify the nearby hospital without any human intervention.

B. Challenges:

- 1) The biggest challenge in this is storage and security.
- 2) Large voluminous data can be generated through this. And hence it will require large data warehouses. Proper data handling algorithms should be put into practice so that unwanted and redundant data does not get stored.
- 3) All these technologies will also require a lot of battery consumption. Power failures need to be in check.
- 4) Sports are of different types. There needs to be a common structure put into place to provide better efficiency.

IX. CONCLUSIONS

IoT has had a notable impact on gaming as well. Social distancing during quarantine has made it difficult for us to play outdoor sports. However, the second-best thing to playing outdoor games is playing indoor games, especially mobile and console games. IoT has made it possible for

online and mobile games to be played solo or with a group of people from across the room or anywhere across the globe.

Followings are the applications of IoT in sports and physical education:

- 1) Athlet's training
- 2) Players safety and injury prevention
- 3) Monitoring performance
- 4) Sports gears
- 5) Performance analysis
- 6) Track records
- 7) Individual training programme
- 8) Fan satisfaction.
- 9) Sports uniform
- 10) Smart stadium
- 11) Smart sports person.

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