Study of Wearable IoT devices in 2021: Analysis & Future Prospects

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Abstract: **Advancement in the Internet of Things created excitement in the market of wearable devices. Wearable devices help humans to restructure the e-medical facility. The cost of monitoring the health parameters also gets reduced by implementing IoT-based wearable devices. This paper studies and reviews the most prominent wearable devices present in the commercial market. The hardware and software specifications of different devices are dealt with here. Perhaps the main component fundamental in information assortment is the sensor. During ongoing years with progress in semiconductor innovation, sensors have examined a full reach of boundaries nearer to acknowledgment. Some privacy issues may concern users, as these devices are connected to the internet for communication. As these devices are also used on the military front, privacy is the main concern in the field. These factors are also analyzed in this review paper.**

Keywords: **Fog Computing, IoT, Wearable Devices**

I.   INTRODUCTION

A.   Background

Internet of Things laid the platform for the rapid development of smart human wearable devices. These devices enhance the lifestyle of humans and even provide them data of their body parts in handheld devices like smartphones.

The IoT is characterized as the organization of devices that are upheld by innovative technology for information correspondence and sensors to cooperate with both inner and outer device states and their surroundings [1]. And, Wearable devices can be defined as "gadgets that can be worn or mated with human skin to consistently and intently screen a person's activity, without hindering or restricting its movements" [2].

Table 1 predicts the expected growth of Wearable IoT devices in 2026 which is about 265.4 USD billion. The industry is growing at a pace of 18.0 % CAGR (Compound Annual Growth Rate) [8].

Year	Market Size [in Billion]	Source
2021	116.2	*Wearable technology market* [8]
2026	265.4	

Table 1 – Expected growth in Wearable IoT Devices

Today, the scope of wearable frameworks, including miniature sensors flawlessly incorporated into materials, purchaser gadgets inserted in popular garments, mechanized watches, belt-worn computer with a head-mounted showcase, glasses, which are worn on different pieces of the body are intended for broadband activity [3]. The area of wearable IoT devices is further growing to minimize the size of devices, so the devices can be more comfortable in wearing and hiding in clothes.

This paper is framed to review and analyze various available IoT devices under the wearable category. The Paper also evaluates the prospects of these devices.

II.   RELATED WORK

A.   Existing Research

Many kinds of research show the use of wearable IoT devices. Most of them give the idea of using these devices in healthcare systems.

Jie Wan et al. [4] discussed wearable IoT-enabled real-time health monitoring systems. They also present a novel approach to cloud and IoT-based wearable devices. The impact of using smartphones in these devices is also discussed.

Kamalnathan Kandasamy et al. [5] analyze the cyber risk assessment framework. They reviewed the existing risk assessment methodology used in IoT systems. A method is developed to rank and quantify the IoT risk.

T. Rashid et al. [10] proposed a micro strip antenna as a wearable IoT device for medical applications. Whereas R. Rahul et al. [11] have proposed a smart wearable device for gesture controlling, and recognition of criminals.

Q. Lin et al. [12] proposes a smart 5G network based on backscatter communication, through which they propose the reduction in the size of the equipment, and increases the comfort of wearing. U. Farooq et al. [13] proposes an approach to secure IoT-based devices. Silva et al. [15] framed architecture to validate the wearable devices. They present an FR-CWS system for single and multiple user systems.

III. UNDERSTANDING THE REQUIREMENT

The demand for wearable IoT devices increases significantly because now they are coming in small sizes with more intelligence and can perform various functions. These components are PCs that are with the client constantly. Wearable gadgets are convenient while working and usable without obstructing the hands. These gadgets have sensors, assemble, and treat information even in a detached state, other than being consistently dynamic and running [16].

Basic objectives of using Wearable devices are [17]–

- They should introduce portability;
- They should increase reality;
- They should collect information about the surroundings at any time.

Wearable devices can have mass acceptance if they have the following capabilities [17] –

- Unbiased Use;
- Adaptability;
- Basic and natural use;
- Give distinguishable data;
- Fault resilience;
- Low effort;
- Proper measurements (small in size).

IV. TOP WEARABLE DEVICES IN THE MARKET

Various IoT enabled Wearable devices that adhere to the market are –

A. Cove

Figure 1 Cove [18]

Feel more Labs developed Cove, a wearable device on ears. Cove applies delicate, quiet vibrations simply behind your ears. The particular recurrence of the vibration is intended to animate the touchy sensitive spots of your skin into enacting a profound piece of your cerebrum (the back isolated cortex) that is straightforwardly engaged with the balance of pressure. In clinical examinations, the organization said 90%

of 3,500 members utilizing Cove announced a 41% pressure decrease and 50% rest quality improvement [18]. The weight is 50 grams; the battery has a life of over 4 sessions with 60-80 minutes of charging. It has a heart rate sensor and a 3D accelerometer. The price ranges at 36,524 Indian Rupees [18].

B. Bioheart

Figure 2 Bioheart [19]

Bioheart is used for tracking heart performance. The gadget is worn utilizing a breathable chest band, and it utilizes dry lead anodes to gather ECG information [19]. Bioheart will also be used to get respiration, calorie burn-up data. It is launching in June 2021. Its price ranges from 11, 000 to 15, 000 INR.

C. Fossil Smart Watch

Figure 3 Fossil Smart Watch [20]

Fossil launches its Gen 5 LTE touch screen smart watch in 2021. It has an inbuilt feature of making calls and texting via Google Wear OS. Various sensors Accelerometer, Altimeter, Ambient Light, Compass, Gyroscope, Off-body IR, PPG Heart Rate are used in this smart watch. Its battery charges 80% within 50 minutes and 24+ hr battery backup.

This smart watch came with Bluetooth 4.2 LE, Mobile, GPS, NFC, WiFi connectivity. It also has Loudspeaker, Microphone, and Vibration as actuators. The cost of these wearable devices is around 22, 995 INR in the Indian market.

D. Jlab JBuds Frames

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Figure 4 Jlab JBuds Frames [21]

This is a wireless speaker that can be attached to any eyeglasses. Audio is heard only by those who wear it as it has 16mm drivers. They are water-resistant and can be used in rain etc. Their batteries are made up of 120mAh lithium polymer and have a backup of over 8 Hrs. These speakers came with a price range of 3,500 to 4,000 INR [21].

E. *Think Reality A3*

Figure 5 Think Reality [22]

Lenovo is the global leader in laptop manufacturing. The company develops virtual-reality-based smart glasses named as Think Reality A3. This adaptation of the keen glasses can show redid "virtual screens," which empower the utilization of Windows applications that are set in the client's field of view.

With high-quality performance, Think Reality A3 is based on the Qualcomm Snapdragon XR1 platform. It has a 1080p display and has a maximum of 5 virtual screens. It has a built-in 'room-scale tracking' with a dual fish-eye 8MP camera.

F. *Mudra Band*

Figure 6 Mudra Band [23]

Planned and created by Wearable Devices Ltd, Mudra Band is a wrist-worn wearable that permits clients to control music, oversee calls, plan arrangements, and excuse notices utilizing easy finger developments. The item is furnished with IMU

(6-DOF) movement sensor, 3 Surface Nerve Conductance (SNC) sensors, and a gyroscope sensor. While the SNC sensors are intended to catch neural signs from the mind, the inbuilt profound learning calculations help translate the sign examples to investigate and arrange the finger developments progressively. In particular, the watch learns the expected motions versus unintended activities and interfaces them with the setting of the client's action.

The cost in the Indian market is around 17,000 INR.

G. *NFC Smart Ring*

Figure 7 Smart Ring [24]

NFC Smart Ring is implanted with sensors and network connectivity. It allows users to share data easily with NFC devices like mobile phones having NFC wireless frequency communication. With this ring, there is no need to carry credit cards, debit cards, and even home or car keys. All you need is NFC-enabled devices. It is compatible with Bluetooth technology. It has a battery life of 365 days. The cost of this smart ring is around 1,000 to 1,500 INR in India.

H. *Gaming Simulator*

Figure 8 Smart Ring [24]

This IoT device is like a boon to gamers. It has sensors that detect activity in the user's muscles and arms, and then use this electrical energy to simulate the gestures in the virtual character. There are body suites also available for an enhanced gaming experience. The ARAIG bodysuit is one of this type that has surround sound, vibration system, and self-stimulating behavior.
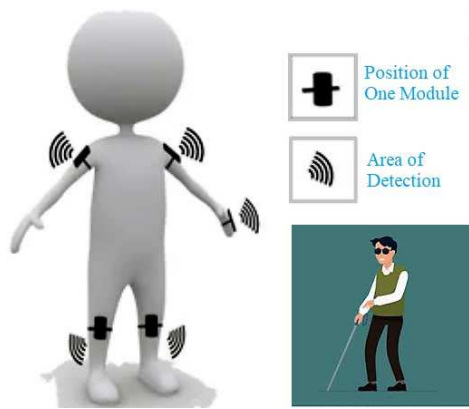
I. *Smart Band for Blinds*

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Figure 9 Smart Band for Blind [24]

Toyota is developing an IoT-based wearable device for blind people that will improvise their mobility. This device has a shaped band that can be worn near the shoulders. Input is generated with cameras that can detect nearby objects and with the help of nose and vibration warns blind people. It additionally gives planning, object recognizable proof, and facial acknowledgment, which would help make a stunningly better encounter for the visually impaired. It decides hindrances around the client's body from the floor to the head, and train the client that the moving surface is comprised of holes or surfaces.

V.   CHALLENGES AND LIMITATION

In recent trends, the wearable IoT industry is seeing remarkable development in technologies. These developments significantly improve the daily life and habits of common people. As these devices become a part of daily life there arises some issues that need to be addressed before investing/purchasing.

- *Maintenance Cost*

  Wearable devices have lots of sensors incorporated within. Therefore they need servicing at regular intervals which raises the cost of maintenance. Therefore it is needed that the sensors with lower cost can be implemented while developing the device.

- *High Power Consumption*

  Almost all of these devices run on batteries. And batteries are placed at the time of incorporating a sensor in the device. These batteries are not easy to replace very easily. So devices need to be developed that have their power regeneration facility.

- *Normalization*

  There is a very large number of the manufacturer that is developing a wide range of wearable devices. These devices follow a different set of rules and designs. So

they are incompatible with each other as well. This is a major problem that needs to be addressed. Normalization or standardization of all devices should be there.

- *Information Privacy and Security*

  Almost all wearable devices works in a network like Bluetooth, Zigbee, and NFC, etc. In a normal connection, these networks are open to cyber attacks. Personal information related to identity and health is not secure with these devices. So, there must be some secure mechanism applied to these devices and networks so that all the information should be secured.

- *Adaptability*

  The ability of the devices to change or adapt according to their environment is very necessary. As these devices work in a real-time environment the high adaptable devices are needed.

- *Self-Configuration*

  The power of configuration of the wearable devices is to be given to the person wearing that device. This is valuable to the person as he can change the setting according to his requirement.

VI.   CONCLUSION

In this paper, we have studied some of the highly demanding and upcoming IoT wearable devices. We have given a far-reaching audit of the 9 diverse IoT devices. The various highlights that accompany each IoT device make it ideal for specific applications, however not for all. In this manner, for choosing a specific wearable IoT device one needs to remember the above devices highlights with their task need. There are some security concerns also discussed in this paper. So before purchasing any of the devices stated above one needs to consider these issues also in mind. Future advancement in these devices will revolve around removing the concerns. The future is also looking very promising with growth at the rate of 18%.

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