Future of Augmented Reality in Healthcare Department

Gouri Jha, Lavanya shm. Sharma, and Shailja Gupta

Abstract In today's world, augmented reality (AR) is a highly challenging and immerging technology which presents some additional information to the existing real world. This is done by using special glasses like Google glasses or with help of advanced devices. This technology is an advance version of virtual reality. As, in VR, we have to work in a completely virtual environment, but in this technology, we do not have to work in virtual world, but being in the real world, we are getting some additional information. This paper provides a brief description about the architecture of AR, possible solutions provided by several researchers, and academicians, their challenging issues and real-time application in medical or emergency department.

Keywords Augmented reality · Virtual reality · Medical field · HOLO- BLSD

1 Introduction

Augmented reality (AR) which is a self-defined by its name as augmented means adding something more to anything and reality means real world. So, adding something to the existing real world defines augmented reality. It is an upgrade version of virtual reality (VR). As, in VR, we are completely in a blind condition due to VR glasses, AR glasses are like normal glasses; it just add some additional information to the real world. In medical world, new technologies are introducing day by day [1–3]. These technologies are resulting in ease of medical operations and education. With the help of these technologies, it becomes very easy to learn and perform complicated tasks. Among these emerging technologies, there is a technology known as

G. Jha (✉) · L. Sharma
Amity Insititute of Information Technology, Amity University, Noida, Uttar Pradesh, India

S. Gupta
Department of Computer Science and Technology, Manav Rachna University, Faridabad, India

P. K. Singh et al. (eds.), *Proceedings of Second International Conference on Computing, Communications, and Cyber-Security*, Lecture Notes in Networks and Systems 203,
https://doi.org/10.1007/978-981-16-0733-2_47

Fig. 1 Applications of augmented reality [1]

augmented reality (AR) [4–6]. This technology not just contributed in the development of medical but also other fields too. Not just in the medical field but also in other fields like architecture, gaming military, etc., these technologies are contributing lot as shown in Fig. 1.

It just changed both the perspective of learning as well as applying it in real world. Augmented reality is an emerging technology, and its contribution in the medical field results in life-saving operations. Operations like spinal surgery and sinus are a bit complex before augmented reality. Augmented reality had done two significant tasks; the first one is "reduction of stress" and the other one is "reduction of time limit." There are some challenges with this technology because it is a newly emerging one [7, 8]. People are unfamiliar with the correct use of AR, and as a result, many life-taking incidents had occurred. One of the examples of this type of case is Pokémon Go game [9, 10]. This game had resulted in many serious accidents which had risked some lives.

This paper is categorized into seven sections. Section 1 deals with introductory part of AR in medical department, whereas in Sect. 2, related work is discussed. Section 3 deals with architecture of AR. In the next Sect. 4, real-time applications of AR in medical department are discussed. In Sect. 5, challenges of AR are discussed. In Sect. 6, some more fields other than medical are discussed where AR is used. In the next Sect. 7, future scope of AR in medical department is discussed. In the last, conclusion of the work is discussed.

2 Literature Review

This section deals with the work done by various researchers in the domain of augumented reality for health care. Rodriguez and Huang [2] discussed about the usefulness of AR/GIS and also the way through which student can do independent study of AR/GIS. Deshmukh et al. [11] discussed a 3D manual system for advances and effective learning using AR. Çolak and Yünlü [3] discussed the use of augmented reality and virtual reality in engineering education. Sharma and Garg [12] discussed

about enabling opportunities and challenges of e-health system applications. Bottino et al. [13] discussed a self-directed life support system using AR; using this, humans can get life-saving education without any expert. Wasenmuller et al. [14] discussed an application for discrepancy check for industrial purpose. Mizell [15] discussed a HUD set used for manufacturing many products like aircraft manufacturing, form board diagram and other masking devices. Azuma et al. [16] discussed a survey potential of AR applications in medical, designing and repair of complex equipment. Dünser et al. [4] discussed a survey report based on the analysis of published paper since 1993–2007. Atkuri et al. [17] discussed technique, scope and status of AR in medicine. Sharma and Lohan [5] discussed about visual surveillance systems and conventional methods in different suspectable environments.

3 Architecture

The AR glasses or the AR devices have four basic requirements. As like in the AR glasses, these components are as follows:

- *The Display*: This AR display is also known as combiner. As it combines the eye glasses with the digital LED or OLED display, the computer-generated images can be sent to the eyes [18]. So, when we wear AR glasses, we are analyzing two things; the first is the real world and the other one is the computer-generated images.
- *The Camera:* The second component is camera. This camera is placed in your AR glasses, and if you are using the AR app, then your phone camera is used. This camera is used to capture the images real-world images as your eyes cannot capture it. [10, 19].
- *The Registration:* The registration consists of some icons, and these icons are not visible to the user. These icons help the glasses to place a virtual object in the real world. That is why you can see a car placed in your garage or a sofa pops up in your room when you are using home décor app. These icons use various things like the corners of wall and length of wall for guidance and placing of virtual object [8, 20].
- *The Computer Vision:* This is the stage where the magic of AR takes place. Here, both the images which are taken by the camera and the registration are combined and placed on the display which are sent to our eyes [21] (Fig. 2).

4 Applications of Augmented Reality

There are many surgeries, checkups and medical subjects existing where augmented reality is used [23]. As augmented reality is used for creating medical applications for surgeries and for study purpose too, here are some fields of medicine where AR is used:

Fig. 2 AR glass composition [22]

1. *Spinal Surgeries:* The old medical system is a bit complex for performing spinal surgeries. As spinal is the back bone for our body and its very sensitive, the doctors have worked with extra alertness. The old system for spinal surgery requires high cost CT scan, and it is very difficult to determine the anatomy of spinal. With this scan and difficulty in anatomy, there is one more big problem that is doctor' s have to see the screen many times while performing the surgery. So, all these problems are solved with help of augmented reality in the following way [24]:
    - *AR Helped in cost effectiveness:* As it requires a lot of money for the CT scan of spine, now with help of Microsoft HoloLens and AR technology which cost just $3000, it is basically one-time investment (Fig. 3).
    - *AR helped in building the anatomical structure of spine:* Just by using the AR, there is an inaccuracy in depth perception, so the combination of AR and VR was introduced [18]. Now, by this combination, doctors can get the distance between instruments and organs in a single window.
    - *Reduction of stress and helped in projection of spine without any physical cut on body:* As in old spinal surgeries, doctor' s have to watch the operation screen, and the patient at the same time which creates much stress and complications. But now, with the help of Microsoft HoloLens, the doctors

Fig. 3 Doctor using AR glasses [17]

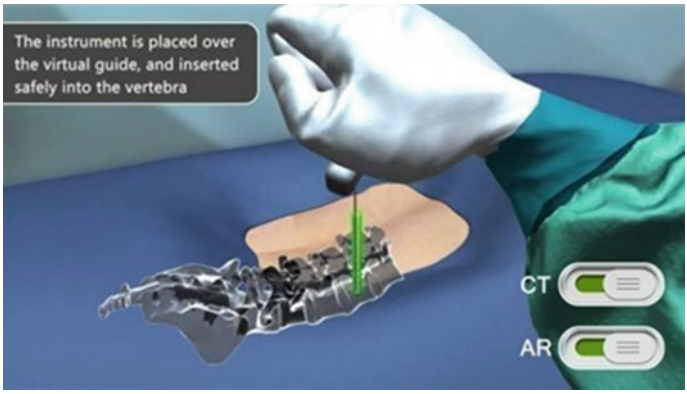

Fig. 4 Inserting screw in spinal using AR glasses [5]

can watch the Spin CT through the skin and can perform the drill and pre-plan to place the screw before surgery [25, 26] (Fig. 4).

2. *AR in Bone Tumor Resection:* The physicians of South Korea have developed an AR system that work as navigational device, and it focuses on the navigational imaging of bone tumor [27]. As in old techniques, CT scans and X-rays are used to identify the tumor area which is not so much accurate. But, with this system, the accuracy is increased. In this study, physicians had used Microsoft Surface Pro 3 for the tracking as well as for workstation too. The camera is used to track the distance between the target and the instruments [26, 22]. The image data which was received from the camera was filled in the software, and as a result, the system provides an image with the virtual bar which contain five sections. In this section, the blue colored area shows the normal bone reason, the green colored area shows the safety margins and the red color area indicates the bone tumor (Fig. 5).
3. *AR in sinus surgery:* Sinus surgeries are traditionally done through endoscopy, but in this surgery, there is a risk of damaging the other body tissues and nerves. So, an AR-based system was introduced which produces computer-generated images with real-time surgery [24]. This system shows the distance between the sinus and instrument in mm. This system also prevents physical damages of untargeted organs like optic nerves and arteries. It provides an alert sound if the instrument is very close to the target or damaging an untargeted organ (Fig. 6).
4. *Augmented reality in virtualizing 3D Radiology images:* Augmented realty is used for making the 3D radiology images. These images create a 3D model of the organs and present all the different part of that organ with different colors. With the help of this 3D model, doctors can see the conditioning of the organ more precisely. The main advantage of this 3D model is that now, doctors can see the infected area in layering means with the help of AR we can see the different layer of any body part [18, 30] (Fig. 7).

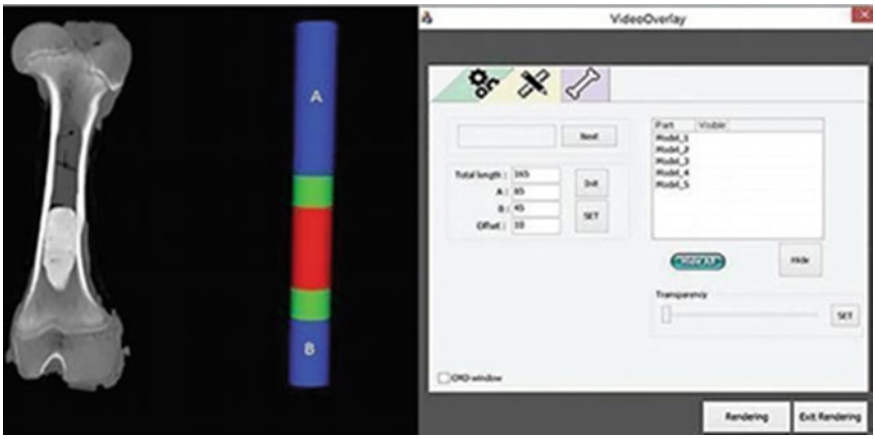

Fig. 5 Software showing the bone analysis [28]

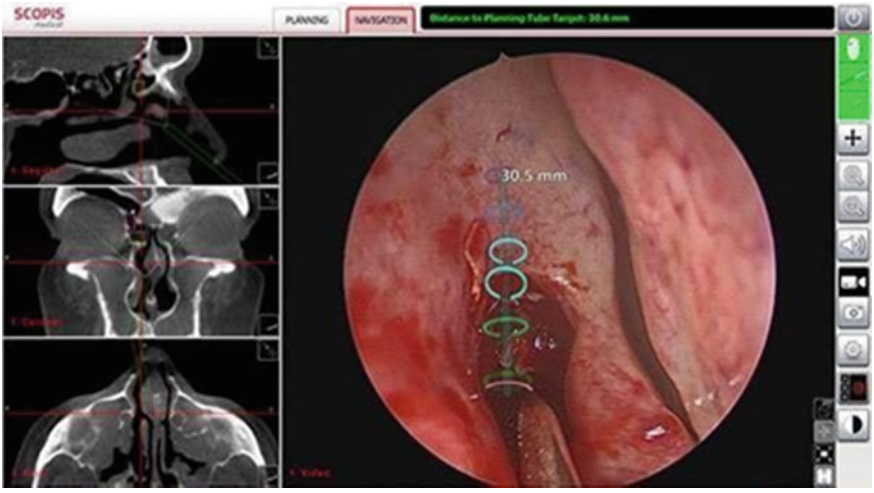

Fig. 6 Live screening of sinus operation using AR [29]

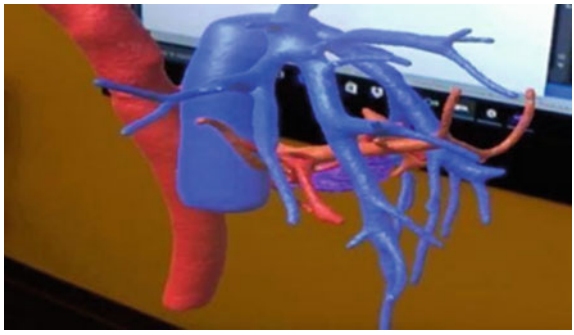

Fig. 7 View of 3D radiology image of liver using AR glasses [31]

This image shows the 3D radiology image of liver. In this, the purple area indicates the tumor and the red area shows the arteries. So, like this, we can create 3D imaging of any body part and watch it layer by layer.

5. *Augmented Reality in Veins and allergy detection:* Augmented reality helps to detect the veins through the skin [18, 32]. Now, the nurses can see the veins of a baby or adult through the skin with help of AR glasses. This will save time and can help to reduce the number of mistakes (Fig. 8).

Not only this but also AR helps to detect weather a person has some kind of allergy or not before an operation. This can be done by watching the relevant data on the AR screen of the glasses.

6. *Use of Augmented Reality in Medical Education:* Medical students are getting a lot of help by using augmented reality. As of now, students can see the detailed design of any body part like 3D model of radiology imaging [20] (Fig. 9).

Students can learn without the help of an expert. Students can tackle with the future technical difficulty if they had already gone through whiles their practice. It helps in just-in time and just-in place learning.

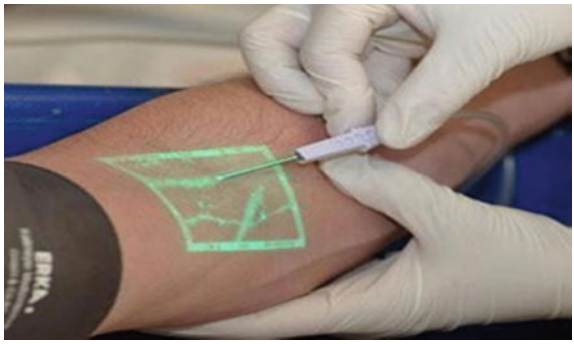

Fig. 8 Watching veins of hand using AR glasses [21]

Fig. 9 Human body structure using AR glasses [33]

5 Challenges in Augmented Reality

This technology is an advance version of virtual reality. Some of the major challenging issues of AR are listed below:

- *Lack of Knowledge:* As augmented reality is an emerging technology, there are very less people who know the correct use of it. So, it is the biggest challenge while using it [7, 34].
- *Security Issue:* Augmented reality has a breach of security issue because while using augmented reality, the user is in two worlds: one is real and other is virtual. So, sometimes, they forget one world and start working in virtual one. This led to serious accidents. The biggest example of this breech is Pokémon Go game. We all know that while using this game, many humans had lost their life [10].
- *Not Well-Developed Technology:* Augmented reality is a new concept, and there are very less developers and tools available for its development [7, 10, 35].
- *Lack of Business Models:* Augmented reality had taken a kick start, but many investors still do not want to invest a huge amount of money because there is not a lack of proper business model as we saw in Pokémon Go that people gone crazy because of the brand Pokémon, but after some time, the hype goes down and no business strategy helps it to rise again [7, 35].

6 Some More Fields of Augmented Reality

There are several fields in which augmented reality is playing and could play a vital role. These are listed below:

1. *Architecture field:* Architecture field is using AR technology in a very interactive way [8, 36]. Now, engineers can just design the architecture of any building in paper, and with the help of that design, AR can show how the house will look after completion of construction.
2. *Military:* AR has become an important part in modern military training [20, 22, 30]. It is helping militaries in many ways, and one of them is training the

new bees with the help of augmented reality war field. In this field, trainees have special glasses and special equipments; now, they can kill the virtually created terrorists and can make their performance better. The second is AR sand table; this table helps soldiers to understand the battle field more easily and efficiently. The explainer can add more graphical things like airplanes and ships movements while explaining a war situation.

3. *Gaming Industry:* Gaming industry is one of the main industries who is using AR as well VR at a very high level [10, 25]. Now, we can play AR games on our mobiles without any AR glasses. In AR games, you can create your own track in your own room or at any place where you want, and not only this, you can also have a race on this track. The battle games are the category in which we

can play more interesting AR games. In this, we can make teams and can play multiplayer games in any area of real world. You can detect which had killed or how much power is still remaining of that player [25].

7 Future Scope of AR in Medical Field

The scope of augmented reality in medical department is growing day by day [37, 38]. As it is the second most highly money invested field of AR. There are many medical operations where radiology is used and AR has become a very efficient technology for the radiological data. So, for making and analyzing the anatomy of different body parts, AR can be used [39].

- AR is also contributing in educational field. So, AR technology can be used for learning complex medical operations with or without experts or we can say that it can result in an independent study for the medical students [19, 40].
- AR can also assist the patients for having their medicines and how and when to take it. Such as if a patient wants to inject an injection for pain relief and no doctor is available their, so he can get assisted by an AR application for proper injecting location and technique [27].
- AR can also be used for scanning and displaying a detailed 3D structure of a tumor. As all the details and the infected area will be known to the doctors, then they can handle the operation very easily [4]. AR is used for detecting the blood veins and differentiating the blood vessels and soft tissue [8, 40]. AR can be used for detecting the infection of blood with the help of old relevant data.
- AR in cosmetics or skin operations. AR can be used for cosmetic operations; for example, we can create a virtual 3D image of the patient with the help of AR and AR application should show the after image that how the patient looks after getting surgery (Fig. 10).

Fig. 10 Augmented reality in cosmetic surgery [41]

8 Conclusion and Future Work

Augmented reality is a very effective technology in medical as well as in other sectors. This technology has a very huge potential, and it can do more innovative things as it had done in the past. This technology had contributed in medical world which has resulted in life-saving processes. For those operations which take a lot of time and had lot of complex task, AR had reduced its complexness and time limit. This technology has some breeches, but with time, those will be filled. Moreover, AR is a new and emerging technology which will help a lot in our future, and we should encourage its development.

References

1. Applications of augmented reality available at: https://vstream.ie/wp-content/uploads/2018/10/Screen-Shot-2018-10-17-at-12.30.02.png
2. Rodriguez J, Huang CY (2017) An emerging study in augmented reality & geographical information system. Int J Comput Theory Eng 9(6)
3. Çolak O, Yünlü L (2018) A review on augmented reality and virtual reality in engineering education. J Ducational ND Instr Stud World 8
4. Andreas Dünser, Raphaël Grasset, Mark Billinghurst (2008) A survey of evaluation techniques used in augmented reality studies. Human Interface Technology Laboratory, New Zealand, Sept 2008
5. Sharma L, Lohan N, Yadav DK (2017) A study of challenging issues on video surveillance system for object detection, J Basic Appl Eng Res, vol. 4, Issue 4, pp 313–318
6. Future of AR: http://www.tekshapers.com/blog/FutureofAugmented-Reality
7. AR challenges: https://theappsolutions.com/blog/development/augmented-reality-challenges/
8. Jha G, Singh P, Lavanya Sharma, (2019) Recent advancements of augmented reality in real time applications. Int J Recent Technol Eng 8(2S7):538–542
9. Challenges: https://www.chrp-india.com/blog/biggestchallenges-facingin-augmented-reality/
10. Sharma L, Lohan N (2019) Internet of things with object detection. In: Handbook of research on big data and the IoT, IGI Global, pp 89–100, Mar 2019. ISBN: 9781522574323. https://doi.org/10.4018/978-1-5225-7432-3.ch006
11. Deshmukh SS et al (2018) 3D Object tracking and manipulation in augmented reality. Int Res J Eng Technol 05(01)
12. Sharma L, Garg PK, Smart E-healthcare with Internet of things: current trends challenges, solutions and technologies. In: From visual surveillance to Internet of Things, Taylor & Francis, CRC Press, vol 1, p 215
13. Bottino A et al (2018) Holo-BLSD: an augmented reality self-directed Learning and evaluation system for effective basic Life support defibrillation training. IMSH 2018, At Los Angeles
14. Wasenm¨uller O, Meyer M, Stricker D (2016) Augmented reality 3D discrepancy check in industrial applications. In: IEEE international symposium on mixed and augmented reality (ISMAR), At Mexico
15. Caudell TP, Mizell DW (1992) Augmented reality: an application of heads-up display technology to manual manufacturing processes. IEEE Kauai, HI, USA, USA
16. Ronald A et al (2001) Recent advances in augmented reality. IEEE Comput Graph Appl
17. Atkuri P et al (2018) Augmented reality in medicine: technique, scope and status. Int J Sci Res 7(2)
18. Sharma L, Garg P (2020) From visual surveillance to internet of things. Chapman and Hall/CRC, New York. https://doi.org/10.1201/9780429297922

19. Makkar S, Sharma L (2019) A face detection using support vector machine: challenging issues, recent trend, solutions and proposed framework. In: Third international conference on advances in computing and data sciences (ICACDS 2019, Springer), Inderprastha Engineering College, Ghaziabad, 12–13 Apr 2019
20. Sharma L, Lohan N (2019) Performance analysis of moving object detection using BGS techniques, Int J Spatio-Temporal Data Sci, Inderscience, vol 1(1), pp 22–53
21. Ar in military: https://www.techradar.com/news/deathbecomesar-how-the-military-is-usingaugmented-reality
22. Shubhankar S, Mohit, Sharma L, Use of motion capture in 3D animation: motion capture systems, challenges, and recent trends. In: 1st IEEE international conference on machine learning, big data, cloud and parallel computing (Com-IT-Con), India, pp 309–313, 14th–16th Feb
23. Sharma L (2020) Human detection and tracking using background subtraction in visual surveillance, Towards smart world: homes to cities using internet of things, Taylor & Francis, CRC Press, pp 317–329
24. Liu Y, Hou R (2010) About the sensing layer in internet of things. Comput Study 5:55
25. AR scope: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4948614/
26. Anand A, Jha V, Sharma L (2019) An improved local binary patterns histograms techniques for face recognition for real time application. Int J Recent Technol Eng 8(2S7):524–529
27. Sharma L, Garg PK, Future of internet of things. From visual surveillance to internet of things, Taylor & Francis, CRC Press, vol 1, pp 245
28. AR in Information: https://en.wikipedia.org/wiki/Augmented_reality
29. AR in Medical field: https://www.archersoft.com/en/blog/howaugmented-reality-usedmedicine
30. AR Future in medical: https://bmcmededuc.biomedcentral.com/articles/, https://doi.org/10.1186/s12909-018-1244-9
31. AR in information: https://www.autodesk.com/redshift/whatisaugmented-reality/
32. Sharma L, Yadav DK (2016) Histogram based adaptive learning rate for background modelling and moving object detection in video surveillance. Int J Telemedicine Clin Practices Inderscience. ISSN: 2052-8442. https://doi.org/10.1504/ijtmcp.2017.082107
33. Body Anatomy: http://scarfedigitalsandbox.teach.educ.ubc.ca/anatomy-4d-using-ar-to-teach-humanbodystructure/
34. Future work: https://www.ijarse.com/images/fullpdf/1508652201_3109_IJARSE.pdf
35. Sharma L, Introduction: from visual surveillance to internet of things. From visual surveillance to internet of things, Taylor & Francis, CRC Press, vol 1, pp 14
36. AR Ftuture: https://haptic.al/vr-and-ar-inmedicaleducation-cd1c90cc3de3
37. Sharma L, Garg PK, Block based adaptive learning rate for moving person detection in video surveillance. From visual surveillance to internet of things, Taylor & Francis, CRC Press, vol 1, pp 201
38. Sharma L (2020) Towards smart world: homes to cities using internet of things. Taylor & Francis, CRC Press. (ISSN: 9780429297922)
39. Sharma L, Garg PK, Agarwal N, A foresight on e-healthcare trailblazers. From visual surveillance to internet of things, Taylor & Francis, CRC Press, vol 1, pp 235
40. Sharma L, Garg PK, IoT and its applications. From visual surveillance to internet of things, Taylor & Francis, CRC Press, vol 1, pp 29
41. AR glass: http://www.arreverie.com/blogs/wpcontent/uploads/2017/11/ar-devices-arreverie-768x271.jpg
42. Kumar A, Jha G, Sharma L (2019) Challenges, potential & future of IOT integrated with block chain. Int J Recent Technol Eng 8(2S7):530–536
43. Sharma L, Singh A, Yadav DK (2016) Fisher's linear discriminant ratio based threshold for moving human detection in thermal video. Infrared physics and technology, Elsevier
44. Sharma L , Sengupta S, Kumar B (2021) An improved technique for enhancement of satellite image. J Phys: Conf Ser 1714:012051

45. Singh S, Sharma L, Kumar B (2021) A machine learning based predictive model for coronavirus pandemic scenario, J Phys: Conf Ser 1714 012023
46. Sharma L (2020) The rise of internet of things and smart cities, Towards smart world: homes to cities using internet of things, Taylor & Francis, CRC Press, pp 1–19
47. Sharma L (2020) The future of smart cities. Towards smart world: homes to cities using internet of things, Taylor & Francis, CRC Press, pp 1–19