Chapter 5
Applications of Artificial Intelligence and Internet of Things for Detection and Future Directions to Fight Against COVID-19

Akshat Agrawal, Rajesh Arora, Ranjana Arora, and Prateek Agrawal

Abstract Recently, coronavirus disease 2019 (COVID-19) has become a prevalent threat for the human life all over the world. The propagation of this virus is very fast, and due to its contagious nature, it is infecting millions of people globally. Scientists and researchers are continuously working to find out the ways, i.e., medicine/vaccine for its cure. In the current scenario, spreading awareness regarding detection and prevention of this pandemic can save numerous lives in whole community. In this context, applications of artificial intelligence (AI) and Internet of Things (IoT) techniques could be a boon to mankind, as they can help in prevention, detection, forecasting, mortality risk of patients and remote operation of curing devices like ventilators, drone sanitization/surveillance, resource management, etc. In the present study, all possible applications of AI technology, viz., collection of infected blood samples, detection of virus, forecasting, etc., have been undertaken. Furthermore, the relevance of IoT in terms of monitoring and controlling electrical and mechanical devices for the cure of COVID-19, communication of interconnecting devices, and supervision of curing appliances has been reviewed here. The use of various AI and machine learning (ML) algorithms in view of detecting the most threatening symptoms and features of this dangerous virus has been demonstrated in the present work. This will significantly enhance the lifesaving probability of human beings and can help in exploring the new methods of prevention and detection of COVID-19.

A. Agrawal · R. Arora (✉) · R. Arora
Amity University Haryana, Gurugram, India
e-mail: rarora64@gnn.amity.edu
P. Agrawal
University of Klagenfurt, Klagenfurt, Austria
Lovely Professional University, Phagwara, Punjab, India

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2021
F. Al-Turjman et al. (eds.), Emerging Technologies for Battling Covid-19, Studies in Systems, Decision and Control 324, https://doi.org/10.1007/978-3-030-60039-6_5
Keywords Artificial Intelligence · COVID-19 · Internet of Things · Machine learning

5.1 Introduction

The COVID-19 pandemic has emerged as a very substantial catastrophe globally, since the time of the Second World War. It has exceedingly affected all the countries of our planet, and its health consequences are quite disturbing and alarming. Till date, nearly 400,000 people have died due to this virus, and unfortunately this data is ordained to rise exponentially in the near future. Besides, the situation has directed to unparalleled social penalties and turmoil. The stupendous fact is projected that more than four billion people (a half of the entire mankind) are today pretentiously facing radical constraints in their activities and social associations [1]. A massive global financial disaster unlike the former eras might tremor the world in the years to come. This prevalent pandemic has majorly affected our customs, trading protocols, communal and financial conventions, devices, working philosophies, and political administrations in a diverse manner globally. It is very astonishing that globally our governing bodies, social administration, and health organizations were improvised to accomplish such circumstances, but now the time has come to handle and improve the situation with all possible apparatuses and tools in order to make this world a safer and healthier place for our upcoming generations.

There is a persistent and abrupt requirement for the community of science and technology, to join hand in hand for delivering innovative and improved procedures, policies, models, and forecasting practices in view to comprehend and diminish the outcomes of this and forthcoming epidemics. These efforts are required in both the nearby and coming future to apprise operative and impartial protocols and procedures to handle such situations. The whole world is looking for new techniques and technologies in this worldwide health crisis, for monitoring and controlling COVID-19 (coronavirus) spread much effectively. Artificial intelligence and machine learning are the answer to such problems which can easily monitor and predict the spreading of such viruses, can categorize the prone patients, and can be highly beneficial to control this contamination in real time. It is also helpful in predicting the mortality rate by effectively investigating the previously obtained data of the sufferers. These tools are effective for fighting against this virus through population airing, medical aids, reports, and ideas regarding its contagious spread [2–7].

The proposed technologies can forecast and predict the pattern of the spreading of the disease with the help of data available, social platforms, and media, rate of the infections and is contagious spreading risk globally. Furthermore, it could also find the number of active cases and deaths that occurred in any area since the time of inception of this virus. These techniques can be helpful in recognizing the most susceptible sections, individuals, and nations to adopt all the safety measures consequently [8–10].
In the present work, a critical review on the applications of artificial intelligence and Internet of Things for detection and future directions to fight against COVID-19 has been presented in view of identifying the high-risk areas and individuals and to adopt the safety measures consequently. The work is highly beneficial for monitoring and controlling the spread of this life-threatening virus and can significantly improve the situation by making the world a safer and a healthier place for the upcoming generations.

5.1.1 Motivation of the Study

The study has considered the following critical points to present a thorough and a comprehensive review to overcome the COVID-19 pandemic.

1. To analyze the artificial intelligence and machine learning tools for their effectiveness in monitoring of COVID-19 spread.
2. To investigate the effect of IoT on estimation, prediction, monitoring, and controlling of the COVID-19 spread.
3. To explore various forecasting tools to monitor the spread of virus in different regions of the nations.
4. To check the possible effectiveness on the application of artificial intelligence, machine learning, and IoT on the lifesaving devices like ventilators, drone sanitization/surveillance, resource management, etc.
5. To spread awareness in the society for fighting against the virus and save the lives globally.

5.2 Machine Learning and Artificial Intelligence Techniques Used for Forecasting of Spread of COVID-19

The artificial intelligence and machine learning technologies have the great utility to improvise the scheduling, handling, and testified consequences of the COVID-19 sufferer, using the tools based on facts and evidence collected in the near past cases. These can make up a smart and effective platform for the prediction, monitoring, and cure of the spread of the disease. A neural network technique could be developed in order to get the prominent characteristics of the virus and can be highly beneficial in the treatment of the infected lot. It can also give the updates and current number of cases active in a particular area and their probable solutions for the prevention of its spread.

The huge range of data for active COVID-19 cases can be amalgamated and investigated by latest machine learning and AI algorithms in view of providing a much better understanding of the spread of the virus. It can further help in improving the diagnosis speed and precision and development of novel therapies and
psychological treatments to genetically cure the disease at faster rate. Stupendously, in a short span of time since the spread of this pandemic, these advanced AI and machine learning technologies have been employed in hieratical arrangement of COVID-19 genomes [11–15]. Figure 5.1 shows the procedural steps followed by AI and machine learning tools for helping out the health workers in order to identify COVID-19 symptoms and active infections.

5.3 IoT Applications for Surveillance of Various Virus Detection Devices

Internet of Things is playing a vital role in online monitoring, area tracking, SMS alerting, and gear up scheduling for favorable detection, monitoring, scheduling, and treatment provided for COVID-19 patients. Figure 5.2 shows the linkages of schedule management, off route maintenance, instruction management, and database decision-making of COVID-19 with respect to the prescheduled guidelines and real-time updates on standardized protocols of the disease spread. Recently, a number of researchers [16–30] have applied advanced optimization techniques, viz., genetic algorithm, NSGA-II, PSO, etc., to carry out optimum values of various design variables for different systems. In the present work, applications of these AI and ML techniques are reviewed for surveillance of various virus detection devices.
Further, ten major functions of IoT diagnosis and curing system for COVID-19 are shown in Fig. 5.2:

5.4 Analysis of Available Data

The data pertaining to COVID-19 active cases is demonstrated through various platforms like media channels, research community, and government agencies/websites which are increasing day by day due to the deadly spread of this dangerous virus. The presentation of the data is very important as it can significantly help in obtaining the pattern of its spread and ultimately the knowledge
to prevent it. In this study, the data has been categorized in three different forms, viz., countries having active patients less than 10,000, active patients between 10,000 and 100,000, and countries with above 100,000 patients globally.

Figure 5.3 demonstrates the data pertaining to various countries having less than 10,000 active COVID-19 cases. This data is helpful for other countries to adopt their model to control the spread of COVID-19 at their place. The data of active patients is recorded from January 25, 2020, to May 30, 2020, in view of thoroughly monitoring the spread of COVID-19 in the whole world. It has been observed that there is a steep rise in the number of active patients from mid-March in almost all the countries shown in the time line. It is further observed that feeble rise in the activity of virus is found in the countries having average temperature more than

Fig. 5.3 Countries having active patients less than 10,000
50 °C. Depending upon the number of cases, these countries may be kept in the green zone in the safety scale.

Figure 5.4 demonstrates the data pertaining to various countries having less than 100,000 and more than 10,000 active COVID-19 cases. The data of active patients is recorded from January 25, 2020, to May 30, 2020, in view of thoroughly monitoring the spread of COVID-19 in the whole world. It has been observed that there is a steep rise in the number of active patients from mid-March in almost all the countries shown in the time line except China. A stringent rise in the number of active cases is observed in China from January 25, 2020, to February 20, 2020. After that the situation has been controlled as shown in the saturation in the number of active cases in the country. It is further observed that an alarming situation has arrived due to rise in the number of sufferers in all other countries around the world. The cases in these countries have not been stabilized and still
increasing day by day as shown in Fig. 5.4. These countries may be kept in the orange range.

Figure 5.5 demonstrates the data pertaining to various countries having more than 100,000 active COVID-19 cases. The data of active patients is recorded from January 25, 2020, to May 30, 2020, in view of thoroughly monitoring the spread of COVID-19 in the whole world. These are the countries which are marked in the red zone as observed from the very sharp rise in the number of active cases. It has been observed that there is a steep rise in the number of active patients from mid-March in the USA as compared to other countries shown in the time line. The situation is still not under control, and the cases are not stabilized till date. Further, the number of active cases in top ten countries around the world is shown in Fig. 5.6.

The daily rise in the number of active cases of COVID-19 in top four countries of the world is demonstrated in Figs. 5.7, 5.8, 5.9, and 5.10. The utmost rise is observed in the USA followed by Brazil, Russia, and Italy. It is found that the rise in US active cases steeply rises from mid-March and has not attained a saturation till date, as shown in Fig. 5.7. On the other hand, Brazil has shown a rise in active case from the last week of April 2020 as shown in Fig. 5.8, and still the life is in threat in this country. Likewise, Russia is showing rise in the number of active COVID-19 cases from mid-March, and the situation is not still under control in this country (refer to Fig. 5.9). Whereas in

![COVID-19 Patient Growth Across the Globe](image)

**Fig. 5.5** Countries having more than 100,000 active patients
Fig. 5.6  Top ten countries with most COVID-19 active patients

Fig. 5.7  Daily increase in number of cases in the USA
Italy, although the number of active cases steeply increased from mid-March, they have adopted very good models due to which the situation is under control, and a fall in the number of active cases has been observed in this country (refer to Fig. 5.10).

Fig. 5.8 Daily increase in the number of cases in Brazil

Fig. 5.9 Daily increase in the number of cases in Russia
5.5 Conclusions and Future Scope

In the present work, a critical review on the applications of artificial intelligence and Internet of Things for detection and future directions to fight against COVID-19 has been presented in view of identifying the high-risk areas and individuals and to adopt the safety measures consequently. The major outcomes of the study can be summarized as follows:

The artificial intelligence and machine learning tools are significantly beneficial to identify the infections caused by COVID-19 and could be helpful to monitor the state of infected people in a region. The Internet of Things is a novel tool which can remotely control and monitor the health measures like ventilators, drone sanitization/surveillance, resource management, etc., in a very effective and efficient manner.

These tools can abruptly upgrade the curing frequency and decision-making for the patients with the help of very fast algorithms. These are very useful in the treatment and cure of active COVID-19 cases and also in monitoring their health posttreatment.

These tools can facilitate to inform and alert the people regarding the spread of the virus by investigating the available data and are helpful in predicting, forecasting, and monitoring the health conditions.

The society can be made aware of this contagious virus and the ways to prevent/fight against COVID-19.

The work can further be extended to track the pandemic spread at various levels such as molecular, medical history, and epidemiological claims by using various other artificial intelligence and forecasting techniques. Further, the study can be effective to overcome the major tremor caused at different scales of economic, social, healthcare, and psychological prevalence in the society.
References

1. Haleem, A., Javaid, M., Vaishya, R.: Effects of COVID 19 pandemic in daily life. Curr. Med. Res. Pract. 10(2), 78–79 (2020). https://doi.org/10.1016/j.cmrp.2020.03.011

2. Bai, H.X., Hsieh, B., Xiong, Z., Halsey, K., Choi, J.W., Tran, T.M., Pan, I., Shi, L.B., Wang, D.C., Mei, J., Jiang, X.L.: Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT. Radiology. 296(2), E46–E54 (2020). https://doi.org/10.1148/radiol.2020200823

3. Hu, Z., Ge, Q., Jin, L., Xiong, M.: Artificial intelligence forecasting of COVID-19 in China. arXiv preprint arXiv:2002.07112 (2020)

4. Haleem, A., Vaishya, R., Javaid, M., Khan, I.H.: Artificial intelligence (AI) applications in orthopaedics: an innovative technology to embrace. J. Clin. Orthop. Trauma. 11(Suppl 1), S80–S81 (2019). https://doi.org/10.1016/j.jcot.2019.06.012

5. Biswas, K., Sen, P.: Space-time dependence of coronavirus (COVID-19) outbreak. arXiv preprint arXiv:2003.03149 (2020)

6. Stebbing, J., Phelan, A., Griffin, I., Tucker, C., Oechsle, O., Smith, D., Richardson, P.: COVID-19: combining antiviral and anti-inflammatory treatments. Lancet Infect. Dis. 20(4), 400–402 (2020)

7. Cao, Y., Li, L., Feng, Z., Wan, S., Huang, P., Sun, X., Wen, F., Huang, X., Ning, G., Wang, W.: Comparative genetic analysis of the novel coronavirus (2019-nCoV/SARS-CoV-2) receptor ACE2 in different populations. Cell Discov. 6, 11 (2020). https://doi.org/10.1038/s41421-020-0147-1

8. Fang, L., Karakiulakis, G., Roth, M.: Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? Lancet Respir. Med. 8(4), e21 (2020). https://doi.org/10.1016/S2213-2600(20)30116-8

9. Ge, Y., Tian, T., Huang, S., Wan, F., Li, J., Li, S., Yang, H., Hong, L., Wu, N., Yuan, E., Cheng, L., Lei, Y., Shu, H., Feng, X., Jiang, Z., Chi, Y., Guo, X., Cui, L., Xiao, L., Li, Z., Yang, C., Miao, Z., Tang, H., Chen, L., Zeng, H., Zhao, D., Zhu, F., Shen, X., Zeng, J.: A data-driven drug repositioning framework discovered a potential therapeutic agent targeting COVID-19. bioRxiv (2020). https://doi.org/10.1101/2020.03.11.986836

10. Gozes, O., Frid-Adar, M., Greenspan, H., Browning, P.D., Zhang, H., Ji, W., Bernheim, A., Siegel, E.: Rapid AI development cycle for the coronavirus (COVID-19) pandemic: initial results for automated detection & patient monitoring using deep learning CT image analysis. arXiv2003.05037 (2020)

11. Metsky, H.C., Freije, C.A., Kosoko-Thoroddsen, T.-S.F., Sabeti, P.C., Myhrvold, C.: CRISPR-based COVID-19 surveillance using a genomically-comprehensive machine learning approach. bioRxiv (2020). https://doi.org/10.1101/2020.02.26.967026

12. Ong, E., Wong, M.U., Huffman, A., He, Y.: COVID-19 coronavirus vaccine design using reverse vaccinology and machine learning. bioRxiv (2020). https://doi.org/10.1101/2020.03.20.000141

13. Randhawa, G.S., Soltysiak, M.P.M., El Roz, H., de Souza, C.P.E., Hill, K.A., Kari, L.: Machine learning using intrinsic genomic signatures for rapid classification of novel pathogens: COVID-19 case study. bioRxiv (2020)

14. Senior, A.W., Evans, R., Jumper, J., Kirkpatrick, J., Sifre, L., Green, T., Qin, C., Židek, A., Nelson, A.W.R., Bridgland, A., Penedones, H., Petersen, S., Simonyan, K., Crossan, S., Kohli, P., Jones, D.T., Silver, D., Kavukcuoglu, K., Hassabis, D.: Improved protein structure prediction using potentials from deep learning. Nature. 577, 706–710 (2020). https://doi.org/10.1038/s41586-019-1923-7

15. Wang, Y., Hu, M., Li, Q., Zhang, X.-P., Zhai, G., Yao, N.: Abnormal respiratory patterns classifier may contribute to large-scale screening of people infected with COVID-19 in an accurate and unobtrusive manner. arXiv2002.05534 (2020)

16. Arora, R., Kaushik, S.C., Kumar, R., Arora, R.: Multi-objective thermo-economic optimization of solar parabolic dish Stirling heat engine with regenerative losses using NSGA-II and decision making. Int. J. Electr. Power Energy Syst. 74, 25–35 (2016)
17. Arora, R., Kaushik, S.C., Kumar, R., Arora, R.: Soft computing based multi-objective optimization of Brayton cycle power plant with isothermal heat addition using evolutionary algorithm and decision making. Appl. Soft Comput. 46, 267–283 (2016)
18. Arora, R., Arora, R.: Multiobjective optimization and analytical comparison of single-and 2-stage (series/parallel) thermoelectric heat pumps. Int. J. Energy Res. 42(4), 1760–1778 (2018)
19. Arora, R., Arora, R.: Multicriteria optimization based comprehensive comparative analyses of single-and two-stage (series/parallel) thermoelectric generators including the influence of Thomson effect. J. Renew. Sustain. Energy. 10(4), 044701 (2018)
20. Arora, R., Kaushik, S.C., Kumar, R.: Multi-objective optimization of solar powered Ericsson cycle using genetic algorithm and fuzzy decision making. In: 2015 International Conference on Advances in Computer Engineering and Applications, pp. 553–558. IEEE (2015)
21. Arora, R., Kaushik, S.C., Kumar, R.: Multi-objective optimization of an irreversible regenerative Brayton cycle using genetic algorithm. In: 2015 International Conference on Futuristic Trends on Computational Analysis and Knowledge Management (ABLAZE), pp. 340–346. IEEE (2015)
22. Maputi, E.S., Arora, R.: Design optimization of a three-stage transmission using advanced optimization techniques. Int. J. Simul. Multidiscip. Des. Optim. 10, A8 (2019)
23. Maputi, E.S., Arora, R.: Multi-objective spur gear design using teaching learning-based optimization and decision-making techniques. Cogent Eng. 6(1), 1665396 (2019)
24. Arora, R., Kaushik, S.C., Kumar, R.: Multi-objective thermodynamic optimization of solar parabolic dish Stirling heat engine with regenerative losses using NSGA-II and decision making. Appl. Solar Energy. 52(4), 295–304 (2016)
25. Kumar, R., Kaushik, S.C., Kumar, R., Hans, R.: Multi-objective thermodynamic optimization of an irreversible regenerative Brayton cycle using evolutionary algorithm and decision making. Ain Shams Eng. J. 7(2), 741–753 (2016)
26. Hyndman, R.J., Koehler, A.B., Snyder, R.D., Grose, S.: A state space framework for automatic forecasting using exponential smoothing methods. Int. J. Forecast. 18(3), 439–454 (2002)
27. Taylor, J.W.: Exponential smoothing with a damped multiplicative trend. Int. J. Forecast. 19(4), 715–725 (2003)
28. Makridakis, S., Andersen, A., Carbone, R., Fildes, R., Hibon, M., Lewandowski, R., et al.: The accuracy of extrapolation (time series) methods: results of a forecasting competition. J. Forecast. 1(2), 111–153 (1982)
29. Petropoulos, F., Makridakis, S.: Forecasting the novel coronavirus COVID-19. PLoS One. 15(3), e0231236 (2020)
30. Liu, D., Clemente, L., Poirier, C., Ding, X., Chinazzi, M., Davis, J.T., Vespignani, A., Santillana, M.: A machine learning methodology for real-time forecasting of the 2019–2020 COVID-19 outbreak using Internet searches, news alerts, and estimates from mechanistic models. arXiv preprint arXiv:2004.04019 (2020)