Industry 5.0 platform for COVID-19 Pandemic in the UAE using Fog Computing

(Executive Summary)

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1. Introduction

Background: Corobots can do routine tasks like routine checks that physicians undertake thanks to Industry 5.0. Therefore, medical professionals will concentrate on more senior level of jobs. By receiving constant input from surgeons, corobots will be able to perform even the most complex surgeries with pinpoint accuracy during COVID-19 pandemic. Digital twins (DT), edge computing (EC), collaborative robots, IoE, blockchain, big data analytics, upcoming 6G systems and beyond can aid physicians in early disease diagnosis and individualized drug prescriptions. Industry 5.0 was developed to increase operational effectiveness during the COVID-19 pandemic. Corobots, a key enabling technology in Industry 5.0, were among the solutions proposed for treating COVID-19 patients without physical contact. In addition, they

proposed using intelligent robots to scan and treat patients with COVID-19, thereby lowering the risk of viral exposure for front-line healthcare workers. Despite their usefulness, shared resource techniques in healthcare applications, especially COVID-19, have a few significant drawbacks that need to be managed carefully. Preprocessing is a costly process in both money and time, and it frequently results in significant delays in delivering services to end users. Data analytics accuracy and flexibility may suffer if they are outsourced entirely to the network's periphery due to a lack of processing power at those nodes. Although cloud-based and fog-based systems have advantages, their usefulness is limited by architectural constraints. Data redundancy and network slowdown result from the practice of simply broadcasting all data. Not all aspects of fog computing are clearly defined like cooperation and load distribution. Due to resource contention and increased processing latency, edge devices cannot support multiple applications vying for the same set of resources. Many obstacles stand in the way of fog-based middleware providing cloud-based healthcare recommendations. Due to resource competition and increased processing delay, edge devices are unable to manage many applications vying for the few resources. A fog-based middleware will face several difficulties while using suggested cloud healthcare services during the COVID-19 pandemic. The fog layer needs to be adaptable and capable of being reconstructed over time, especially in the face of emergencies as the COVID-19 epidemic.

Due to its limited capacity, a fog node cannot process an extremely high rate of events per second. Fog nodes with limited resources may experience delays in the provisioning of resources for some tasks. Scaling a fog system increases the likelihood of failure. Despite numerous efforts in research and development, Industry 5.0 faces a number of obstacles and problems. We will outline these challenges associated with privacy, security, collaboration activities between humans and robots in the factory, scalability, and availability of qualified workers during the COVID-19 epidemic. With the help of Industry 5.0, we hope to create an intelligent healthcare management system that will allow for better treatment management and early intervention even in the absence of any symptomatic evidence for COVID-19 disease. This revolution will enhance patients' entire healthcare experiences and enable medical professionals to provide better, more effective treatment during the COVID-19 pandemic.

Objectives: Exploring Industry 5.0 Healthcare Technologies, Preprocessing the various medical imaging data as well as data from lengthy forms for COVID-19 disease, the proposed system will allow the development of artificial intelligence models for accurately data analytics for COVID-19 disease, using fog computing to create and implement a patient-focused system for analyzing COVID-19 medical data, testing the proposed intelligent COVID-19 management system in a controlled environment.

2. Research Question(s)

- How can the integration of Industry 5.0 technologies enhance the efficiency and accuracy of healthcare delivery?
- What are the most effective preprocessing techniques for medical imaging data to improve COVID-19 diagnosis and monitoring?
- How can fog computing be implemented in healthcare systems to reduce latency and improve real-time analysis of COVID-19 medical data?

3. Research Methods

Industry 5.0 represents a shift from Industry 4.0, focusing on human-machine collaboration rather than purely optimizing production through technology. In healthcare, this shift integrates advanced technologies such as AI, IoT, and robotics to improve patient care, especially during the COVID-19 pandemic. Fog computing, deployed near end-users, offers a powerful solution by reducing latency, supporting real-time communication, and enabling local data processing. This is particularly beneficial for managing the COVID-19 crisis, as fog computing can address common healthcare issues like scalability, energy efficiency, and reliability. The proposed healthcare management system for COVID-19 integrates Industry 5.0 technologies to enable real-time monitoring and decision-making. IoT sensors, smart devices, and AI algorithms continuously collect and analyze patient data, predicting outcomes, tracking patient progress, and notifying medical personnel when necessary. Collaborative robots (cobots) assist healthcare providers in surgery and patient care. Blockchain ensures secure storage and auditing of patient data.

The system architecture consists of three layers:

- Medical Layer: Uses AI, ML, and IoT to collect and process real-time patient data for predictive analytics and automation in healthcare tasks. Blockchain ensures data integrity, and hyper-customization adapts the system to individual patient needs.
- Fog Layer: Employs intelligent gateways and IoT sensors to preprocess and filter medical data locally, ensuring efficient decision-making and reducing data transmission to the cloud.
- Cloud Layer: Centralized storage and analysis of large-scale, complex healthcare data. The cloud handles long-term data processing and supports advanced analytics for decision-making and patient management.

Together, these layers enable a comprehensive, real-time healthcare ecosystem that improves treatment management and early intervention for COVID-19. The fog and cloud infrastructure ensure low-latency, high-performance processing for better healthcare delivery during the pandemic.

4. Key Findings

- Industry 5.0 emphasizes the collaboration between humans and smart systems, contrasting with Industry 4.0's focus on automation and optimization.
- Fog computing brings computation and data storage closer to the edge, reducing latency and enabling real-time processing of COVID-19 patient data.
- By processing data locally on smart gateways, fog computing reduces the need to send large volumes of data to the cloud, saving bandwidth and ensuring quicker responses.
- The machine learning models predict infection rates, hospital admissions, patient deterioration, and other key factors, helping healthcare providers plan better with a good accuracy rate.
- Blockchain ensures the secure storage and management of patient data, providing transparency, audit trails, and ensuring compliance with healthcare regulations.

5. Implications

- By utilizing fog computing to process data closer to the edge, healthcare providers can make near-instantaneous decisions regarding patient care. This significantly reduces latency and allows for immediate intervention in critical cases, especially during emergencies like the COVID-19 pandemic.
- Industry 5.0 technologies allow for highly personalized healthcare solutions. Through continuous monitoring of patients via IoT devices (e.g., smartwatches, wearables) and the analysis of personal data, healthcare systems can offer customized treatment plans that cater to the specific needs of individual patients, improving care quality and patient satisfaction.
- With the large volume of medical data being generated, particularly during health crises, the use of blockchain technology ensures that patient data is stored securely, with an immutable audit trail, which is critical for maintaining trust and compliance with healthcare regulations

6. Conclusion

- The suggested method makes it easier to identify COVID-19 at any time or place. The interface is user-friendly and simple to operate. In addition, we emphasize the cloud's Quality of Service (QoS) by adding a middle layer between the user and the cloud to lower latency and guarantee real-time response. The integration of Industry 5.0 technologies in healthcare, particularly for managing COVID-19, has the potential to revolutionize treatment and care. By leveraging IoT,

AI, smart sensors, and fog computing, healthcare providers can create a responsive, efficient, and personalized healthcare system. Testing and refining these technologies in a controlled environment will ensure their effectiveness and reliability, ultimately leading to better health outcomes and a more resilient healthcare infrastructure.

- Future Research: Future research could expand the findings of this study by exploring the integration and optimization of emerging technologies, improving healthcare system interoperability, ensuring patient privacy and ethical concerns, and further enhancing the scalability and efficiency of the proposed healthcare ecosystem. The long-term goal would be to create a robust, sustainable, and adaptive healthcare system capable of managing pandemics and improving patient care across diverse global contexts.