Smart City-Enabled Telemedicine: An IoMT–Edge–Cloud Framework

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***Abstract*— Telemedicine is increasingly integral to digital healthcare, particularly in remote monitoring, chronic disease management, and ensuring continuity of care. Despite these advancements, many telemedicine systems remain isolated as stand-alone platforms, exhibiting limited integration with smart city infrastructures, contextual urban data, and distributed computing resources. This study introduces an initial computer science framework for smart city-enabled telemedicine, incorporating Internet of Medical Things (IoMT) devices, wearable sensors, smart home systems, urban sensing infrastructures, secure communication networks, edge and fog computing, cloud-based health data management, artificial intelligence-driven decision support, and resource orchestration. The proposed architecture facilitates context-aware, secure, and scalable healthcare services by linking patient monitoring with risk assessment and service activation. An integrated application scenario illustrates the potential of combining clinical and urban data to enhance responsiveness and continuity of care.**

Keywords*— *Telemedicine; Smart Cities; Internet of Things

I. INTRODUCTION

Telemedicine is a central area of advancement in digital healthcare, enabling the delivery of clinical, diagnostic, therapeutic, and monitoring services regardless of the physical locations of patients and healthcare professionals. According to WHO Europe, telemedicine involves the application of telecommunication technologies to provide medical, diagnostic, and therapeutic services in situations where distance is a significant factor. Simultaneously, smart cities are transitioning from basic digitised urban environments to complex cyber-physical ecosystems in which sensors, IoT infrastructure, communication networks, cloud platforms, edge systems, and artificial intelligence algorithms collaborate to provide advanced urban services [1]. Within this context, health should not be regarded as a separate domain but rather integrated into urban services through models such as smart healthcare, remote monitoring, digital home care, and intelligent management of healthcare resources [2]. This article argues that telemedicine is often perceived as an isolated healthcare platform, focused primarily on video consultations, remote monitoring, and doctor-patient communication. In the context of a smart city, however, telemedicine can be reimagined as a smart urban service that integrates clinical, environmental, wearable device, contextual, and geographic information systems, along with distributed computing infrastructure [3], [4]. Implementing such an approach requires an architecture that supports the entire data life cycle, including acquisition from Internet of IoMT devices, secure transmission, edge-based pre-processing, cloud integration, interoperability with electronic health systems, artificial intelligence-driven decision support, resource orchestration, and dissemination of information to healthcare professionals, patients, caregivers, and local services [5]. The European regulatory framework further underscores this need. The European Health Data Space Regulation, published in 2025 in the Official Journal of the European Union, aims to establish a unified environment for the access, exchange, and reuse of electronic health data. Core principles of this initiative include interoperability, citizen control over personal data, and the secure use of health information. In this context, we propose a foundational framework for smart city-enabled telemedicine that integrates the IoMT, urban sensing, edge and cloud computing, artificial intelligence, healthcare interoperability, and intelligent resource orchestration.

II. MATERIAL AND METHODS

This work adopts an architectural and conceptual methodology. The primary objective is to establish an initial, technically consistent framework that can subsequently be evaluated through simulations, prototypes, or case studies. The framework utilises a multi-level approach, with each layer responsible for a specific system function. The first layer, the Patient and Urban Sensing Layer, consists of wearable devices, home medical equipment, mobile phones, environmental sensors, smart home technologies, and urban IoT infrastructure. Data collected at this layer include physiological parameters, mobility, body temperature, oxygen saturation, heart rate, blood pressure, air quality, ambient temperature, and the patient's approximate location. The second layer, the Communication and Connectivity Layer, incorporates technologies for data transfer, including Wi-Fi, 5G, LPWAN networks, IoT protocols, REST APIs, MQTT, and encrypted channels. This layer ensures dependable, continuous, and secure data transmission. The third layer, the Intelligence Layer on Edge or Fog, processes data at the edge to enable filtering, normalisation, anomaly detection, noise reduction, compression, and local alerting. This layer is essential for reducing latency in critical situations. The fourth layer, the Cloud and Health Data Management Layer, provides storage, healthcare data lakes, Electronic Health Records, Electronic Health Files, interoperable data models, consent management, and access tracking. The fifth layer, the AI-Based Decision Support Layer, applies machine learning techniques, prediction models, risk classifiers, anomaly detection systems, and triage support models. Its purpose is to guide decision-making based on clinical and contextual data, rather than to replace the physician. The sixth layer, the Resource Orchestration and Recommendation Layer, is informed by advancements in resource recommendation systems for telemedicine. This module manages physician availability, teleconsultation slots, IoMT devices, edge gateways, computing resources, clinical priorities, waiting lists, local services, and the activation of physical or digital resources. The seventh and final layer, the Smart City Health Services Layer, encompasses telemonitoring, teleassistance, teleconsultation, chronic patient management, care for frail patients, and integration with local operations centres and emergency services.

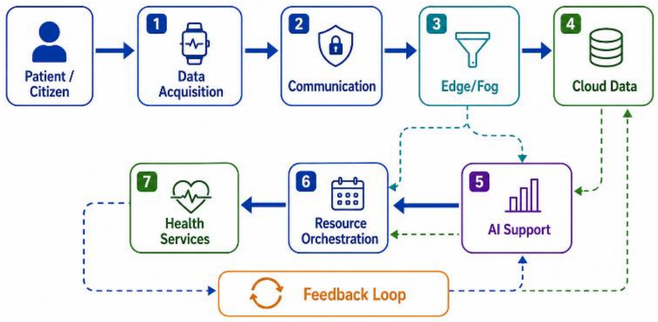

Fig. 1 Workflow proposed

III. Application scenarios

The proposed framework can be implemented in a smart city environment to monitor vulnerable residents, patients with chronic diseases, or individuals requiring follow-up care through wearable devices, IoMT sensors, smart home devices, and urban infrastructure. In this context, telemedicine is conceptualised not solely as remote communication between doctor and patient, but as a distributed digital service capable of coordinating health and environmental data with local resources. Monitoring may include physiological parameters such as heart rate, oxygen saturation, blood pressure, body temperature, activity levels, and sleep quality. Additionally, the smart city infrastructure can provide contextual information, including temperature, humidity, air quality, urban movement, and access to services. Integrating clinical and environmental data enables a more comprehensive assessment of patient health, as changes in vital signs may have different implications when considered alongside adverse urban conditions such as elevated temperatures or poor air quality. This layer facilitates data filtering, noise reduction, preliminary abnormality detection, and the generation of low-latency warnings. Subsequently, the processed information is sent to the healthcare cloud platform, where it can be integrated with the patient's medical history, electronic health records, and relevant local services. The artificial intelligence-based decision support module analyses clinical and contextual data to assess risk levels, determine event priority, and support decision-making. Based on the assessed criticality, the system can activate the resource orchestration module, which selects the most appropriate response: notifying the patient, scheduling a teleconsultation, involving a physician, activating a caregiver, initiating local intervention, or escalating to emergency services. This design effectively links remote monitoring with organisational response. This scenario demonstrates how telemedicine within a smart city context can evolve from an episodic service to a continuous, contextual, and predictive infrastructure. The framework's value lies in its ability to integrate data collection, secure communication, edge processing, cloud management, decision support, resource orchestration, and the delivery of urban healthcare services. Initially, architectural consistency can be assessed by verifying that each layer possesses clearly defined inputs, outputs, and responsibilities. Additional validation considerations include technological performance, interoperability, security, and user acceptability. Key metrics may encompass end-to-end latency, alert generation time, average resource allocation time, service availability, anomaly detection accuracy, and risk classification correctness. The framework must support interoperability with various healthcare systems, electronic health records, IoMT platforms, and local services. Security requirements include authentication, authorisation, encryption, audit trails, data minimisation, consent management, and access tracing.

IV. Conclusions

This study introduces an initial paradigm for integrating digital health services into smart cities, treating them as integral elements of a smart urban ecosystem rather than isolated applications. The proposed architecture incorporates wearable devices and the IoMT, urban sensors, secure connectivity, edge and fog computing, cloud platforms, artificial intelligence-based decision support, and coordinated healthcare service delivery. The primary contribution of this study is the articulation of an integrated, multi-level framework that links remote patient monitoring with contextual risk management and the activation of relevant healthcare services. Through this approach, telemedicine can evolve from a basic remote communication tool into a continuous, predictive, and citizen-focused digital infrastructure. Given the preliminary nature of this study, future work should focus on experimental implementation and validation of the proposed concept. Subsequent activities may include developing a prototype, simulating workflows using real datasets, evaluating edge and cloud performance, integrating healthcare interoperability standards, and engaging end users. These efforts will enable assessment of the framework’s scalability, security, stability, and practical applicability in real-world smart healthcare environments.

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