



# Smart IoT for Sustainable Development

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and Pranav Pawar

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# 5 Comprehensive Study of Wearable Healthcare Devices Using IoT

*Ibrar M. A. Jahan, Archana Yadav, Sarita Kumari, V. R. Balaji, and R. Srujana*

## 5.1 INTRODUCTION

In contemporary times, the technology employed in healthcare sectors is experiencing rapid and significant expansion. Nevertheless, the task of obtaining the most suitable medical data and ensuring safety has emerged as a formidable obstacle [1]. The Internet of Things (IoT) is the latest and one of the highest beneficial technologies in the field of healthcare for three specific underlying reasons. Firstly, IoT enables the management and surveillance of previously identified diseases. Additionally, it functions to improve other technologies, including sensors and high-response diagnostic apparatus, in real time. Thirdly, consumers experience health decline. This last benefit is demonstrated through practical and invaluable applications that are accessible to a wide range of patients. The development of apps on self-care to avoid respiratory diseases is an excellent strategy, given the significant worldwide socio-economic effect on home care [2]. According to the traditional health monitoring system, patients must see doctors on a regular basis to have their conditions monitored. However, the integration of the IoTs into the health monitoring system allows for the automation of health monitoring procedures, saving patients' valuable time. Additionally, the cloud, which transformed data alteration, supports attempts to create a more effective and dependable health monitoring system. Real-time storage and visualization of the health data is possible. The integration of wearable devices with the IoT further enhances their capabilities. The IoT, defined as the network of interconnected physical objects with embedded technology, allows for seamless data communication and interaction between wearable devices and healthcare providers. This integration enables real-time data transfer, remote monitoring, and personalized healthcare, revolutionizing the traditional healthcare delivery model. Recent research has highlighted the potential benefits of wearable healthcare devices in the IoT ecosystem. The ability to track health status continuously and provide personalized insights can lead to early detection of health issues, improved disease management, and better patient outcomes.

This work provides a comprehensive study of the application of IoT for monitoring several physiological data, their advantages, and challenges providing pertinent environmental data for the respiratory system.

## 5.2 MONITORING PHYSIOLOGICAL PARAMETERS

In recent years, several wearable devices have been developed to provide valuable information for assessing and supervising a patient's respiratory function or providing pertinent environmental data for the respiratory system [3]. This section will provide a concise overview of:

- Oxygen saturation level.
- Breathing pattern, respiratory rate, and minute ventilation.

Respiratory monitoring often uses pulse oximetry [4]. Pulse oximeters quantify oxygen saturation by exposing a small area of skin to light at wavelengths of 940 nm and 660 nm and 940 nm and quantifying the photon absorption, which is influenced by the levels of oxyhemoglobin and deoxyhemoglobin. Two ways are typical. Hand-finger transmission oximetry measures hand and earlobe light. Empirical calculations determine oxygen saturation from body-reflected light ("backscattering") at two wavelengths in reflection oximetry. Wearable pulse oximeters must detect motion artifact and poor perfusion, but new signal processing and reflectance technologies are improving reliability, accuracy, and the capability to autonomously differentiate artifacts from true data by examining signal waveforms. The neuron device measures electroencephalography, electro-oculography, motion, and temperature while worn on the head for sleep studies. Earbuds with audio capabilities are a new, exciting trend. Respiratory monitoring often uses pulse oximetry [5]. Pulse oximetry is essential for monitoring breathing, although determining artery oxygen saturation alone is insufficient and presents multiple practical constraints, such as diminished perfusion at the measurement location in hypothermia or shock. The number of breaths per minute and tidal volume determine pulmonary ventilation. Assessing pulmonary ventilation entails monitoring two essential parameters as well as all the characteristics that may be obtained from them, including inhalation time, exhalation time, average inspiring flow, and average expiration flow [6]. These metrics are essential for patient ventilation assessment. An unsteady respiration rate is a key prognostic indicator and an indicator of severe disease. Respiratory rate, often overlooked, can predict severe clinical outcomes like cardiac arrest or ICU admission [7] and differentiate stable people from at-risk patients with greater accuracy than measures of pulse and blood pressure [8]. Many lung and heart diseases, such as pneumonia [9], affect respiration rate, so respiration activity, especially inhaling and exhaling rate, should be continuously monitored in sensitive cases like post-surgery and mechanically ventilated patients. Trends in minute ventilation in cardiopulmonary disease patients may indicate decompensation and consequences [10]. Monitoring sleep ventilation, including hypopneas and apneas, is essential for rapid diagnosis and treatment of sleep disorders. Of course, these values are crucial for

monitoring patient breathing, but they usually need a flowmeter in a mouthpiece, mask, or tube. Clinically, capnography is still used to measure respiratory activity. Piezo-resistive belts and respiratory inductive plethysmography (RIP) are other non-invasive breathing monitoring techniques. These approaches are unsuitable for home respiratory monitoring during everyday activities and sleep following hospitalization. Therefore, it is still necessary to develop non-invasive methods for longitudinally monitoring minute respiration or ventilation rates in these environmental conditions. For this reason, numerous start-up businesses have developed sensitized clothing in the previous decade, and some items are on the market, although few have CE mark or Food and Drug Administration (FDA) designation. Body surface sensors are one option. The chest wall includes the ribs and abdominal wall, which move with the lungs during breathing. Numerous methodologies have been developed to measure the movement of the vertebral column or abdomen [11]. From diameters, circumferences, or cross-sectional areas, calibration methods including isovolumetric, shifting posture, and natural breathing allow for the estimation of volume fluctuations in individual compartments, the lungs, and the chest wall. The circumstances of calibration usually restrict the validity of these procedures.

### 5.3 MONITORING RESPIRATION RATE

IoT architecture uses sensors to acquire signals and programmable cards to process them. Hub-IoT cloud servers record database (DB) signals. Technology service Hub-IoT supports different programming languages. This research uses an Application Programming Interface (API) to obtain, store, process, and analyze DB data. Application development optimization relies on protocols (transport, IoT, and prioritization), communication channels, and technologies with minimal resource usage [10]. Next, a performance effectiveness test app is created in Figure 5.1 and detailed functioning can be understood in Figure 5.1.

A highly efficient wireless personal area network (WPAN) with low-energy sensors and a discontinuous clinical parameter control system are in the primary acquisition module. Dual sensors connect to an e-health card in the WPAN module, i.e., a digital expense body temperature sensor, CMS50DL, and pulse oximeter. This device's e-health communication synchronization protocol prioritizes SpO<sub>2</sub>. Users can access biometric and medical applications that monitor their bodies using e-health cards. The following nine sensors are supported by e-health cards: airflow (breathing), blood oxygen SpO<sub>2</sub> level, body temperature, heartbeat, galvanic skin

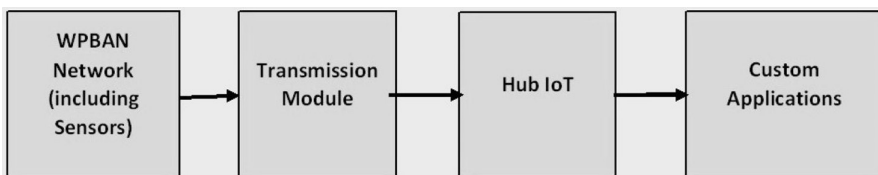


FIGURE 5.1 IoT architecture.