Design of Oxygen-Carrying Autonomous Following and Health Monitoring Robot for Pulmonary Rehabilitation

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Chronic obstructive pulmonary disease (COPD) affects over 16 million people, and is a leading cause of mortality in the United States. Pulmonary rehabilitation (PR) and oxygen therapy are common treatments for COPD patients, involving exercising with oxygen supplies. These therapy modalities require patients to either push an oxygen tank or carry a portable oxygen concentrator with them while walking, which is suboptimal in terms of safety, affordability, and convenience. This study aims to improve safety, treatment efficiency, and life quality for COPD patients. I designed a patient-following robot with an embedded system composed of Arduino boards, an OpenMV Cam microcontroller, ESP32-Azure IoT Kit, motors, displays, transceivers, and other sensors. The robot carries the oxygen tank for patients, follows patients, collects medical information, and monitors health conditions. Based on empirical experiments, the maximum safe following speed was determined to be 0.243m/s, and the average deviation (difference between theoretical following trajectory and actual trajectory) was 1.07% (0.061m/5.65m). Collected medical telemetry data is connected to the Azure Internet of Things Application Central and displayed to patients and doctors through Azure Event Hub, Logic App, Power BI visualization, and webhooks. Doctors are able to analyze both real-time and historical patient performance and can modify their training plans accordingly. This study provides an experimental basis for the application of Internet of Things technology in pulmonary rehabilitation and provides new ideas for the treatment of COPD and other chronic pulmonary diseases.

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