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Enhancing Medical Device Management with IoT Powerstrip

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Abstract. Managing medical devices efficiently was a challenge, especially with manual methods proving error-prone amid staff shortages. To overcome these issues, we developed a novel IoT powerstrip device for tracking usage and location. This helps monitor devices in real-time, empowering more efficient management and utilization. We introduced it in four hospitals, connecting 192 medical devices to the strips and quantitatively confirmed its effectiveness.

Keywords. Medical Devices, Medical Engineering, Internet of Things, LPWA

1. Introduction

The increased portability and complexity of medical devices demand advanced management, a challenge intensified by medical staff shortages and pandemic pressures. Locating unused devices in hospitals is particularly difficult [1]. While some medical devices now feature Wi-Fi and Bluetooth low energy (BLE) for monitoring, cost, security and regulatory changes pose additional risks for the device companies. To overcome these challenges, we developed a novel IoT powerstrip device using Low Power Wide Area (LPWA) network to avoid RF interference, connects to medical device power cables to track power usage and location [2]. We introduced this IoT device in various hospitals and verified its effectiveness by providing real-time status to the staffs.

2. Methods

We utilized IoT powerstrip devices to monitor the operational status of connected medical devices by recording their electricity consumption. Additionally, they determine the location based on surrounding RF signal. The research was conducted from 2022 to 2023 across four hospitals. A total of 192 medical devices were connected to our IoT powerstrip, allowing for the monitoring of their operational state and location.

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The locations of these devices were determined using an RSSI-based indoor localization method [3]. We calculated the utilization rate (UR) of these devices, serving as key indicators for its efficiency and overall management effectiveness, calculated as follows:

$$\text{Utilization rate (UR)} = \frac{\text{Time in operation at designated device use site}}{\text{Total data available time}} \times 100$$

3. Results and Discussion

Table 1 represents the distribution of medical device utilization rate in each hospital as captured by this IoT device. The results reveal that few medical devices operate above the ideal 50% utilization rate. However, the ability to visualize devices with low utilization rates has been demonstrated, suggesting that sharing these devices or transitioning to leasing could theoretically result in a 5~9% cost reduction for overall medical equipment expenses.

Table 1. Number of medical devices by utilization rate (UR) category in each hospital. (UH: University Hospital, MU: Municipal Hospital)

Facility	#Devices	UR>10%	UR>20%	UR>30%	UR>40%	UR>50%
Nagoya UH	124	36	13	8	1	0
Kobe UH	18	6	5	5	3	2
Mie UH	13	5	3	1	0	0
Shinshiro MH	37	5	3	2	2	7
Total	192					

The deployment of IoT powerstrip across various facilities demonstrated a high concurrence with utilization rates in conventional ledger entries. Despite the average positional accuracy of about 3.0m showed in our prior research [2] potentially causing room-level misidentifications, it effectively tracked at the ward-level. This enhanced tracking and operational verification likely contributed device utilization rates.

4. Conclusions

Our validation in an emergency hospital demonstrates our solution's adaptability across diverse healthcare settings, from long-term care to home care. We aim to provide solutions that contribute to the construction of an ecosystem that optimizes the sharing of medical resources on a regional basis by identifying medical equipment assets across the healthcare spectrum.

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