From Innovative Ideas to Reality: Innovative Biomedical Engineering application in Healthcare Settings

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Extended Abstract

Hong Kong's healthcare system is increasingly strained by a growing patient population coupled with a declining number of clinical professionals. This imbalance places significant pressure on public hospitals, resulting in longer wait times for specialist services. The situation is further exacerbated by an aging population, a rising prevalence of chronic diseases, and ongoing medical staff shortages. Addressing these multifaceted challenges requires innovative solutions that improve patient care, optimize clinical workflows, and alleviate workforce constraints.

This study presents our development of three biomedical engineering innovations aimed at enhancing healthcare delivery in Hong Kong: (1) a Journey Monitoring System for stroke and trauma patients in Accident & Emergency (A&E) departments, (2) an Intelligent Tourniquet Management System, and (3) Augmented Reality (AR) Cognitive Assessment Tools. These technologies are designed to improve patient quality of life, increase operational efficiency, and support healthcare professionals in managing growing demands.

Recognizing the critical need for continuous monitoring of stroke patients, we developed a Journey Monitoring System for stroke and trauma patients in Accident & Emergency (A&E) departments that utilizes Bluetooth Low Energy (BLE) Angle of Arrival (AoA) technology to enable real-time, precise tracking of patient locations across critical hospital areas. By capturing checkpoint data and timing information, this system aims to provide continuous patient monitoring, helping to reduce delayed resuscitation during patient transfers that could otherwise prolong recovery [1].

Elastic tourniquets are widely used to temporarily restrict blood flow during medical procedures [2]. However, prolonged application can cause severe tissue damage or even necessitate amputation. To enhance patient safety, we developed a prototype of an Intelligent Tourniquet Management System that monitors and regulates tourniquet usage time for individual patients. The device is compatible with existing disposable tourniquets and includes a dispenser that prints unique codes and logs registration times for accurate tracking. When usage exceeds predefined time limits, alerts are triggered on the device's dashboard with buzzer notifications to remind clinical staff to remove the tourniquet promptly. The code printing format is customizable to meet clinical requirements. Clinical trials and device miniaturization are ongoing, with the goal of ensuring ease of use during blood collection and promoting safer clinical practices by minimizing human error and potential complications.

Approximately 100,000 people in Hong Kong suffer from dementia and cognitive diseases, representing nearly 10% of the elderly population. Early cognitive screening is crucial for timely treatment; however, existing paper-based assessments require professional oversight. We developed an Augmented Reality (AR) Cognitive Assessment Prototype Tool to evaluate multiple cognitive domains, including memory, attention, executive function, and visuospatial skills [3]. We also developed a playback function that supports preliminary evaluation of an individual's cognitive status, helping determine the need for further professional diagnostics or treatment. The AR tool allows patients to complete assessments independently, eliminating the need for supervision. After each self-assessment session, the system generates a detailed summary report outlining the patient's performance across cognitive domains and further recommends personalized interventions, such as targeted cognitive training tailored to the patient's specific needs. Healthcare professionals can use these reports to guide the prescription of appropriate cognitive exercises. Additionally, by maintaining a database of assessment scores over time, the system can analyse correlations between cognitive changes and prescribed training, refining and optimizing individualized intervention strategies to better address each person's cognitive impairments.

References

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