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Prototype Design of a Monorail Delivery Robot for Local Hospitals of Sri Lanka

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Background: Most of the old public hospitals established in the country were not built to automate the activities efficiently. Manual labour handles various medical items such as blood bags, drugs, or samples. Therefore, the transportation of multiple items between departments or sections takes longer, especially when crowded. Technological improvement in the modern health care industry with the utilization of robots to replace manual processes have shown many benefits. However, a primary survey conducted with different healthcare professionals attached to local hospitals revealed that the delivery of small items is inefficient and delayed. The need for this kind of automation system is also addressing the pandemic situation as automated systems can operate with a minimum human touch.

Objective: To identify the most suitable delivery robot and design a mobile robot to transport small items such as medicine, patient's test samples, blood bags considering the existing typical building established structure of local hospitals in Sri Lanka.

Methods: The Teaching Hospital Karapitiya was selected to collect the physical requirements of the setup. Based on the current requirements, specifications of the new automated delivery system were generated. Among the present industrial robots, a monorail robot was identified as the best suitable solution. Then, we followed a mechatronics system design procedure that includes designing the delivery robot's locomotion, monorail moving path, charging-loading-unloading docks, CAD models, control system, drive and communication electronics, and microcontroller program to automate the robot and human-man interface (HMI) to reserve and acknowledge delivery. In addition, the complete system includes a monitoring, safety, and warning system.

Results: A monorail mobile robot developed can carry items with a total weight of 10kgs with the automated path is designed. Although the overall cost of the system and the number of simultaneous delivery requests determine the number of mobile robots required to operate the system, it is required two robots minimum as one robot required to operate while another robot is in charging and in case of emergency. One robot can drive with 1m/s maximum speed, and its battery system is enough to run for 10hrs continuously. The initial prototype developed consists of two docking stations that also equipped with the HMIs and charging.

Conclusions: This paper presents the design of a monorail delivery robot with the required operation infrastructure and the prototype developed with principal components and features. The proposed solution for the manual material handling between the ward, pharmacy, blood bank and the laboratory reduce the transportation delays and labour, thereby increasing the efficient use of the human resources. Furthermore, we planned to demonstrate the prototype monorail delivery robot established in the mechatronics lab of the university to health care professionals. Moreover, the monorail delivery robot system can easily be installed with minor construction and installation time in any hospital setup.

Keywords: *Automation of hospitals, Delivery robot, Manual hospital labour, Monorail robot*