Smart walker for pervasive healthcare

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O. Postolache ; P. Girão ; J.M. Dias Pereira ; J. Pincho ; C. Moura ; G. Postolache All Authors

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Abstract:

The article presents the design and implementation of a smart walker based on microwave Doppler radar, MEMS accelerometers, flexible force sensors and Bluetooth communication technologies. The data from the sensing channels are acquired by a microcontroller platform with ADC capabilities, and then are wireless transmitted to an Android OS smart phone that runs specific developed Java software. The software performs different tasks, such as data processing and graphical user interface, and can also be used for remote monitoring of activity/inactivity of the users, upper extremity kinetics and kinematics during walker-assisted gait. Additional synchronization functions are performed between the smart phone and a physiotherapy web server.

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I. Introduction

The walker is a mobility aid that provides a portable base of support. People of all ages use different kinds of walkers for a variety of reasons. With the correct walker, many people stroll along at the same pace as their companion [1]. Beside the main function of walker in assuring additional support to maintain balance or stability during walking of disabled or elderly people, recently there are researches on the ability of a Smart Walker to acquire useful data to track adherence and progression in rehabilitation [2] [3], vital signs monitoring [3]–[6], energy expenditure [7], biomechanical and functional requirements [8]–[16] for effective walker use. There are a number of projects related to the Smart Walker that are working on obstacle detection/avoidance and guidance/way finding systems [17]–[25], force monitoring, seat usage monitoring, and physiological monitoring [3] [4]. The walkers developed by researchers at Carnegie Mellon University, University of Pittsburgh and the Marquette University provide assistance with obstacle detection and avoidance, combined with varying degrees of path planning and automated guidance. User intent information (e.g. indoor location, direction they wish to steer the rollator), combined with an obstacle detection and drop-off detection system, should be used as a means of obstacle and drop-off warning or avoidance system. This would improve the user safety, and avoid collisions and falls. Moreover, monitoring features should allow residents, friends, family and/or care professionals to view the current state (health and activities of daily living) of the walkers' users within the home. This is important taking into account the increasing cost of healthcare services in the world and an exponential increase in the number of seniors and retirees in developed countries. The prototype Smart Rollator presented by researchers from Carleton University [4] is comprised by; a Hall effect sensor and a series of magnets fitted on a rollator wheel, in a manner similar to a bicycle cyclometer, in order to measure distance/speed of the walker; a strain gauge to measure the rollator loading at each handle; a simple binary pressure sensor placed on the rollator seat that can provide information regarding seat usage; an infrared emitter and phototransistor detector on both handles of the rollator for blood oxygenation and cardiac function monitoring. The Smart Rollator prototype employed a Motorola 68HC11 microcontroller system, which was interfaced to a wireless Bluetooth transceiver capable of performing data transfers to an open source data. This prototype meets the requirements of TeleCare platforms promoting ongoing care-giving/rehabilitation, providing alert family, friends, care givers or the emergency services to dangerous situations and helping older and disabled people to continue living independently in their own homes. In addition, the system can collect data which may be used to inform professionals and care givers of patterns of behavior, lifestyle and changing needs of the user. However, estimation of a user activity/inactivity within a day can be biased when reporting the output of distance/speed and force sensors applied in above presented prototype. We propose a smart walker based on technologies expressed by microwave Doppler radar, MEMS accelerometers and flexible force sensors and Bluetooth communication that can remotely collect data on walker usage, upper extremity kinetics and kinematics during walker-assisted gait. The system is especially designed to assist in physiotherapy session for gait recovery in stroke patients. It allows automatic or semi-automatic gait analysis procedure that can be used by physiotherapists to extract information related to patient's functional disability in walking as a result of motor or sensory dysfunction, but also to evaluate the gait recovery progress.

Authors

Figures

References

Citations

Keywords

Metrics