Wireless Control of a Human Replacement Robot: Design and Implementation

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***Abstract*— The objective of this paper is to design and implement a human replacement robot that consists of a mobile robot holding two 6-DOF manipulator arms and two wireless cameras mounted on moving plate attached on top of the robot. The human operator can control the robot wirelessly via wearable suit and virtual reality glasses. Moreover, the operator can control robot movement by special pedals placed under his legs. The experimental and simulated results confirm that the given prototype perform the same tasks and movement obtained by the operator with acceptable accuracy and speed. Such a robot is suitable for unreachable areas with minimum training needed for operator to start using the robot.**

Keywords*— Mobile robot, Manipulator, Humanoid robot, Human replacement robot, Wireless sensor networks.

I. INTRODUCTION

Due to the advances in applied sciences and technology, researchers are working to adopt technology in the design of robotic systems to make life even easier. The integration of both human's ability to think and robot physical power is necessary to create a programmable machine that closely cooperates with humans[1]. Humanoid robots are new research area with many challenges in research laboratories and in industry. Developing humanoid robots to investigate the interaction between humans and robots is not an easy task. Several research papers have been published in this field and even several companies have commercialized humanoid robots. Some researchers [2-6] are concentrating on mechanical design and control algorithms of humanoid robots; others are dealing with hardware development and intelligent control [6,7]. Recently, walking stability and control of humanoid robots is the main research area [8-10]. Albers et.al.[1] highlight demand for efficient design of humanoid robots. They mentioned that humanoid robots work with humans in a shared space, and should be designed as universal helpers with ability to learn new skills.

A full-body walking humanoid robot with 29-dof and actuated by DC motors through d-Space microcontroller is proposed by Erbature et.al[5]. They mentioned that smooth and stable walk can be achieved by applying control algorithms based on parameters obtained by trial and error. Another platform [4] has been designed for the study of dynamic walking of a small size humanoid robot based on concepts of the artificial intelligence. It has 17-dof and each joint is driven by a DC servo motor. Set of sensors and video camera are used to navigate the robot, together with force and tilt sensors in the walking control. Two microcontrollers were used in the design, one for high level control tasks, and the other for waking control. Most of the research efforts were spent on dynamic simulation and online walking of the humanoid robots on flat ground and stairs. However, humans depend mainly on hands to make various kinds of activities such as eating, printing on computer keyboard and doing everyday tasks, while legs are usually used to move around only (except in some special cases). Legs are difficult to design, implement and stabilize then one can replace them with wheels or belts that are known to be easier to design, cheaper, efficient and are more stable on different types of surfaces.

A robotic arm can be considered as a programmable tool with similar functions to a human arm. Robotic arms can be classified depending on their range and capability. An anthropomorphic robot is resembled to a human's hand, with independent fingers and thumbs [11]. Different control techniques were applied to control robotic arms. Chakravarthi et.al.[7] propose an artificial neural network tuned on three sets (move forward, stop and move left) and applied on a robotic arm has 4-dof. The obtained results demonstrate that the solution works well with accuracy reaches 93% and recognition time of 190ms in average. However, when wireless control technique was applied, a certain delay happens which is unacceptable for some real time applications. Another technique proposed by Cherubini et.al.[12] to control a robotic arm. It is based on Kinect camera to recognize operator movement, extract angles of arms and send command wirelessly to robot. This technique shows an acceptable accuracy where the camera is near the operator in an ideal environment which is not always available. Bio sensors, such as EEG headset, were used to translate human movements to the robot [13]. This method could be more accurate if enough sensors are used to detect waves. This is expensive and not easy to achieve because it needs expert assistance, and it needs a lot of training for operators in order to use it. Thus, such method will only succeed in very specific applications. Guiochet [14] uses two robots, one with operator that can interact by moving its arms to specific direction, and it will send commands to the second wireless robot in order to move in same direction and speed. This method is fast and accurate but it is costly and has a risk. Thus this method will be good for offline robots training but definitely not for online real time jobs. Designing a human controlled dump robot is better than designing an intelligent robot in some applications. Humans are able to wear a suit with virtual reality glasses and

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