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CONTENTS

CHAPTER ONE: Mechatronics System Design and Applications

CHAPTER TWO: Modelling and Simulation

CHAPTER THREE: Intelligent Systems

CHAPTER FOUR: Instrumentation, Dynamics and Control

CHAPTER SIX: Speech and Image processing

CHAPTER SEVEN: Robotics and Automation

CHAPTER EIGHT: MEMS and Materials

CHAPTER NINE: MEMS and Materials

CHAPTER TEN: MEMS and Materials

CHAPTER ELEVEN: MEMS and Materials

Reduction of Motion Artifact in Portable Pulse Oximetry

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ABSTRACT

Pulse Oximetry, an optoelectronic device capable of measuring heart rate and blood oxygen saturation (SpO2), has been shown to be a valuable device for monitoring patients in critical conditions. In order to incorporate the technique into a wearable device which can be used in ambulatory settings, the influence of motion artifacts on the estimated SpO2 must be reduced. This paper investigates the use of portable wearable medical devices that capable of continuously monitoring an individual's vital signs in real time. A review of the techniques commonly used for attenuating motion artifacts in pulse oximetry is presented. Proposed design is introduced that acquires photoplethysmographic (PPG) signals continuously, without restricting the wearer motion. A comparison of techniques currently used in this field is presented.

1. INTRODUCTION

There has been an increasing demand for a complete wearable monitoring system for the telemedicine purpose. An online, continuous, and real time monitoring allows not only the detection of abrupt change of the patient's health, but also the assessment of the right dose and timing of medication. This type of monitoring has become a highly demented for the daily life of a wide slot of people, especially elderly patients who need continuous monitoring around the clock. Subsequently, allowing such patients to engage their normal activities of the daily life, rather than staying at home or close to specialized medical services, which in turn may improve the quality of life. However, moving the focus of care from the hospital to the ambulatory environment can bring about considerable economic benefits. On the other hand, relying on the traditional health examinations is not enough, especially for cardiac patients. In this regard, it is commonly known that cardiac problems may disappear during the examination time or even when the patient is hospitalized. In addition, continuous monitoring is a very useful tool in some places like bathroom, which is one of the most dangerous places in the home. According to [1], more than 10,000 people mostly hypertensive and die in bathrooms every year. As an answer for the previous demands, there have been many attempts to develop a reliable ambulatory monitoring system to meet the previous requirements. However, primary designs were faced mostly by the bulky size, wearer discomfort, and low signal quality. In addition, the power consumption was also a serious issue. Moreover, there has been an argument about the best sensor architecture and place that would provide both wearer comfort and acquisition stability. For instance, people tend to remove any ambulatory device that might discomfort them, especially during the shower, even if it was a wrist-watch. Consequently, it is necessary to address the wearable sensor shape among the other issues. Regardless hardware design issues, software algorithms have been extensively studied. The main obstacle with the software is the motion artifacts, which are induced by wearer motion. Since the system is designed to be wearable, then the motion will be an inevitable case, so it must be tackled without restricting the wearer motion.

Wearable sensors have been implemented using different monitoring techniques. These techniques started with the wearable ECG sensor [2] till the most recent researches on the textile sensors [3]. Among these techniques, the wearable pulse oximetry (WPO) sensor [15]. Pulse oximetry (PO) or PPG sensor is a very useful technique for monitoring both heart rate and blood oxygenation non-invasively [4]. This sensor normally has two LEDs in different ranges, namely red and infrared, and one photodetector. POs have a variety of commercial shapes and brands, but they have the same concept, that is utilizing the pulsation nature of arterial blood to get an impression about the cardio-pulmonary system functions. PO sensors can be attached to the fingertip, ear lobe, forehead, toes, etc