Health Monitoring System for Elderly Drivers Using IoT Platform

Se Jin Park, Seunghee Hong, Damee Kim, Young Seo, and Iqram Hussain

Abstract— IoT (Internet of things) is considered most innovative technology in smart healthcare monitoring system which is able to demonstrate real-time physiological parameters in computer and mobile platform. Driving has been an integrated part of our lifestyle and sometimes stress and health abnormality arises during driving, specialy for elderly drivers. Among all kinds of health problems, stroke is most deadly diseases and real-time health monitoring is desired to detect stroke onset during regular activities. The aim of our study is to develop a health monitoring system for elderly drivers using air cushion seat and IoT devices in order to detect health abnormality such as stroke onset during driving. We have also made a prototype of health monitoring system using Quad-chamber air cushion system and IoT devices. This system can display ECG, EEG, heart rate, seat pressure balance data, face/eye tracking etc. using IoT sensors, generate alert and send message to relatives and emergency services if any health abnormality happens during driving to provide emergency assistance.

Research Keywords—Internet of things, Elderly Healthcare, Real-time health monitoring, Brain Stroke.

1 INTRODUCTION

The Internet of Things (IoT) performs a significant role in the development of smart vehicles, which offers smart transportation, cloud connectivity, vehicle-to-vehicle interaction, smartphone integration, safety, security, and e-healthcare services. Recent development trends show that auto industries are already paying attention to develop IoT cars that could integrate driver's health status and driving safety. Both auto industry and key global original equipment manufacturers are integrating healthcare services into their next-generation products [1].

Health has become a major point of interest nowadays. People pass significant amount of time of daily life on driving seat. Some health complexity happens during driving like heart problem, stroke etc. Driver's health abnormality may also effect safety of other vehicles. So, automotive manufacturers and users are interested to include real-time health monitoring in car system. World population is aging rapidly and aged population is getting much more concern nowadays. Aging originates from increasing longevity and results in deteriorating fertility [2].Population aging is taking place in nearly all the countries of the world. As age increases, older drivers become more conservative on the road. Age-related decline in cognitive function hampers safety and quality of life for an elder. As the aged population in the developed world is increasing, so the number of older drivers is becoming higher [2]. Research on age-related driving has shown that an increased risk of being involved in a vehicle crash is more at around the driver's age of 65. Certain behavioral factors, in particular, may contribute to these statistics: drifts within the traffic lane, confusion in making left-hand turns, and decreased ability to adjust behavior in response to an unexpected or fast-changing situation [3].

Stroke is the second top reason of death above the age of 60 years, and its proportion is rising [4]. Many health abnormality happens after stroke. Postural disorders is observed as one of the most common disabilities after stroke [5].

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Some developments in the wearables and embedded sensors to measure physiological and biosignals during driving have been already done [6]. Faurecia developed an automotive seat which detects traveler's heart rate and breathing rhythm through unique types of embedded sensors [7]. A car seat with a capacitive sensor developed The Nottingham Trent University is capable to detect traveler's heart rhythm [8]. IPPOCRTE designed a steering wheel could measure vital physiological parameters including ECG, eye gaze, body temperature, and pulse rate [9].

This paper focused on briefly explaining the design and framework of the elderly drivers' health monitoring services in connected car using IoT devices. The purpose of this study is to develop a real-time health monitoring system for elderly drivers' in order to detect health abnormality such as stroke using quad-chamber air cushion and IoT devices successfully and generate messages & alerts to responsible ones such as family members, emergency services or hospitals about drivers' stroke onset while driving and transfer victim to hospital or clinic.

2 Model and Methodology

2.1 IoT Car Seat Model

A model of air cushion is designed for monitoring health status of driver. The dimension of the rectangular cushion is about 23.5 cm x 18 cm and each chamber size is about 11.5 cm x 8.5 cm. Air chambers are pumped by a small air compressor to maintain inflation in order to detect symmetric body pressure. Air cushion is made of polyvinyl chloride, very common kind of synthetic plastic polymer.

For measuring pressure in each cell, each air chamber is equipped with air pressure sensor. Each cell has one air inlet, one air drain line. This air cushion is inserted to inside of air seat and covered with seat cover. For better comfortability, air cushion top surface is placed in same level of car seat flat surface (Fig. 1). To add an air cushion in the seat cushion, small modifications have been done to make room for the air cushion. In order to get effective pressure response, air cushion has been placed in middle position of car seat. Air hoses are attached to chambers for connection with air compressor.

In back part of the seat, ECG sensor is attached and remains in contact with wearable clothes. Wearable clothes are made of woven conductive fabric. In front of seat, proximity heartbeat sensor is placed in order to measure driver's heart rate. Face tracking and eye tracking camera will monitor face pattern and eye movement from the front side of driver.

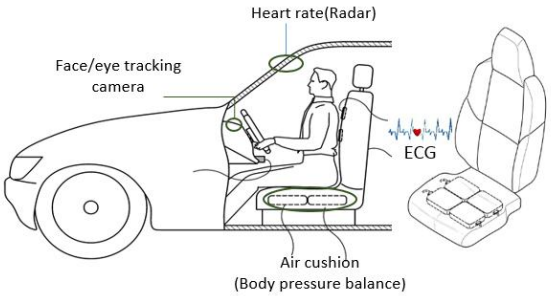

Fig. 1. Model of IoT sensors and Quad-chamber air cushion installed in driving seat.

2.2 Design of health monitoring system

IoT sensors such as ECG/EEG sensor will monitor heart spectrum, pressure sensors will monitor body pressure balance, and heart rate will be measured using proximity sensors. Air cushion cell pressure can detect drivers' postural balance in order to detect brain stroke onset of elderly drivers. Arduino Mega ADK is used as an interfacing platform with air cushion pressure sensors and Arduino platform is capable to feed data to Car control system and cloud server also.

BIOPAC ECG sensor will monitor heart spectrum. For measuring heart rate, TI Launchpad based proximity radar sensor has been used. As victim lose conscience after stroke onset, postural position of drivers becomes unstable [10]. Front & rear, right & left side inclination of postural position can be happen during stroke onset. Body unbalance can be happen for other reasons such as doing additional activities during driving. So, only one sensory system is not sufficient to detect stroke during driving

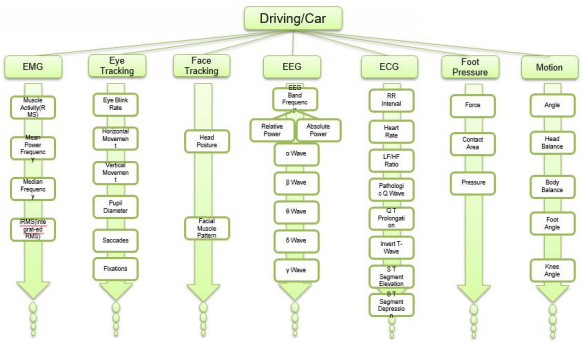

Fig. 2. Data analysis methodology of health monitoring system using Air cushion seat and IoT bio-signal devices.

for elderly people. ECG, Heart rate and air cushion pressure data together can detect any abnormalities during driving. Data analysis method for driver's health monitoring system using Air cushion seat and IoT bio-signal devices is shown in Fig. 2.

3 Architecture and Framework of Drivers Health Monitoring System

Real-time heath monitoring is most influential for detecting stroke onset. Air cushion chambers can effectively measure symmetric body pressure that is important for detecting body pressure balance of elderly driver. ECG and EMG data also vital physiological parameter to understand health status during driving. Heart rate data will be also monitored. Firstly, IoT sensors will measure physiological signals and feed these data to cloud platform. In cloud, drivers' health record, normal physiological data have to be stored first as reference data. Real-time ECG/EMG/heart rate will be compared with reference normal data in order to find out health abnormality during driving.

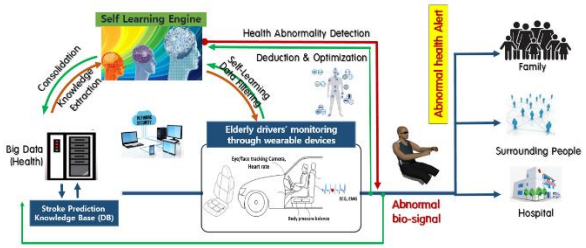

Fig. 3. Framework of drivers' health monitoring system using Air cushion seat and IoT devices.

Framework of newly designed Air cushion based drivers' brain stroke detection system is presented in Fig. 3. Real-time data also train-up big data and capture ECG/EMG/heart rate/face pattern that boost up Self-learning engine. For real-time IoT sensor data, MapR Streams is used for scalable data collection, Spark streaming is used for data processing. Processed data is stored using MapR-DB(HBase).

Complete system will feed drivers' physiological data to cloud engine for comparison of real-time data and already stored reference data in order to detect stroke onset of elderly drivers. System will also generate an alert and deliver messages to emergency services, family of the victim, people around the victim, and hospitals in order to ensure the immediate medical assistance. Each sensor prediction result contributes in large set of IoT sensor network. The more sensor in health monitoring system, the more reliability of monitoring system.

Fig. 4. Developed IoT sensor based newly developed seat installed in a car simulator.

Health monitoring system has been prototyped and installed in car seat (Fig. 4).

4 Conclusions

This paper provides information about framework and prototype of Real-time health monitoring such as stroke detection system using Quad-chamber air cushion and IoT devices for elderly drivers. To evaluate the sensitivity of developed elderly drivers' stroke detection system, experimental tests were performed. From body pressure balance using air cushion, we can conclude that the developed car seat is expected to identify stroke in tilted unbalanced postural position. In addition, ECG/EEG, heart rate sensor embedded in car seat can monitor and detect abnormality when brain stroke onset happens. In Overall, body pressure balance using air cushion, ECG, heart rate data can detect abnormal health status of elderly drivers' during driving. In future study would consider a range of bio-sensors and techniques such as image processing of facial condition using face tracking and eye tracking, thermal imaging of elderly drivers' body in order to detect stroke onset during driving.

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