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In-Vehicle Driver Health Monitoring System

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Abstract—**Automotive industry is moving towards connected systems where many of the vehicles parameters can be monitored and controlled remotely. IoT (Internet of Things) is also making its way into numerous aspects of human life. "In-Vehicle Driver Health Monitoring System" will use multiple sensors capable of capturing human activity parameters, process the captured health data and feedback to avoid loss. Benefits of bringing IoT power to In-vehicle health monitoring system can be tremendous.**

Index Terms—**IoT (Internet of Things), Wearable Sensors, Activity tracking, Cloud Computing, Health Care, Automotive industry.**

I. Introduction

This concept is towards ensuring safe health conditions of a person driving a vehicle. A person driving a vehicle needs to be healthy and be able to concentrate on driving. Any prolonged or sudden health complications of the person driving the vehicle can cause serious accidents/damages. Safety can be ensured by continuous monitoring of some of the health parameters of the driver and feedback fed into the In-Vehicle control system to alert or take possible measures to avoid unsafe driving causing accidents and damages.

A driver's body parameters like body temperature, heart rate, brain activity, muscle motion and other critical data affecting health conditions can be collected and monitored. Driver's facial expressions can be kept under continuous observation for example; blinking of eyes - If the number of times of blinking of eyes is not within a normal range, then it can be treated as sleep deprivation and his condition as not safe for driving. If any of the parameter under observation deviates from a normal value/range, an alert system connected within the vehicle can caution about it and even intrude and slowdown vehicle, bring it to halt until the alert is acknowledged and addressed. All the data from the system can be saved in a cloud server.

Wearable Sensors for Activity Tracking, Camera sensors and multiple other sensors can be used for parameters monitoring. This data will be analyzed by an IoT platform connected to cloud server. Regular/critical outputs from the data processed can be provided as feedback data to the in-Vehicle monitoring system or to the user's smart phone. So that driver can park the vehicle nearby and take a break or some safety feature in the vehicle can intervene and apply the brakes or stop the vehicle and give indication lamps (blink the PBL).

II. Sensors

To achieve our goal here, we can categorize the sensors required into following three groups;
A. Wearable sensors
B. Device/Accessory connected sensors and
C. External sensors.

Now let us discuss the requirements for each group of sensors and some sensors available in each of these categories.

A. Wearable Sensors

The simplistic form of a wearable sensor, a wrist band or a watch, is already available abundantly in the market. There are different vendors developing and selling multiple varieties of wearable sensors [1]. These are capable of monitoring human activity parameters including body temperature, brain activity, blood pressure etc... The sensor(s) can also be in the form of ring, chain or any accessory that can be used on human body. Driver can have one or multiple wearable sensors to collect the activity parameters.

1. Hydration sensor: this can analyze various electrolyte levels on the spot,that monitors sweat to determine hydration status andyet can fit in a palm or be worn on a wrist.The sensing element or sensor can be calibrated for a specific user or group of users.The patch can then transmit all the information to the smart phone.
2. BioStamp RC system: wearable sensor that can be placed on various body locations to capture targeted data. It can gather surface electromyography (to detect driver drowsiness) and electro cardiac activity. Easily accessible on tablet and web applications allows cloud basedstorage.
3. Emotiv EPOC is a 14-channel device that requires the application of saline solution on the user's head to increase the quality of the EEG signal recorded.

B. Device/Accessory Connected Sensors

These are type of sensors which may not be feasible to wear all the time by the user, but can be part of the accessories that are in vehicle viz Drivers seat, seat belt, steering wheel, gear liver, brake pedal

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etc... These can be fitted with sensors that could collect data on certain body parameters and help analyzing driver health condition. Heart rate, breathing analyzers etc...

1. Scanadu scout: A handheld sensor that when placed against the forehead for 10 seconds allows you to analyze, track, and trend your vitals, including temperature, blood oxygen, heart rate, respiratory rate and blood pressure data to a smartphone with 99% accuracy. This sensor could be fitted onto the steering control application.
2. NeuroSky Mindset™ (2009), an audio 3 headset equipped with a single, dry EEG sensor. It uses the Bluetooth® technology to transfer signal samples wirelesslyto the host computer.(http://www.andrew.cmu.edu/user/btan/thesis.pdf)
3. Ice: can be connected to the helmet or seat belt to detect the impact of the collision or accident and give warning signal. ICEdot crash sensor is used in this.

C. *External Sensors*

These are set of sensors that are placed nearby, to monitor useful parameters that could help in analyzing driver's health. These include camera sensors for facial expression detection including closing or blinking of eyes, head posture, yawning etc...

1. Cardiio : Calculates the person's resting heart rate.
2. AliveCor: Diagnoses Heart attacks.
3. Withing: Measure air quality and monitor heart rate.

III. DATA PROCESSING AND ANALYSIS

Data from all the devices (heartbeat rate, body temperature, brain activity data, camera images etc..) connected in this health monitoring ecosystem could be collected through a hand-held device like smart phone or an in-vehicle device which is capable of collecting data wirelessly[Sensor wireless network][2]

Health parameters data collected is transmitted to a cloud based system for data processing. Data could be stored in the cloud server for stipulated time for any further reference. Data analytics on these data could help in analysis of different use cases including these health parameters. Enabling cloud computing for processing of these data can be done through an IoT platform like Amazon Web Services IoT or any other similar IoT platform [Internet of Things][4]. Data is processed to derive vital information about driver's health with all the combinationsof data obtained.

Clinical methodologies to be adopted at the remote system to provide information on the status based on the obtained health parameters.

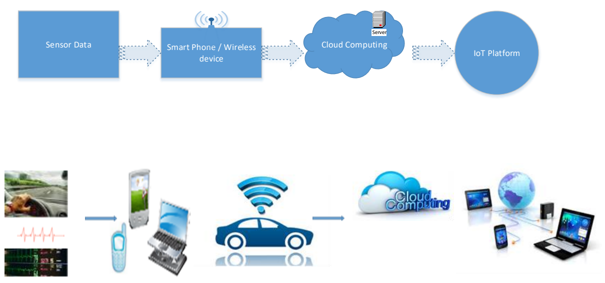

Figure1.Data flow

IV. SIMULATION

As shown in the Figure 1, data from sensors and actuators will be sent by sensors to the smart phone wirelessly. The sensors could be calibrated to single user or multiple users depending on the application of the sensors.

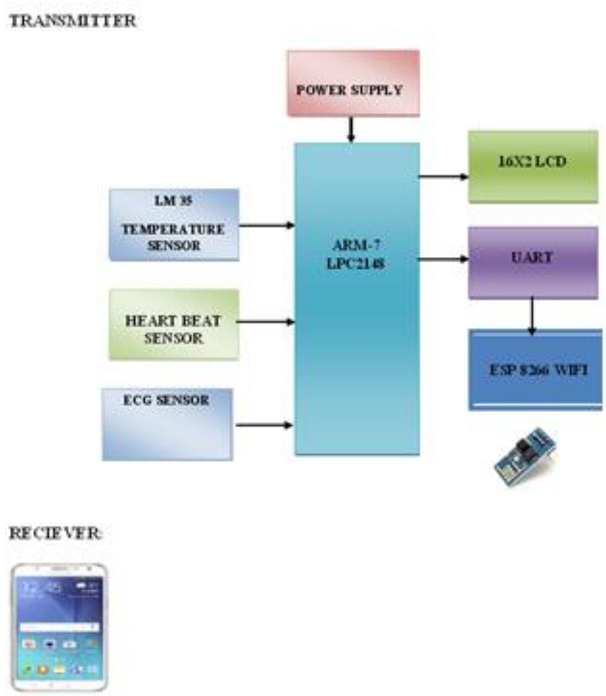

Figure 2.Block Diagram

As shown in Figure 2, we can have all the sensors connected to the microcontroller. Here we have taken ARM7 LPC2168 for the simulation purpose. All the sensor information could be collected in a microcontroller. Over Wifi we can transmit the sensor data to the mobile phone. We have a 16x2 LCD display connected to show the sensor readings, Wifi connectivity etc... We have android phone at the receiver end, which can get all the information sent by the sensors.

We need to calibrate the Wifi device, ESP 8266 by giving proper AT commands. At the receiver end you can get all the sensor data with an android app. First you need connect with ESP 8266 wifi connection.

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When we have successful connection LCD displays the message: Wifi connected.

In this we check the patient's health condition by monitoring the heart beat. The heart beat is monitored with the pulse rate of the body. The high intensity light sensor senses the expansion and contraction of the heart with the help of the nerves. That beam will transmit the signal to the receiver and the minuet change in the pulse is noticed as the heart beat. If there is any change in the pulses then it is noticed as the change in the heart and then the controller will get a disturbed pulse count which indicates the fault or malfunction of the heart. The controller is fixed for a number of pulses initially. If there is any change in any of the pulse counts, then it is considered as a malfunction of the heart and then it transmits the pulse count with the patient's ID to the doctor in the hospital and at the same to it sends a SMS to a fixed number in the microcontroller. After that we are adding another two sensors for human. The precision in body heat measure is +0.5degree centigrade.Measured the body heat through lm35 temperature sensor. Another sensor is ECG sensor.

A key product in this area is the SparqEE range of products, including the original tiny CELLv[3]1.0 low-cost development board and a series of shield connecting boards for use with the Raspberry Pi and Arduino platforms.

There are bewildering connectivity options for application engineers working on products and systems for IoT.

Cellular is capable of sending large quantities of data over GSM/2G/3G/4G, especially for 4G, while this can be costlier and power consuming. But it can be ideal for sensor-based low-bandwidth-data for projects that will send very low amounts of data over the Internet.

Many communication technologies well known such as WiFi, Bluetooth, ZigBee and 2G/3G/4G cellular can be used,but there are also several new emerging networking options such as Thread.

It should give sufficient information in real time, and make it available remotely. The intention is not to achieve perfect clinical accuracy but the device is able to detect anomalies in the measured data and it also has alerting features. Authorized observers (clinicians or family) can monitor at any moment the state of the patient through the internet.

V. FeedBack and Alert System

Report of the analysis can be categorized as Normal, Deviated and Critical status. Status to be displayed on display of the vehicle Infotainment system. Any Critical data could override the current data (some video-Audio running) on the display. Deviated/Critical data can also be shared to people who need to know the data, for example ,driver's immediate family and/or health care providers etc. Data on the cloud storage can be retrieved any time for data analytics. The analysis of the stored data can be obtained from IoT platform on any smart phone or PC.

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