Available online at www.elixirpublishers.com (Elixir International Journal)

Adoc Network

Elixir Adoc Network 40 (2011) 5442-5446

ISSN: 2229-712X

# Pervasive computing based healthcare using body sensor networks

G.R.Kanagachidambaresan, V.R.Sarma Dhulipala and D.Vanusha

Department of Physics and Associate Faculty (Pervasive Computing), Anna University of Technology, Tiruchirappalli.

**ARTICLE INFO**

**Article history:**
Received: 9 September 2011;
Received in revised form:
26 October 2011;
Accepted: 14 November 2011;

**Keywords**
Health monitoring,
Body sensors,
Wearable computing,
Pervasive computing,
Smart environment.

**ABSTRACT**

Wearable computing has variety of applications in which Body Sensor Network (BSN), or Wireless Body Network (WBN) used for pervasive health monitoring and pervasive smart environment. Application of sensors is increasing in the modern environment. In this paper an attempt has been made for probable preventions of drunken and medically affected driving strategies. This leads the future generation vehicles which are invisible servant or pervasive in nature to use pervasive intelligence based inbuilt application such as automatic configuring of car accessories. This paper deals with various characteristic parameter based analysis and design of a smart vehicles that guides the said categories of drive systems. Our simulation results proved good enough for drunker (or) medically affected drunken strategies, with the selected set of the unique parameters under consideration for our experiment.



## Introduction

Prerequisites of the paper needs attention of the following concepts. "Wearable computing is will be the future technique" as quoted by Mark Weiser, the father of ubiquitous computing needs the technological aspect of Body Sensor Network (BSN) architecture for parameter monitoring in the drunken and medically affected strategy. This aims to set a standard for the development of common approach towards pervasive monitoring [1]. BSN is facing challenges in terms of monitoring patients (or) objects where they have never been monitored before. Pervasive based smart environment is growing drastically in the recent technology. Especially pervasive (self guiding) cars has attracted good number of researchers and intellectuals as more the 50% of the toll rate is due road accidents was reported [2]. The smart sensors helps in reasonably good prevention of the accident by the design of smart environment based car system. For every minute a person dies due to drunken drive activity which motivated the idea of introducing smart car. The smart cars have the intelligent computing system which is inbuilt and used for pervasive architecture.

Wearable computing brings the power of a pervasive computing environment to a person by placing computing and sensory resources on the user in an unobtrusive way. These computers can be specialized and modular, like clothing. Unlike laptops or handheld computers, wearable computers offer many new models to interact beyond keyboards and touch screen, in a natural, intuitive way, such as sound and tactile feedback. In addition, wearable's can easily be reconfigured to meet specific needs of applications [3].

## Smart Environments

Smart environments link computers to everyday settings and commonplace tasks. A smart environment is a small world where all kinds of smart devices continuously work to make inhabitants' lives more comfortable. The most basic feature of smart environments is the ability to control devices remotely or automatically. Tremendous advances have been made in the development of sensor technology and in the ability of sensors to share information and make low-level decisions. As a result, environments can provide constant small adjustments based on sensor readings and can better customize behaviors to the nuances of the inhabitant surroundings [4-6].

## Biosensors

Biosensors convert the biological activity of the human body to electrical signal. In a biosensor the phenomenon is recognized by a biological system called a bio receptor, which is in direct contact with the sample and forms the sensitive component of the biosensor [7]. Biosensor has a wide number of applications in patient monitoring, measurement of metabolites, insulin therapy, the breath analyser is used for monitoring the odour of the object. Small wireless sensors attached to the patient body, measure vital sign of data, and transmit them through the established sensor network to an external observation unit. However, current sensor network solutions have to evolve to be suited for the medical domain, which requires flexible and safe set-up of the system as well as reliable, fail-safe operation. Today's sensor networks, mainly used for environmental monitoring, are either statically pre-configured for a certain task, or build as spontaneous ad-hoc networks. For medical usage, this system behavior is to be transformed to a reliable and defined system set-up, working automatically but nevertheless being under explicit control of a medical practioner [8].

## Related works

In this section, the state of the art concerning pervasive smart vehicles is investigated. The result of this section enhances a new methodology in smart pervasive vehicles. Medical monitoring practicing inside a car can contribute both to safety issues (supervision of driver fitness) as well as healthcare issues by vitals signs imperceptibly which is safety to the individuals as well as public[9,10]. A car-integrated medical sensor system could be capable of detecting such critical conditions and initiate appropriate measures ranging from drive interventions (e.g. safety auto pilot) to emergency services (e.g. car to car or car to emergency communication services, qualified ambulance call)[11].

**Tele: +91-9994320197**
**E-mail addresses: dvrsarma@gmail.com**

The stability of in-vehicle networks is suboptimal due to increases in wire length, difficulty in diagnosing sensor failures, and fault tolerance issues. Because control and sensing data are transmitted in a single network, it is difficult for in-vehicle portable devices to collect sensor data to check a vehicle status [12]. Heart rate reactivity during alcohol intoxication has been widely used in alcohol challenge studies (a) stress response dampening (b) alcohol and (c) the psychomotor stimulant theory of addiction. Studies have shown that an increase in baseline heart rate during alcohol intoxication is associated with (a) changes in mood associated with the stimulant properties of alcohol (e.g. energetic–tired dimension) (b) enhanced sensitivity to reward[13]. Heart rate, breathing and metabolic activity of varies based on physical activity[14].Alcohol Intoxication causes visual imbalance and posture imbalance to the object (i.e.) driver[15].

**Pervasive smart vehicles using smart sensors Methodology**

Fig.1 describes the proposed smart vehicle system. The vehicle when integrated with sensor which monitor the pulse can be impregnated in the acceleration and control unit of the vehicle (or) safeguards like helmet (or) belt of the rider. The output of the sensors are connected wirelessly to the microcomputer of the vehicle. The output of the sensors are being processed by the microcomputer as per the algorithm shown in Fig 1. The microcomputer which is in the vehicle inbuilt system works accordingly and the output of it is given to the ignition coil, and medical accessories, emergency units of the vehicle. Further, the microcomputer blocks the ignition coil system and it does not allow the vehicle to get start. The microcomputer is also capable of troubleshooting the sensors which are connected both wired and wireless mode with the intelligence. The power to all the accessories is supplied by power source. Thus the system is rechargeable and not power starving in nature.

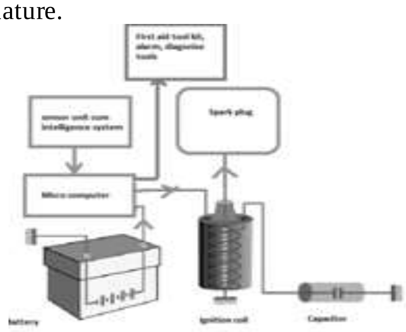

**Fig. 1 Proposed Smart Vehicle System**

```
Input(od,hb,bp,pr)
Function input (od,hb,bp,pr)
//input from the various sensors
Begin
monitor()
        {
if((od||hb||bp||pr)==0)
go to Diagnose tools();
// diagnose tools for sensor troubleshooting
else If ((od||hb||bp||pr)==nor)
start ignition&&monitor();
// data is normal and the ignition is allowed
else if ((od||hb||bp||pr)==abnor){
go to cross check();
// data is abnormal the data is to be cross checked
        }
}
cross check()
        {
// cross checking first time
       if(no)
            {
             go to input;
            }
       else
// cross check is clear
            {
       go to range abnor;
            }
range abnor(α,ß,γ)
       {
        range(α)
             {
             Declare drunk;
             Block ignition;
             }
        range(ß)
             {
             Open oxy mask;
             Go to input;
//oxygen is mask is opened and the system is forced to monitor again
        }
        range(γ)
             {
              cross check(|=1)
             Go to input;

declare Cardiac arrest(if cross check==1)
             {
              first aid&& alarm;
              }
         }
end
```

**Fig. 2 Algorithm1- Parameter monitoring of Body sensor Network**

```
diagnose tools()
//diagnose tools are used to avoid false alarm
       {
Begin
tbleshoot() {
If(poss)
                    {
restart sensor;
                    Go to input;
                    }
else()
                    {
buzzalrm;
                    }
              }
end     }
```

NOTATIONS IN ALGORITHM DESCRIPTION

od-odour
hb-heart beat
bp-blood pressure
pr-pulse rate
nor-normal
abnor-abnormal

tbleshoot-troubleshoot
α-alpha
β-beta
γ –gama function
poss-possible
imposs-impossible
buzzalrm- buzz alarm
oxy mask- oxygen mask

**Fig. 3 algorithm 2 -trouble shooting of body sensor networks**

Algorithm in Fig 2: represents about the input and processing of data and corresponding output of the smart vehicle such as alarm and emergency call to medical Centre, Algorithm in Fig 3: represents about the troubleshooting of sensors under fault condition.

**Flow chart description**

The flow chart in Fig 4: describes the process flow of the proposed model, at the first stage the system is classified the input to three stages

•Normal: i.e. the object that is examined is normal and the ignition is allowed instead of processing further.

•Abnormal: Which says that the system rechecks the data again by scanning it from the sensors correspondingly. Once the data is thoroughly checked, it is pushed to the next level to detect the range of abnormality.

•The input may not be detected due to some fault nature of sensor or due to incapability of getting input, under such condition the data is again examined by scanning the sensors or pushing to troubleshooting stage.

**Range of Abnormality**

The next level i.e. the range of abnormality is detected and classified into three stages, namely α, ß, γ, α which designate the person is drunk and the ignition of the vehicle is blocked by the microcomputer, ß represents whether the person is in hypertension or in scared stage and the oxygen mask is to be opened which reduces the tension by supplying more oxygen to the lungs there by reducing the hypertension. γ indicates the person is underwent cardiac arrest, thereby alarm signal is given to circuit and emergency call to the nearby medical Centre take place.

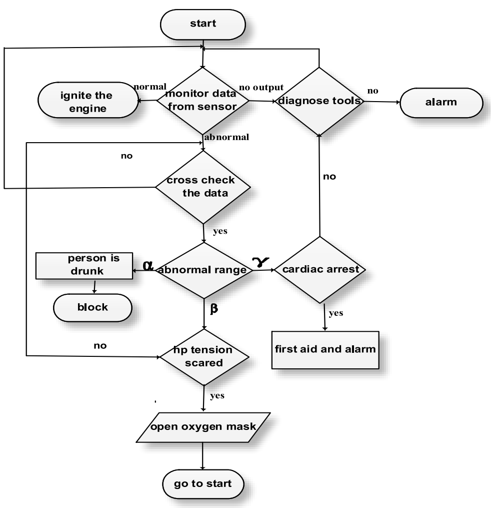


**Fig.4 Flow chart for proposed model**

**Process Description**

For the analysis of the said strategies we have chosen characteristic parameters like odour, pulse rate, heartbeat, blood pressure of the persons obtained from the various sensors attached to the vehicle under consideration. The monitored sensors data is fed into the processing unit where it process the data and analyse the validity of the data and proceeds to next stage of the processing, before sending the data to the next stage the data from the sensors is cross-checked and repeatedly monitored. In next stage of processing, the input data is shuffled many times and accordingly the range of the data is classified into namely α, ß, γ. The α signifies that the object i.e. the driver is in drunken stage and the ignition of the car is blocked. The ß level is understood when the object is in hypertension level and oxygen mask gets opened and prior medication is given. The last level γ describes that the patient is under cardiac arrest and the alarm signal is given which calls the nearby emergency medication facility.

**Experimental**

Model validation and simulation results are done using truetime simulator [16] in MATLAB.

**Data Set**

Table 1 describe the typical pulse rate, odour, heart beat and blood pressure of the real time data liquor habitants and medically affected victims. The data from the rehabilitation centre classified the range of abnormality to α,ß,γ the pulse rate, heartbeat, hypertension of the object has varied based on the status of the object (i.e.) driver. The detailed data from survey motivate our approach to deal with EEG and ECH signals further. The details from the literature survey strengthened our real time data collection, not only the heartbeat, pulse rate seems to changing the EEG and ECG signals used to vary as per the physician.

**Experimental design**

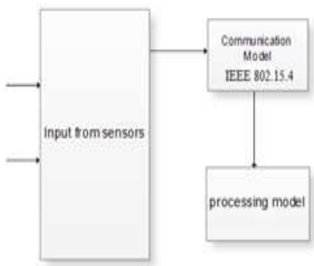


**Fig. 5 Ensemble approach of the proposed model**

**Mathematical Description**

In the proposed approach, the sensors are modelled by solving the non linear equation[17].

$Z(x_i,\lambda_i) = h(x_i,\lambda_i)$--------------------------------------------------(1)

Where

Z- output of the sensor
Xi- Sensing location
λi- characteristic parameter

Solving non linear equation (1) –

$$H(s) = \frac{A}{(1+\alpha s)(1+\beta s)} \quad \text{-----------------------} \quad (2)$$

A, α, β are real parameters[18].

**Simulation results and discussion**

We simulated our model with true time toolbox that works in matlab.

**True Time toolbox**

True Time is a Matlab/Simulink-based simulator for real-time control systems. This toolbox facilitates co-simulation of controller task execution in real-time kernels, network transmissions and continuous plant dynamics. It is written in C++ MEX language, uses event based simulation and external interrupts. True Time toolbox (for Matlab) as a simple and easy way how to realize several network types[19& 20].

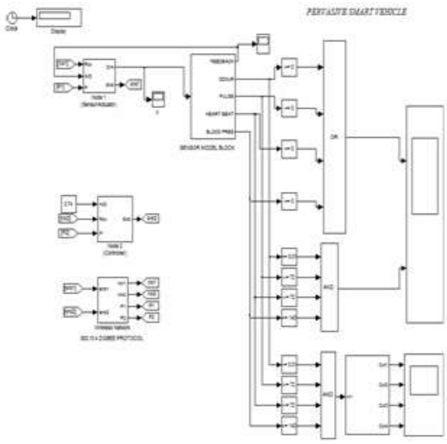

**Fig. 6 Schematic of Pervasive Smart Vehicle**

Fig 6 shows the simulation diagram of the proposed smodel using True time simulation tool box, the nodes 1 and 2 share the information using 802.15.4 ZIGBEE protocol, at this the control signal and actual signal is treated and the output is given to the logical block.

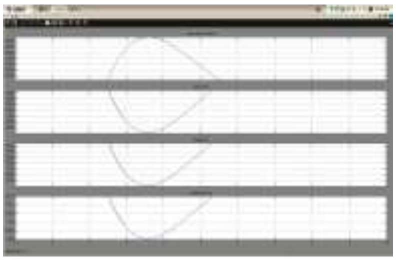

**Fig 7: Typical transient response of various sensors**

**Fig. 8 Typical steady state response of various sensors**

Fig 7, 8 represents the transient and steady state response of the sensors respectively. The data during transient state is varying in nature, hence the data is processed when it enters the steady state value as shown in the Fig 8.

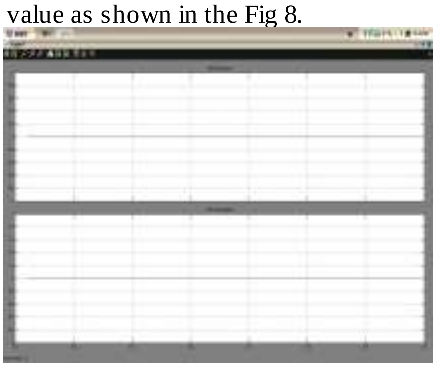

**Fig. 9a Output from the processing unit under normal**

**Fig. 9b Output of the processing unit under abnormal condition**

**Normal condition**

Fig 9a and 9b shows the processing unit under normal and abnormal conditions. As indicated in the Table 1 when the signal follows α,ß and γ ranges the blocking signal will be activated.

**Conclusion and Future work**

In this paper we have proposed the intelligent based smart vehicle for avoiding the drunken and medically affected driving strategies. We also proposed the algorithm for monitoring the driver's health condition. The algorithm used here performs the various characteristics parameters analysis like hypertension, cardiac arrest. Our goal of the work is to prevent the accidents due to driver's instability. We are in the process of validating the proposed model. The future work focuses on adding various parametric analyses like EEG, ECG to our proposed in realistic algorithm in realistic.

**References**

[1] Guang Zhang yang, "Body sensor Network", page -151, Springer publication, 2006

[2] www.wikipedia.org

[3] Dan siewiorek, Asim Smailagic, Thad Starner, "Application Design for Wearble Computing".MORGAN &CLAYPOOL PUBLISHERS, 2008.

[4] Fei-Yue Wang;" "Agent-based control strategies for smart and safe vehicles", IEEE International Conference on Vehicular Electronics and Safety, 2005.

[5] Diane J. Cook and Sajal K. Das," Smart Environments Technologies, protocols and Applications", Wiley Publications,2005.

[6] Stefan posland, "smart device, environment interactions", john wiley & sons Ltd 2009.

[7] Minh Canh Tran, "Bio Sensors" page -7, Springer publication, 1993.

[8] H. Baldus, K.Khalbunde, G.Mush. "Reliable Set-Up of Medical Body-Sensor Networks",pp 353-363,Springer-verlag Berlin Heidelberg,2004.

[9] Wuhong Wang;, "A digital-driving system for smart vehicles", IEEE Intelligent Systems,Volume: 17 , Issue: 5 ,2002.

[10] Terrace j. dishongh and Michael mcgrath, "wireless sensor networks for healthcare applications", intel 2010.

[11] Marian Walter Benjamin Eilebrecht Tobias Wartzek Steffen Leonhardt., "The smart car seat: personalized monitoring of vital signs in automotive applications", DOI 10.1007/s00779-010-0350-4, Springer,2011.

[12] Hong-bin Yim, Pyung-sun Park, Hee-seok Moon, and Jae-il Jung "An Efficient Sensor Network Architecture Using Open Platform in Vehicle Environment" ICUCT 2006, LNCS 4412, pp. 232–241, 2007, Springer-Verlag Berlin Heidelberg, 2007.

[13] Lara A. Ray a,*, John McGeary b, Erin Marshall a, Kent E. Hutchison, "Risk factors for alcohol misuse: Examining heart rate reactivity to alcohol, alcohol sensitivity, and personality constructs", Elsevier, 2006.

[14] J. Vander sloten, P. Verdonck, M. Nyssen, J. Haueisen (Eds.), "Towards a capacitively coupled electrocardiography system for car seat Integration", ECIFMBE 2008,IFMBE Proceeding 22, pp 887-890,Springer verlag, 2008.
[15] M. Patel,F. Modig,M. Magnusson, P.A. Fransson, "Alcohol intoxication at 0.06 and 0.1% blood alcohol concentration changes segmental body movement coordination", Springer verlag, 2010.
[16] Martin Ohlin, Dan Henriksson, Anton Cervin, "TRUETIME 1.5—Reference Manual", Department of Automatic Control Lund University.
[17] Holger Karl, Andreas Willig," PROTOCOLS AND ARCHITECTURES FORWIRELESS SENSOR NETWORKS", Wiley, 2005.
[18] J.W. Gardner,E.Llobet and E.L. Hines," PSPICE model for resistive gas and odour sensors",IEE Proc-Circuits Desives Syst., Vol 146, No 3, June 1999.
[19] www.mathworks.com
[20] G.R.Kanagachidambaresan,V.R.Sarma Dhulipala, D.Vanusha and M.S.Udhaya," Matlab Based Modelling of Body Sensor Network Using ZigBee Protocol",appeared in Springer -Verlang,CIIT-CCIS 250, pp.773-775, 2011.

**Table 1: Data collection in Practical Rehabilitation scenario**

| | Pulse rate | Heart beat | BAC | Blood Pressure |
|---|---|---|---|---|
| Normal | 72 | 72 | <0.01% | 120/80 |
| Drunken (α) | (-10to-3)-72+(6to9) | (-10to-3)-72+(6to9) | >0.01% | Based on status |
| Hypertension (ß) | 72+(3to8) | 72+(3to8) | <0.01% | 140/90 |
| Scared | 72+(6to9) | 72+(6to9) | <0.01% | 140/90 |
| Cardiac Arrest(γ) | 0-10 | 0-10 | <0.01% | 0-10 |