

“Automatic Car Control during Cardiac Arrest with Pre-Programmed Messaging System”

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Abstract: Traditional heart monitoring solutions exist for many years such as Holter device which records the patient's ECG or the heart beats for 24 to 48 hours and is analyzed afterwards by the cardiologists. The patient can wear the device and go home and resume his/her normal activities. The main drawback of these solutions is when a major incident occurs during the monitoring phase, heart rate is recorded but no immediate action is taken to help the user. The proposed system is an improvement in helping cardiac risk patients over the existing systems, which also does sending messages to nearest hospital and safely parks the car in case of emergencies.

The Proposal consists of a Heart rate monitor (HRM) that monitors the frequency of the heart beat and checks for the Ventricular Tachycardia (VT) (a condition that leads a person to the cardiac arrest), An Emergency Message Sending Module (EMSM) that triggers the pre-programmed message to nearby hospital and police station etc and an C

The HRM consists of an ordinary stethoscope drum to piezo air-tight chamber or stethoscope-microphone combination and wavelet filter to capture highly accurate Heart beat pulses. This sensor module is fitted to the seat belt of the car and is then checked for the high heart rate (VT). The sensor module is connected with the ECU to trigger the ASPS and EMSM modules simultaneously.

The car control is done by ASPS to safely park the car in the left hand side of the road. The ASPS module takes care of obstacles on all sides of car, speed of the front and back obstacles, lane observations, divider and nominal speed of the other road vehicles. The EMSM module is also simultaneously triggered to send messages instantaneously to pre-defined contact numbers such as nearest hospital, police station etc, and triggers an alarm which indicates the other road users of the emergency. Since, car is a very noisy environment, the reliability of the heart rate signal must be focused to ensure proper detection and triggering of the EMSM and ASPS.

Through this system, the accidents are prevented and the safety of the driver as well as the other road users is ensured. This system also improves safety awareness in using the seat belts while driving cars. The system triggers a new research field of road safety and new techniques of proper communication in case of Emergencies.

Keywords

- HRM Heart Rate Monitor
- VT Ventricular tachycardia
- EMSM Emergency Message Sending Module
- ASPS Automatic Safe Parking System

Introduction

Cardiovascular disease is the leading cause of mortality. Every year about 500,000 people die because of heart attack. With an ageing population it will only increase over the next 10 to 15 years since cardiovascular diseases occur predominantly in then age group of 55 and over. The current idea improves the existing Heart rate monitors providing a method of controlling car and thus avoiding accidents.

Proposal

If the driver is collapsed by cardiac arrest in car, it would instantly react, using heart and motion sensors on the side of the car and safely steer to the side of the road, stop; put on emergency lights and send a message to doctor (relatives/friends). An Acoustic type of heart sensor will be fitted to the seat belt to monitor the heart rate of the driver (cardiac risk patient).

Process in Brief

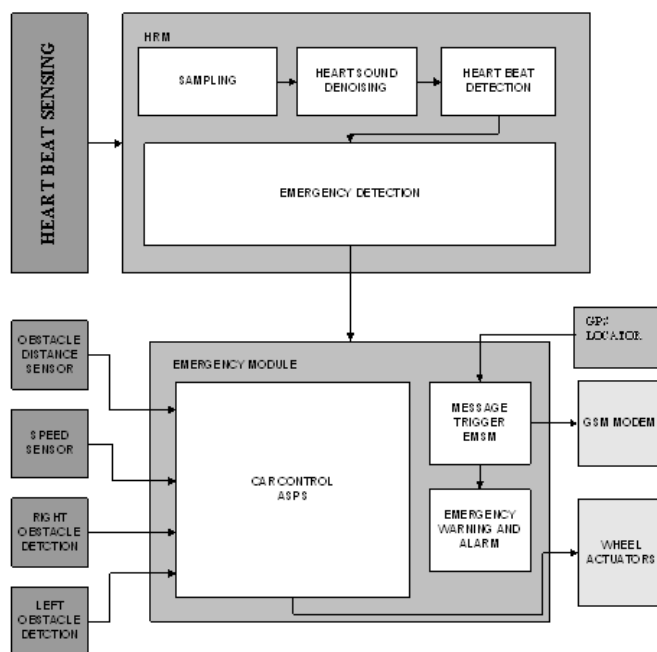


Figure1. Block Diagram of Proposal.

The implementation steps are

1. Heart Beat Sensing
2. Heart Beat Processing
3. Emergency Detection
4. Obstacle Speed and Obstacle Distance, Lane Measurements
5. Emergency Module(ASPS and EMSM) trigger

1. Heart Beat Sensing

The Heart Beat sensing can be done using any one of the following three types:

- 1.Acoustic Sensor(Consists of Stethoscope-PiezoSensor)
- 2.ECG Sensors
- 3.Optical Sensors

1.1. Acoustic Sensors

The acoustic sensors works on the principle, when the heart beats, its lub-dub sound produces the corresponding electric pulses from which the Heart rate is measured. Listening to heart beats using a stethoscope, a process known as Auscultation, is a more accurate method of measuring the heart rate. The different types of sensors like stethoscope, microphone, piezosensor, stethoscope-mic module etc can be used. The sensors are placed in the seat belt to facilitate capturing of heart beat rate waveform from chest.

1.2. ECG Sensors

An electrocardiogram, or ECG (also abbreviated EKG), is one of the most precise methods of heart rate measurement. Continuous electrocardiographic monitoring of the heart is routinely done in many clinical settings, especially in critical care medicine. Commercial heart rate monitors are also available, consisting of a chest strap with electrodes. The signal is transmitted to a wrist receiver for display. Heart rate monitors allow accurate measurements to be taken continuously and can be used during exercise when manual measurement would be difficult or impossible (such as when the hands are being used). This sensor is not situated for car environment as the driver would feel uneasy due to the gel beneath the electrodes.

1.3 Optical Sensors

The pulse rate must be measured through changes of blood flow through an index finger. Each pulse of blood from the heart will increase the density of blood in the finger pulsatile tissue and cause a decrease in light power received by the photo-sensor. The photo-sensor will not pick up a purely AC signal since there are some DC components received from other non-pulsatile tissues and ambient light levels. The varying light levels received will be converted into a varying resistance in the photo-sensor. The varying resistance will be converted into a varying voltage by using a resistance network and power source. In order to do this, a red led will be used in combination with a photo-sensor to detect and transmit the pulse rate. Since the tissue in the human body acts a filter for red light, a red LED was chosen to allow the maximum amount of light energy to pass through the index finger.

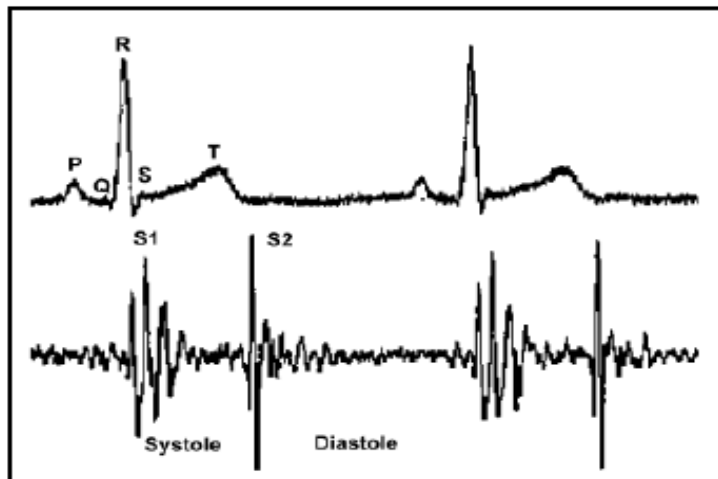


Figure. 2 The Correlation between ECG and Heart Sound Signal

2. Heart Beat Processing

The heart sounds are utilized by using a digital stethoscope which interfaces directly to PC along with signal processing algorithms. The sensor is based on a noise cancellation microphone, with the 450 Hz bandwidth and is sampled at 2250 samples per second with 12-bit resolution. It is compared with a piezo-based sensor with a 1 kHz bandwidth. A major problem is that recording of heart sounds into these devices is subjected to unwanted background noise, which can override the heart sounds and results in a poor visual representation. This noise originates from various sources such as skin contact with stethoscope diaphragm, lung sound and other surrounding sounds such as speech. To eliminate this, wavelet denoising techniques was used. The coding of the waveform into wavelet domain is achieved with relatively few wavelet coefficients, in contrast to the many fourier components that would result from conventional decomposition.

The background noise can be reduced by a 'Threshold Operation' in the wavelet domain. The principle is that the background noise is splitted up into many small broadband wavelet coefficients that can be eliminated without degrading the original signal.

3. Detection of Cardiac Arrest

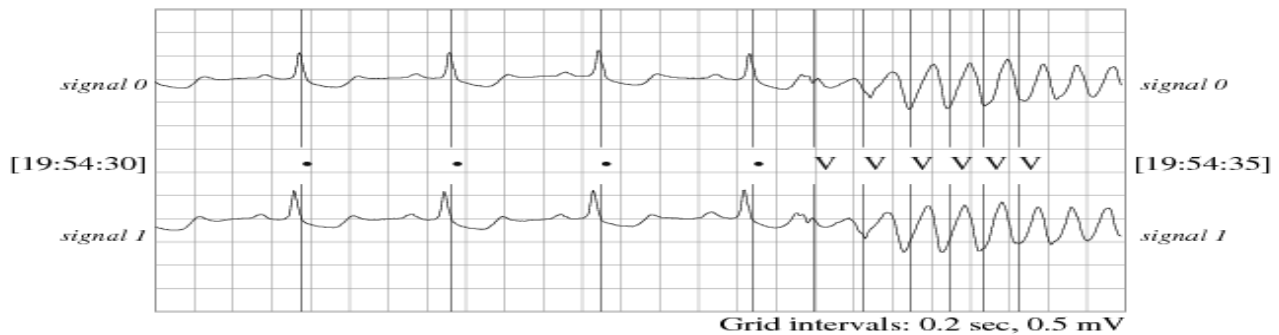


Figure 3. A ventricular tachycardia condition for first 5 seconds.

Sudden cardiac arrest is not a heart attack. It occurs when the heart stops beating and cannot pump blood. It can be caused by dangerously fast and chaotic heart beats, called ventricular fibrillation (Figure 3), or when the heart just stops beating entirely. In contrast, a heart attack happens when the blood supply is cut off to part of the heart but the rest of the organ continues to function. Heart attacks are not usually fatal, but sudden cardiac arrest is. Less than 5 percent of people who suffer a sudden cardiac arrest and get treated with CPR will survive long-term. That's why many people are working on better ways to treat this fatal problem.

4. Obstacle Speed, Distance and Lane Departure Measurements

To ensure safe parking in the left, we have to measure the obstacles distance, the relative speed and the lane in which it travels must be measured after the ASPS is activated. The available options for measuring the distance of obstacles are Ultrasonic Sensor and Infrared Sensor. The lane measurement is possible by using CCD cameras and doing image processing techniques. The speed Measurement is possible by Ultrasonic Sensors or RADAR or LIDAR.

5. Emergency Message Sending Module and Emergency Warning System

5.1. EMSM

The emergency module consists of emergency warning and emergency message sending module. We have to use the GPS Locator and GSM Modem connected to the ECU (EMSM) serially. The SMS messages are

sent through AT commands. The following text lists part of the Hayes command set (also called the AT commands: "AT" meaning *attention*).

The Hayes command set can subdivide into four groups:

1. basic command set - A capital character followed by a digit. For example, M1.
2. extended command set - An "&" (ampersand) and a capital character followed by a digit. This extends the basic command set. For example, &M1. Note that M1 is different from &M1.
3. proprietary command set - Usually starting either with a backslash ("\") or with a percent sign ("%"); these commands vary widely among modem-manufacturers.
4. register commands - Sr=n where r is the number of the register to be changed, and n is the new value that is assigned.

A *register* represents a specific physical location in memory. Modems have small amounts of memory onboard. The fourth set of commands serves for entering values into a particular register (memory location). The register will store a particular variable (alpha-numeric information) which the modem and the communications software can utilize. For example, S7=60 instructs the computer to "Set register #7 to the value 60".

Although the command-set syntax defines most commands by a letter-number combination (L0, L1 etc.), the use of a zero is optional. In this example, "L0" equates to a plain "L". Keep this in mind when reading the table below.

Some of the most important characters that may appear in the modem initialization string follow. Normally one should not change these characters.

- AT - "Attention": tells the modem that modem-commands follow. This must begin each line of commands.
- Z - Resets the modem to its default state.
- , (a comma) - Makes the software pause for a second. More than one comma can appear in succession: for example, ",,," tells the software to pause four seconds. (The setting of register S8 governs the duration of the pause.)
- ^M - Sends the terminating Carriage Return character to the modem. This is a control code that most communication software translates as a carriage return. (Note, when this is sent to the modem, it is sent as a single byte, ASCII CR (0x0D), or "Control-M" not the two characters ^ and M.)
- ; (a semi-colon) - Return to command mode immediately after dialing. This makes it possible, for example, to dial more than 45 digits numbers, or to walk through interactive menus.
- W - wait for dialtone. The modem will wait for a dialtone before dialing numbers following the W. For this to work, waiting must not exceed a timeout, generally configured in the S7 register.

- ! - flash hook put quickly the modem on/off hook.

When in data-mode an escape sequence can return the modem to command mode. The normal escape sequence is three plus signs ("+++"), and to disambiguate it from possible real data, a guard timer is used: it must be preceded by a pause, not have any pauses between the plus signs, and be followed by a pause; by default a "pause" is one second and "no pause" is anything less.

6. Likely problems

There are two major problems with this idea. First, the activation of the device is a problem (auto mode) and cardiac bands (seat belts) are out of the question (nobody's going to bother to put them on and they detect too specific a circumstance); slumping would be hard to detect (and do people "slump" when they're having a heart attack?). Automated driving is not good enough to trust in normal conditions, but might be good enough to take over as a last resort. Second, there's the economics of it. If we start with a regular car, we've got to add a lot of gadgetry to make this work, and it's going to cost a lot. The most people would not be willing to pay a significant premium for a safety device which will almost certainly never be used.

7. Conclusion

Thus the proposal aims at reducing the accidents happening due to the driver's emergency condition (Cardiac Arrest). Presently, the focus is only on cardiac arrest, but it can be improved further. Also, the emergency can be properly communicated to the persons (relatives, policemen, emergency centre, hospital, etc).

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