Electronic Simulator of Sound (Noise) Effects for Electric Vehicles in Urban Areas

Georgi Pavlov[1], Galina Cherneva[2], Radoslav Katsov[3], Ivaylo Nenov[4], Ilko Tarpov[5]

Abstract - **The report proposes a technical solution based on a microprocessor electronic system for reproducing real noise effects with the silent movement of electric vehicles in the urban areas. By its mounting on an appropriate place in the electric vehicles and parameterization depending on the specific conditions, problems, related to their disability (silence), will be solved.**

Keywords – **Electric Vehicles, Electronic Simulator of Sound**

I. INTRODUCTION

Electric drives powered by a rechargeable battery were used in mobile equipment as early as in the late 19th century. What followed was a rapid progress of the so-called electric vehicle that even before the beginning of the 20th century overcame the dreamt limit of 100 km/h. However, the rapid rise was followed by a failure related to its relatively high price and limited mileage. Vehicles powered by internal combustion engine won the battle with electric vehicles thanks to their great advantage, virtually unlimited mileage.

For the recent years the use of electric vehicles has come ahead in searching for a new generation of power sources and vehicles. The reasons for their appearance on the market are related to the crisis and the rising price of liquid fuels, global environmental problems, global warming and all other consequences related to it. This has united efforts to reducing car emissions in cities. [1]

In general, all car manufacturers have specified the production of electric cars in their programs that can be classified into the following groups: electric vehicles designed to move only in cities; specially designed electric vehicles and electric cars based on the previously existing classic cars; sports EVs.

From the surveys accomplished, it has been established that now mainly EVs of the first group are available on the market: mini cars or the so-called urban electric vehicles. The EVs of other two groups are under development and experimental studies. The problem is what the cost of technology will be and what their consumer ratings will be from an economical point of view. If sophisticated environmental technologies are used, they may be too costly in terms of energy saving and efficiency and it could be a bad solution. Such an expensive solution can be used for sports cars but it could not be a solution for electric vehicles of mass production. [2].

It means that the use of expensive technology will be inappropriate at this stage and probably in future. Perhaps this is the main reason now for some manufacturers to solve the problem based on classic cars.

Recently the **NHTSA (National Highway Traffic Safety Administration)** in the USA has issued a statement about the process of drafting a law from 2011, **Pedestrian Safety Enhancement Act**. The Act requires **NHTSA** to investigate whether quiet cars are more dangerous, whether to introduce a requirement for electric cars to imitate some noise and formulate a regulation if such a noise is necessary. Others reject the idea of adding artificial warning to electric cars. [3]

In many countries it is considered that electric cars are more dangerous because they are quieter. The considerations are that people face to a greater risk because they can not rely on their hearing to detect and avoid approaching vehicles.

On the other hand, the problem of noise pollution must be considered. Cities are noisy places and the additional noise causes various health problems. Electric cars offer a solution to this serious problem of noise.

These studies are aimed to establish a standard requiring the equipment of electric and hybrid cars with an appropriate sound generating range for warning pedestrians if necessary by 2013. The idea is to help "visually impaired" and other pedestrians to detect the presence, direction, location and operation of such vehicles.

Based on the mentioned above, this paper further presents a device developed by us, which is based on a microprocessor electronic system for reproducing realistic noise effects with electric vehicles movement in urban areas. The electronic system does not require a large power supply and allows setting parameters depending on specific conditions.

II. MAIN FUNCTIONS AND FEATURES OF A SIMULATOR FOR GENERATING SOUND EFFECTS OF ELECTRIC VEHICLES

The electronic device (Fig. 1) used to generate appropriate sound, noise effects intended for a remote detection of moving

[1]assoc. prof. dr. Georgi Pavlov - Todor Kableshkov University of Transport, Bulgaria, Sofia, 158 Geo Milev Str.

[2]assoc. prof. dr. Galina Cherneva - Todor Kableshkov University of Transport, Bulgaria, Sofia, 158 Geo Milev Str.

[3]Radoslav Katzov – student at the Todor Kableshkov University of Transport, Bulgaria, Sofia, 158 Geo Milev Str.

[4]Ivaylo Nenov – student at the Todor Kableshkov University of Transport, Bulgaria, Sofia, 158 Geo Milev Str.

[5]Ilko Tarpov – PhD at the Todor Kableshkov University of Transport, Bulgaria, Sofia, 158 Geo Milev Str.

electric units is a complex system composed of electronic blocks with specific function and operating by a predefined algorithm.

The hardware consists of two separate duplicate schemes that operate in a particular specified line. The main function of the first scheme is to simulate the sound of the engine when accelerating speed and the second circuit simulates the sound with speed decreasing.

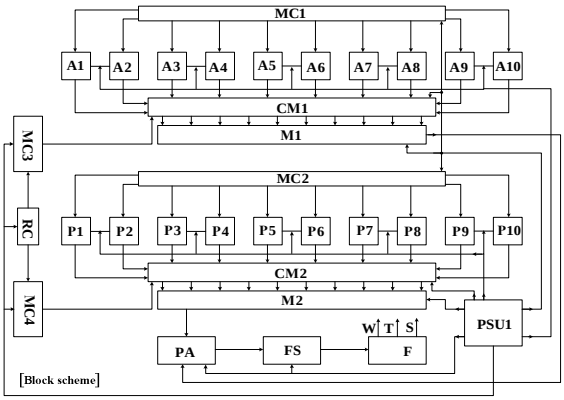

Fig.1. Block scheme of an electronic simulator of sound (noise) effects for electric vehicles in urban areas

Description of main blocks in the scheme structure:

MC1 - microcontroller of ATMEGA 8 (48) series. It generates electrical impulses that are pre-programmed in a way to input beat to memories in a specified time interval. This in turn leads to a cyclic repetition of the simulated sound.

Blocks **(A1-A10)** and **(P1-P10)** are electronic devices (memories), which mainly store and generate the simulation.

CM1 –controlled module of a significant application. This module is filled with a different set of electronic circuits that allow a smooth transition from one to another state of simulation.

M – mixer, which serves to unite ten channels into two stereo channels.

RC – resistive circuit, which changes the resistance of microcontrollers **MC3, MC4** of ATMEGA 826 series. Their function is to regulate the voltage of the controlled module.

PA – preamplifier. Its function is to partially amplify the signal and then transmit it to the final stage **FS** where the signal is increased to optimal levels, then filtered by filter **F.**

PSU is a power supply unit, which ensures the normal mode of system operation.

III. Algorithm of System Operation

The sound simulated by hardware is recorded by an external source in advance. The record is installed on a computer and is converted from analog into digital with the help of appropriate software. The transformed signal is made discrete into a series of pulses with duration of one second. The signal treated in this way is recorded from the computer onto separate memories connected to the controlling microcontroller. It is programmed in a way to repeat the integrated signal continuously in the individual memories thus forming a cycle.

The outputs of the individual memories are connected to a control module. The main function of this module is to receive the signal from memories and ensure a smooth transition from one signal to another. The control of this module is performed by another microcontroller that, with changing its input resistance within 0 and 47 kΩ, regulates simultaneously both the strength of the signal from the control module and the smooth transition of the signal from one state to another. As a result simulation is accelerated. The signal that comes out from the controlled module is a multi-channel one. Therefore each signal is connected to a mixer, which reduces the number of outputs from ten to two.

The second part of the scheme operates by an opposite principle. The microcontroller potentiometer or the input controller impedance varies within the same range. The difference in the operation algorithm of duplicate schemes is that, with reducing the resistance of the first microcontroller, the memory switch with the help of the control device is done by successively merging the signals of memories from A1 to A10 and, with an increase of the resistance, the signal of memories from A1 to A10 is ignored. Thus, with increasing the input resistance, the microcontroller starts gradually switching signals gearing down from P1 to P10.

The resulting sound simulation passes through a number of filters and finally the signal is enhanced multiple times through the preamplifier and output stage.

IV. Conclusion

The limited use of electric vehicles in the country at this stage is only temporary and as slowly as things move, this type of cars sooner or later will start to enter our market. What we can do until then is to trace all possible trends, the solutions of various problems related to electric vehicle technology and the development of regulatory regimes for electric mobility across countries.

The main function of the designed electronic simulator upgraded in an electric car is to create the necessary noise effects identifying it as a vehicle. It will create conditions for safe operation in urban areas in terms of pedestrians and especially of the blind and people with low-vision.

The advantages of the proposed electronic system are related to high reliability, low cost, lower power consumption and ability to adapt to specific requirements and operation modes of various electric vehicles.

References

1. http://www.bg-history.info/882/
2. http://cars.actualno.com/-actualno.com
3. http://ecobusiness.dnevnik.bg/show/?storyid=530001