Traffic safety in using cellular phones while driving a cars

Miroslav Mikula - Slavko Šarić - Zvonko Kavran

University of Zagreb
Faculty of Traffic and Transport Engineering

The use of cellular phones in cars offers a number of possibilities, but represents also a real danger while speaking, and especially while dialling the number of another subscriber. The number of cellular phones in cars is growing constantly, as unfortunately also the number of traffic accidents caused by the use of cellular phones while driving. This was the reason for studying the possibilities of hand-free dialling, e.g. by using speech only. This requires a high level of speech dialling recognition, which is provided by the application of neurone networks. The paper describes the operating principle of such a system, SPRED. Besides, the legislative regulations are also considered regarding the use of cellular phones in cars in certain countries.

1. Introduction

The number of cellular phones worldwide is growing very rapidly (50% a year) so that there were already over 200 million of them at the end of 1998. More and more drivers want to buy cellular phones because this provides them, both in business and privately, with the opportunity of both making and receiving phone calls at any time. There is a great assortment of cellular phones on the market today, and their use in cars is offered with a number of advantages, but it represents a real danger while speaking, and especially when dialling the other user's number. The number of cellular phones in cars is constantly growing, but unfortunately, so is the number of traffic accidents involving drivers who have been using the cellular phone while driving.

2. Analysis of the influence of using cellular phones while driving on the traffic safety

The scientists at the University in Bremen and the Institute of Forensic in Cologne have compared the actual data on inappropriate drivers' reactions and errors in driving, with and without using the phone while driving (Figure 1). The behaviour of 50 drivers was tested, and they drove three times different 15km driving routes (urban, inter city, and motorway driving).

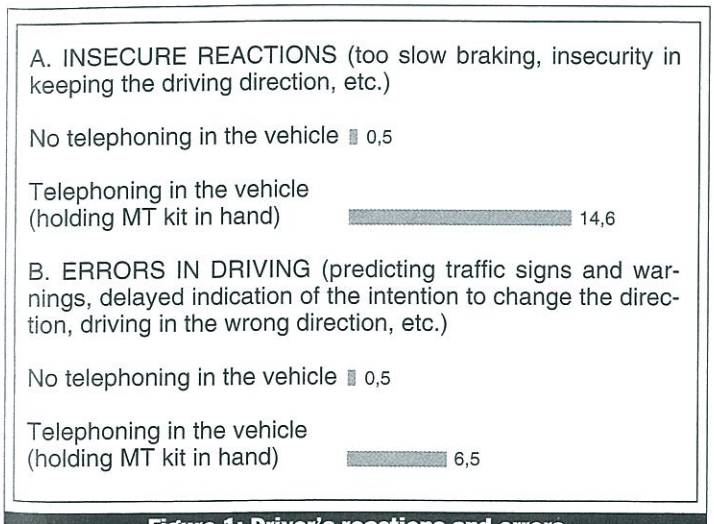

Figure 1: Driver's reactions and errors with and without using the cellular phone while driving

According to statistics of traffic accidents in the Republic of Croatia for 1997, cellular phones caused 164 traffic accidents (Table 1).

3. Problem of holding mt kit of the cellular phone while driving a car

The use of a phone in a car may be postponed if this is required by the situation in traffic and it is generally recommended to use the phone before or after driving, which means when the car is not moving. However, receiving telephone calls during driving cannot be avoided, except by switching off the cellular phone. In order to answer the telephone call without affecting severely the driving safety, cars are fitted today with an additional device, the so-called HANDS FREE device, which enables telephoning without having to hold the MT kit, so that both hands can remain on the wheel. With such a telephone it is possible then to telephone from the car without using your hands. The problem, however, remains when the driver wants to make a phone call, and has to dial a certain number. This operation requires additional optical control of the numerical input on the indicator, which significantly influences the driver's concentration. This was the reason for studying the possibilities of hands free dialling from a cellular phone, e.g. using speech only.

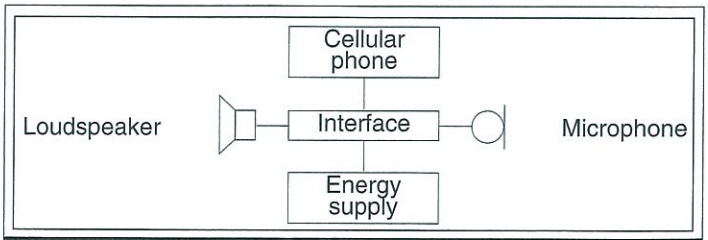

Figure 2. Hands free devices in a vehicle

Ord. No.	Total number of traffic accidents	Number of accidents involving drivers who were not using cellular telephones	Number of accidents involving drivers who were using cellular telephones	Traffic accident consequences
1	653	651	2	Killed
2	4251	4239	12	Severely injured
3	10825	10803	22	Lightly injuries
4	97608	97480	128	No injuries
Σ	113337	113173	164	

Table 1. Traffic accidents in the Republic of Croatia in 1997

Problem of dialling a number from the cellular phone while driving a car

The speech dialling principle i.e. automatic dialling by pronouncing the name of the subscriber is relatively simple. The cellular phone is programmed in such a way that a certain dialling number is input over the keyboard, and then the voice recognition logic installed in the device dials the subscriber's number. This means that when dialling, only the name of the subscriber has to be dictated into the microphone, and the electronic dialling unit selects it among a number of previously stored names, repeating it acoustically for confirmation and at the same time co-ordinating the dial number and its indication on the cellular phone display.

The speech recognition electronic unit consists of two basic groups (Figure 3). In the PARAMETERS EXTRACTION group, the relevant parameters are selected from the input voice signal, based on which decisions are made in the CLASSIFICATION group, regarding which word it was. The practical realisation of electronic voice recognition is, however, very complicated and related to multiple problems. The human capability of recognising and understanding speech is today highly developed and adaptable, whereas this cannot be achieved by far with computers. Besides, the environmental factors are also present, specific characteristics of words and speakers, lacking speech redundancy, and insufficient level of recognition.

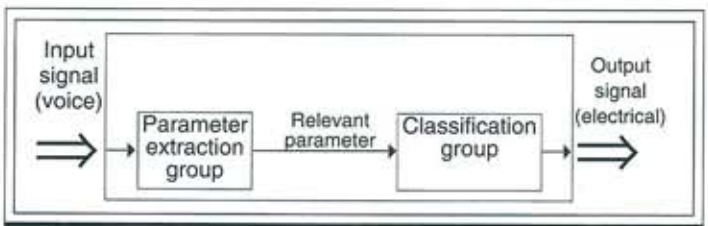

Figure 3. Operating principle of electronic unit for voice recognition dialling

Human ear can discern environmental noises up to a very high level of voice intensity, and simultaneously filtrate the pronounced word very selectively so that the noise around is practically inaudible. On the contrary, voice recognition electronics cannot do this, since the vehicle environment is full of sounds, ranging from the relatively loud engine noise, possible music or news from the radio, as well as noise from the outside which burden the pronounced name of the subscriber.

If the result of electronic recognition of the pronounced name after several trials of voice dialling were low, the user would reject using such a device any more. Therefore, very high level of probability of recognition, of over 95%, is required for successful usage of electronic voice identification in cellular phones. In designing a voice recognition system it is not possible to determine all the words that need to be processed, nor can the users know which parameters have a certain similarity, and which are specially distinguished. Therefore, adaptive procedures of parameter extraction have been developed, which take into consideration the statistical algorithm samples, as well as training samples. In the majority of today applicable speech recognition units, the parallel classification algorithms are used. They re-calculate the appropriately defined distances between parameters of notions which need to be recognised and training sar· ·s, and they classify according to the selective criterion t. .ninimum distance with the final probability of the desired notion, i.e. in voice dialling, the name from the register. Using this procedure, the probability of recognition remains within the range of around 95%, but it is greatly reduced as the ambient noise increases.

Better results and increased level of recognition can be achieved by new algorithms and technologies, the so-called NEURONE NETWORKS. The artificial neurone network is a system composed of densely interconnected processing units, arranged in layers with especially emphasised input and output layer. The basic element of the artificial neurone network is the processing unit. Characteristics which distinguish the artificial neurone networks as parallel models composed of processing units (artificial neurones, nodes, stations) from serial models are the following:

- there are links between units, and each link is assigned a weight which determines the strength of the connection,
- there is a rule of signals distribution, which on the basis of input signals into the unit and weights of the links connected to the unit, calculates the efficiency of the input signal of the unit,
- there is a rule of activation, which on the basis of the input signal efficiency calculates the value of the stimulation signal, i.e. the value of the output signal,
- there is a rule of learning, by the application of which the strengths of links between units change,
- there is the environment, from which input signals are received by the model.

The operation of an artificial neurone corresponds to the operation of a biological neurone. Artificial processing unit collects input signals from its environment and generates the output signal, transferring it to other units linked to it (Figure 4).

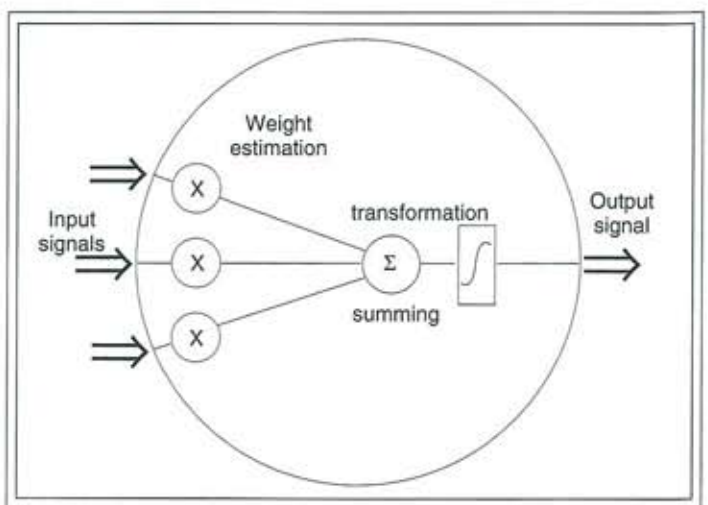

Figure 4. Operating principle of neurones as basic elements of a neurone network

The units of the artificial neurone network are organised in groups which form the network layers. The network is made up of at least two layers, the input and the output layer. Input layer provides distribution of data from the environment to other network layers which process the data (input layer elements do not process the data). The output layer elements deliver the data processing results to the environment. A network can contain several inner hidden layers, which have no direct connection to the environment, but perform the data processing. The topology of the network is determined by the methods of connecting the units within a layer, and their connection between the layers. The efficiency of the artificial neurone network lies in its capability of learning and memorising the interdependence of symbols, thus indicating the main cognitive properties. In the training phase, i.e. in pronouncing the names of subscribers, classification according to various names is carried out in the electronic neurones classification unit. Speech dialling using neurone network is called SPRED (Speech Recognition and Dialling). When using it with the cellular phones the typical environmental conditions need to be taken into consideration (e.g. high level of disturbing noise). Figure 5 presents the design principle of the basic speech dialling unit, and the analogue interface for recording and reproduction of speech signals can be seen, as well as the digital interface for communicating with the cellular phone.

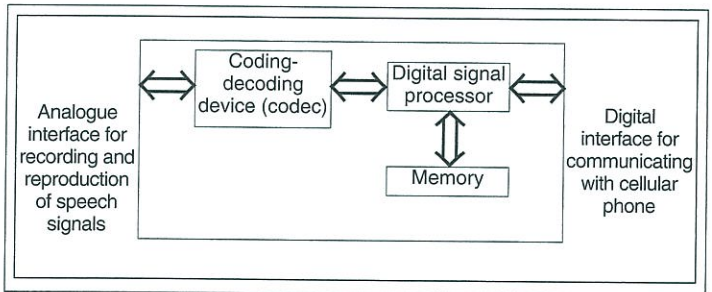

Figure 5. Operating principle of the speech dialling unit SPRED

The incoming analogue speech signal is digitised in Codec, and further transferred to the digital signal processor, which implements all the functions of parameter extraction and classification, which means also the neurone network itself. In one memory the resident data are stored (mainly training samples and the neurone network coefficients). For confirmation of the input speech dialling (the name of the required subscriber), after the procedure of recognising the identified name in spoken form is over, the digitised signals are transformed in Codec into analogue signals which are transmitted further through analogue interface. The information is conducted over the digital interface to the telephone, and there it is further processed. The processed information is used in such a way that the related number from the memory "Telephone directory" is loaded and displayed on the dialling indicator.

5. Regulations in the world and in Croatia regarding use of cellular phones while driving

An increasing number of countries is banning the use of cellular phones in cars during driving, except if a hands free system has been installed. In some countries the use of cellular phones is forbidden even for co-drivers riding in vehicles, since this causes distraction for the driver. Every phone call, namely, causes a slight stress in participants and an acceleration of heartbeats has been measured. Such condition lasts not only during the conversation itself, but also one minute following it. Legislative regulation on using the cellular phone while driving treats this issue very differently in different countries:

- strictly forbidden: in Italy and Portugal
- forbidden: in Australia, Brazil, Israel, Hungary, Poland, Slovenia and Switzerland (except Hands-free)
- not recommended: in France, Germany and Spain
- act being drafted: in Austria and Great Britain

In the Republic of Croatia, the problem of using the cellular phone in cars while driving is for the moment being considered.

6. Conclusion

The situation today is such that the problem of holding the MT kit of the cellular phone while driving is mainly solved by the application of the HANDS FREE system, and many car manufacturers today already deliver these devices as standard equipment.

Regarding cellular phone dialling problem while driving, it has also been solved technically today by means of a speech dialling device, but the price of such devices is still rather high. Therefore, when dialling while driving is concerned, the drivers will have to accept for some time still, the recommendation by psychologists and other scientists in the field of traffic, to make the phone calls in rest areas, which means while the car is stationary, and not while driving.

LITERATURE

[1] GOLD, H. (1991) Konekcionizam kao sredstvo modeliranja informacijskih sustava u prometu, Promet 3.

[2] WAGENLEHNER K. (1993) Mobiltelefon gehorcht aufs Wort, Telcom report 16, Heft 6.

[3] MCCLELLAND J. L. AND RUMELHART D.E. (1988) Parallel Distributed Processing, MIT Press, Cambridge, Massachusetts, London, England.

[4] Internet http://www.cellulardepot.com/handsfree.html (1999)

[5] ROSS T.J. (1995) Fuzzy logic with engineering applications, McGraw-Hill, USA.

LITERATURE

[1] *Berth Throughput, Systematic Methods for Improving General Cargo Operations*, United Nations, TD/B/C.4/109 and Add.1, New York, 1973.

[2] BRONSON, R.: *Operations Research*, McGraw-Hill Book Company, 1982.

[3] CHANG, Y.L.-SULLIVAN, R.S.: *Quantitative Systems for Business Plus*, Version 1.0, Prentice-Hall, 1988.

[4] ČERIĆ, V.: *Modelling by Simulation*, Školska knjiga, Zagreb, 1993. (in Croatian)

[5] FRANKEL, G.E.: *Port Planning and Development*, John Wiley and Sons, New York, 1987.

[6] GROSS, D.-HARRIS, C.M.: *Fundamentals of Queueing Theory*, John Wiley and Sons, New York, 1974.

[7] KAUFMANN, A.: *Méthodes et modèles de la recherche opérationnelle*, Tome 1, Dunod, Paris, 1970.

[8] KIRINČIĆ, J.: *Ports and Terminals*, Školska knjiga, Zagreb, 1991. (in Croatian)

[9] MILLER, A.J.: *Queueing at Single-Berth Shipping Terminal*, Journal of the Waterways, Harbors and Coastal Engineering Division, ASCE, Vol.97, No.WW1, February 1971, pp. 43-56.

[10] Mrnjavac, E.-Zenzerović, Z.: *Model for Determining the Optimum Number of Berths of a Port Container Terminal*, Proceedings of the 6th International Symposium on Electronics in Traffic, ISEP '97, Elektrotehniška zveza Slovenije, Ljubljana, pp. 149-156.

[11] NEWELL, G.F.: *Applications of Queueing Theory*, Chapman and Hall, London, New York, 1982.

[12] NORITAKE, M. - KIMURA, S.: *Optimum Number and Capacity of Seaport Berths*, Journal of the Waterways, Port, Coastal and Ocean Engineering, ASCE, Vol.109, No.3, August 1983, pp. 323-339.

[13] NORITAKE, M. - KIMURA, S.: *Optimum Allocation and Size of Seaports*, Journal of the Waterways, Port, Coastal and Ocean Engineering, ASCE, Vol.116, No.2, March/April 1990, pp. 287-299.

[14] *Port Development, A Handbook for Planners in Developing Countries*, United Nations, New York, 1978.

[15] *Port Development, United Nations*, TD/B/C.4/175/Rev. 1, New York, 1985.

[16] PLUMLEE, C.H.: *Optimum Size Seaport*, Journal of the Waterways and Harbors Division, ASCE, Vol. 92, No. WW3, August 1966, pp. 1-24.

[17] SCHONFELD, P. - FRANK, S.: *Optimizing the Use of a Containership Berth*, Transportation Research Record, 984, January 1984, pp. 56-62.

[18] SCHONFELD, P. - SHARAFELDIEN, O.: *Optimal Berth and Crane Combinations in Containerports*, Journal of the Waterways, Port, Coastal and Ocean Engineering, ASCE, Vol.111, No.6, November 1985, pp. 1060-1072.

[19] SCHULZE, G.: *Modellierung hafen-betrieblicher Prozesse*, Transpress, Berlin, 1977.

[20] SPIEGEL, M.R.: *Probability and Statistics, Schaum's outline Series in Mathematics*, McGraw-Hill Book Company,1980.

[21] Šošić, I.-SERDAR, V.: *Introduction to Statistics*, Školska knjiga, Zagreb, 1997. (in Croatian).

[22] WANHILL, S.R.C.: *Further Analysis of the Optimum Size Seaport*, Journal of the Waterways, Harbors and Coastal Engineering Division, ASCE, Vol. 100, No. WW4, November 1974, pp. 377-383.

[23] WEILLE, DE J. - RAY, A.: *The Optimum Port Capacity*, Journal of Transport Economics and Policy, Vol.VIII, No.3, September 1974, pp. 244-259.

[24] ZENZEROVIĆ, Z.: *Optimization Models of Planning Seaport Capacities*, Doctoral Dissertation, University of Rijeka-Faculty of Economics , Rijeka, 1995.(unpublished, in Croatian).

[25] ZOGRAFOS, K.G.-MARTINEZ,W.: *Improving the Performance of a Port System through Service Demand Reallocation*, Transportation Research-B, Vol. 24B, No.2, 1990., pp. 79-97.

[26] ŽILJAK, V.: *Simulation by Computers*, Školska knjiga, Zagreb, 1982. (in Croatian).