ARTIFICIAL INTELLIGENCE ESPECIALLY NEURAL NETS AS SUPPORT FOR TRAFFIC MANAGEMENT

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Abstract:*There are described in the article the possibility of using neural networks in the road transport, the advantages and disadvantages of using neural networks, brief description of neural networks. The main subject of the article is a description of some applications of using neural networks in the road transport.*

Key words: perceptron, artificial intelligence, neural nets, feed forward neural net, unmanned vehicle, ATS.

1. Introduction

We can observe the rapid pace of developments in Artificial Inteligence that provides the enhance the performance of different industries and businesses, including the transport sector. The innovations introduced by AI include highly advanced computational methods that mimic the way the human brain works.

Intelligent technologies which are penetrating to different parts of human life don't ignore transportation. As an example we can take intelligent transport systems and automated transport systems which use information, transportation and communication technologies implemented to vehicles or to infrastructure. These systems aim to increase people or goods mobility along with increasing road safety and transportation comfort, reduction of transport collisions and impacts on environment.

Information technologies usage became inherent component of "human" development. Ability to effectively process and use information and knowledge became one of the most important parts of economic growth and prosperity. In transportation, the still changing environment of many participants, special attention should be paid to artificial intelligence – progressive information technology.

2. Characteristic of Artificial intelligence and main areas of its utilization in transportation

There are a lot of definitions of Artificial intelligence (AI), for better imagination what AI is I choose following two from Marvin Minsky and John L. Gordon:

Marvin Minsky : *Artificial intelligence is the science of making machines or systems do things that would require intelligence if done by men:*

John L. Gordon: The aim of Artificial Intelligence is to create intelligent machines and through this, to understand the principles of intelligence. At the moment, we can settle for creating less stupid machines.

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According to these definitions we can say that AI systems are characterized by:

They think like people

Tthey act like people

They think reasonably (rational)

For their implementation is the necessary to get information and knowledge and using information and knowledge to achieve the goal or solution. [7]

2.1. Main reasons for successful growing of AI at present

However AI theory is developing some decade years already its using had to wait for progress in IT technologies area. Including AI in transport machines or systems requires:

- The huge development of IT technologies.
- The development of computer components – mainly speedy processors, high capacity memory devices etc.
- Digitalization of sound and image – for inputs.
- Computer networks creation and growth as wireless nets, logistic systems, Internet are.
- Satellite and mobile nets.
- Progress in transport devices area.

Artificial Intelligence contains ways and means to be used in transportation such as neural nets, AI planning, evolution algorithms, knowing and expert systems, fuzzy logic, multi-agent systems, vector regression, data mining, optimizing techniques, etc.

2.2. Main areas of AI using in transportation

AI at present provides instruments and allows solving problems in each kind of transport and their interaction (air, road, railway and water transport) and is used in areas such as:

- Transport policy, planning, projecting and managing, Real time transport managing.
- Questions related to environment, toll – roads, reliability and safety.
- Transport systems operation.
- Usage and administration of new technologies.
- Travel demands analysis, predictions and transport organization.
- Travel information systems and services.
- Transport and surroundings intelligence technologies, simulations.
- Pedestrian and herd behavior analysis and simulations.
- City planning of sustainable mobility.
- Service oriented architecture of vehicles and vehicles in communication infrastructure.
- Transport technology review and evaluation.

AI techniques allow using applications for entire transport system managing – vehicle, driver, infrastructure and the way in which these components dynamically offer transport services. All-purpose AI instruments and their power are suitable for complicated and diversified transport systems [8].

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2.3. Artificial neural nets definition

Artificial neural nets can be defined as massive parallel computing system open to saving and following execution of information while simulating human brain in collecting data during learning process and saving of these data using inter-neural connections.

Artificial neural nets are one of the options in situations where there are no strict rules according to which it is possible to simulate result of the situation or where these rules are too complex or incomplete. Statistical methods, multi-agent systems or adaptive computing systems are further alternatives. It is suitable to use standard AI methods when rules are known. [9]

3. Examples of tasks solvable by neural nets

Neural networks generally can be used in following areas:
Function approximation problem, Category classification, situation classification, Prediction problem solving, Signal transformation, Association problems, memory simulation.

3.1. Advantages of using neural nets in transportation

Following advantages and disadvantages of using neural nets applies broadly as well as in road transport. For this reason I am mentioning them in this article:

- *Neural nets allow parallel data processing and by using appropriate hardware it is possible to allocate calculations on more parallel processors.*
- *Neural net doesn't need any information about process structure to which it is implicated, it learns and does not to be reprogrammed.*
- *If neural net is used with learning algorithm it can be adapted to changes in parameters.*
- *Neural nets are suitable for identification, classification and sorting of models* – using in recognition of road signs, registration plates, driving licenses, people faces and others.
- *If neural nets are implemented without learning algorithm they are quite fast.*
- *NN allows abstracting managing rules for different regulators (such as human being or regulator with long computing time) and replace them.*
- *NN allows data reduction to smaller dimension.*
- *NN are universal approximator – they allow approximation of any function with any accuracy.* [7]

3.2. Disadvantages of using neural nets in transportation

- *Artificial intelligence and NN also need a huge hardware support.*
- *There is no methodology for neural net architecture and functions for neural description.* Implementation is done by experiments and mistakes what increase time demand on solution.
- *The architecture of a neural network is different from the architecture of microprocessors therefore needs to be emulated.*
- *Learning process can take very long time.*
- *During the learning process can became the situation when neurons reach the state of saturation consequently their outputs lead to extreme values for example sensible error signals.* [7]

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4. Some neural nets application description in road transport

The following section describes some important and interesting applications of neural networks in a road transport and explains NN using in these solutions.

4.1. Driving of unmanned vehicles or computer controlled cars

When appeared vehicles on the road without steering wheels of a man for the first time they aroused a wave of interest. Simply because it is amazing to see how the car passes several thousand kilometres without a driver and no crash.

Currently is their development in full drift and they have already driven more than a half million kilometres, usually without an incident. [1]

Unmanned vehicles development is related to development of **Automatic Transport Systems ATS**. These systems use only electric vehicles and different transport organization as usual. Main feature is using only unmanned vehicles and eliminating other drivers from limited ATS area what will bring more discipline and less accidents in the transport. Only electric vehicles are planned in this project to clear away exhaust fumes and to enrich environment. Such projects are currently realized in some countries, in others is its development financed.

4.2. Driver behaviour modelling

Sometimes using GPS or other navigation doesn't have to be the best solution. Driver has to decide about by-pass road or using highroad etc. There are models allowing designing such transport systems which consider safety and effectiveness of human mobility. Feed forward neural nets are used in analysing desirable road from interactive simulators. [3]

Such system was created as following: Neural net was designed with volunteers providing trial journeys. During the journey they were deciding about the most effective and the most suitable way from many different criterions. According to the actions of volunteers neural net training set was created. This neural net learned same decisions as volunteering drivers and was able to choose journey from unknown data.

4.3. Creation of models which can forecast following of traffic signs by driver

There are algorithms created to solve this problem. Current models use fuzzy logic and neural nets combination to overcome limitations of existing algorithms. Using neural nets to solve such problems is preferable due to their ability to solve nonlinear relations and because they are immune against mistakes obtained from imperfect inputs. NN are suitable for reactive behaviour modelling which is often described as rules connecting perceived situation with attributable measures. [5]

These models can be used as a part in Intelligent transport system (ITS) or ATS.

4.4. Systems for advising maintenance and repair of paths and roads can forsee problems on the roads caused by weather or abrasion

ITS and ATS need to have such parts which offer overall view of roads and paths state for either road participants or transport companies which are in charge of road conditions.

Systems for advising maintenance and repair of paths and roads can be divided to two

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subsystems – diagnostic and prognostic. [4]

Diagnostic subsystem can be classified as pattern detecting problem. Neural nets are used here to process road surface snapshots and assigning them to different defect categories. Diagnostic subsystem also automatically detects by-pass roads or damaged roads.

Prognostic subsystem is complex according to its conformity – road repair actions are not only dependant on actual road condition but also on traffic intensity and on financial needs required for road repair. Data collection for all potential situations is extremely difficult. Suitable solution might be connecting more neural nets to one system.

4.5. Systems for classification and registering of passing vehicles

NN are in this case used to process input data from signallers built beside the roads (video cam with high performing snapshot processing, sensors, etc.) Their main contribution is noticeable during bad external conditions. These systems were successfully run in licensed trademark reading. [1]

4.6. Traffic net analysis and Journey planning and optimizing

These systems use neural nets to diagnose traffic jams and analyse season changes in the traffic and can plan the most effective route what can shorten journeys, lower accidents and finally save environment. The most difficult part is setting parameters for the problem which is nonlinear. [9]

4.7. Traffic streaming forecast

Very important parts of ATS or ITS are systems to recognize and predict congestions to inform all road users about actual situation.

The benefit of a neural network to solve this problem is that it absorbs patterns in data and so can learn to generalize. The main features of a neural network approach are trials of its application to a congestion recognition problem to short term and long term forecasting of flows Models to recognize and predict congestions include: [2]

Short term forecast – forecasting few minutes, part of transport managing system.
Long term forecast – forecasting months or years, in planning and building roads.

4.8. Transport economics

Neural nets can also be used in solving problems in the area no one would expect – impact of noise on real estate price close to transport arteries. Used neural net consisted of instrument which could analyse many variables – real estate condition, age, largeness and of course noise factor of vehicles. [6]

4.9. Traffic sign recognition

There are devices that can detect, recognise and follow traffic signs from moving vehicle. Recognition is done by colour segmentation and neural nets classification. Existing systems can not only recognise traffic signs but also locate and gather them. Locating is realised by approximating location from GPS device and location of traffic sign acquired from

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video cam or video file. Traffic signs gathering help to build traffic sign database which in the same time composes training data set. [10]

Traffic signs are characterized by features from which the most important for detecting and recognising are colour and shape. Detection is done by classical methods based on tresholding and colour segmentation using different colour models or shape models (in black and white images) or their combination. 3D modelling is also often used.

There are more methods which use machine learning algorithms for classification and detection.

5. Conclusion

Artificial Intelligence and Neural nets included in there have broad utilization in every area of transport. Their applications can be found in all systems involving road transport management, such as:

- Automatic transport systems using electric computer managed vehicles
- Intelligent road systems
- Intelligent highway systems
- Traffic road logistics and many other.

Nowadays all rich developed countries involve in development of these systems which costs high financial means.

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