Application of the artificial intelligence in automobiles

Ahmed Talal Selem, Amr Karam Abo-Salem, Ahmed Ezz-Elregal, Mahmoud Ismail, Mohamed Romeih
Automotive department, Military Technical College, Cairo, Egypt, ahmeddabbour53@gmai.com, amkaram59@gmail.com,
ahmedezz89@gmail.com, mahmoudismail43@gmail.com, mohamedromieh33@gmail.com

Supervisor: Hisham M.Eltaher, *Professor*
Military Technical College, Cairo, Egypt, hisham.kamel@mtc.edu.eg

Abstract- The objective of this paper is to show the application of the artificial intelligence in automobiles field. Recently, artificial intelligence has been implemented into the different stages of automotive development. The automotive being a highly complex product with a user friendly interface benefited from the introduction of such technology. Artificial intelligence can be implemented in the design stage, production, planning, and driver assistance and collision avoidance systems.

This paper starts by briefly introducing the concept of artificial intelligence. Then, it presents the role of artificial intelligence in automotive industry starting from design through production up to operation. This a recent application of artificial intelligence shows a great prospect for improving the whole automotive life cycle. Moreover, the development of big data sensing, recording and storage offers a huge opportunity to obtain a better understanding of the performance of the automotive. This ultimately, will lead to a better and safer automobile.

Keywords — artificial intelligence; automotive design; crashworthiness; mobility.

I. INTRODUCTION

First of all, we should know that we are in a great contact with artificial intelligence in our daily life without knowing that these applications are made by AI.

These applications made our life of course easier than before such as (SIRI-ALEXA-Google home-…. etc.).

It also gets in many fields like (autonomous driving) which uses robots as drivers, not only that it also in smart manufacturing and design and many major applications and fields.

AI also in some small hidden details in our life that we can't notice like playing the desired music from Spotify via voice input, creating shopping lists and it can be used in facial recognition systems.

The artificial intelligence ensured a more comfort, easy and economic future for us in all details of our life by offering the magic sauce for each problem and challenges face our daily life.

We can say that all the world is trying increasingly to make any application with artificial intelligence and the countries are putting all their money and investments to develop and wide spread the artificial intelligence and its applications in all possible fields it.

II. ARTIFICIAL INTELLIGENCE

The first born of AI was in China, the scientists defined it by various methods one of them was by (RICH at 1983) which says that (AI is the study of how to make computers to do thing at which, at the moment, people are better) in another definition (AI is the ability of machine to perform cognitive tasks that we associate with the human mind) this includes possibilities for perception as well as ability to argue, to learn independently and thus find solutions independently.

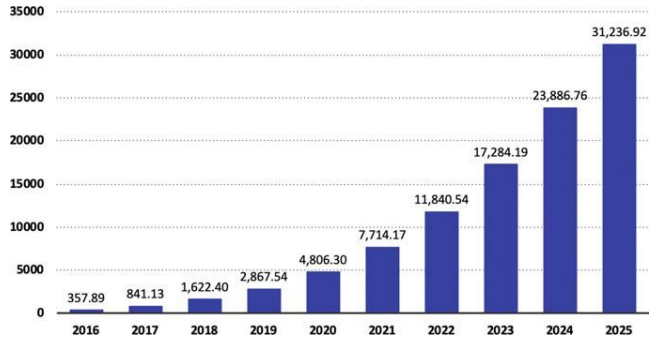


Fig.1 Forecast of turnover with enterprise applications in the field of Artificial Intelligence worldwide from 2016 to 2025 (in US-$ million) [1].

Capabilities of artificial intelligence

During development of AI a phenomenon appeared which is : the first tasks of AI were difficult for humans but easy for AI systems to handle like complex computing processes on other hand it is difficult for computers to cope with tasks that is easy for human like object recognition , that human can easily differentiate between chair and table although both of them has 4 legs but AI we must introduce many photos to them to be able to differentiate .Never the less , this system is not yet recognize the actual meaning of the objects , like if we want it to differentiate between shepherd dog and wolf by introducing many photos to them but if we put the shepherd dog in same condition like wolf it will misled it like introducing shepherd in snow as the most photos are in snowy background and vice versa.

Contents of artificial intelligence and difference between them

There are main contents in Al:

(1) Neuronal networks
(2) Machine learning
(3) Deep learning

Brief description of neural network:

It is a system of hardware and software whose structure oriented towards human brain.

It works with large number of processors that work in parallel not via linear functions which is possible by linking the neurons and special processing functions, in this way even the most complex dependencies can be mapped.

The neural network consists of layers which are: (input layer - hidden layers1, 2, - output layer).

The input layer that's receives raw data (which is like optic nervous in human).

The hidden layers receive the output of the input layer and the previous hidden layers where no longer the data processed in, as each processing node has each knowledge area and this not only includes the original rules which it is programmed on but also the knowledge, rules and experiences that is developed in it and this is which called the machine learning.

Machine learning:

The machine increasingly emancipates itself from original inputs during its use, by aid of AI it tries to develop and learn independently in order to achieve better results on the basis of gained experience.

The algorithms used initially only represent the breeding ground for development of new algorithms, if new algorithms proved to be more accurate the machine continues to work with independently.

We will now be going to talk about deep learning:

It is a special design of neural networks and subset of machine learning, it can process a wider range of data resources, requires fewer human data preprocessing and often deliver more accurate results.

The deep refers to large number of layers of neural networks, special networks are set up for this purpose, which can receive very large number of input data and process them over several layers. In addition, special optimization methods are used which have an even more extensive internal structure than the classical one.

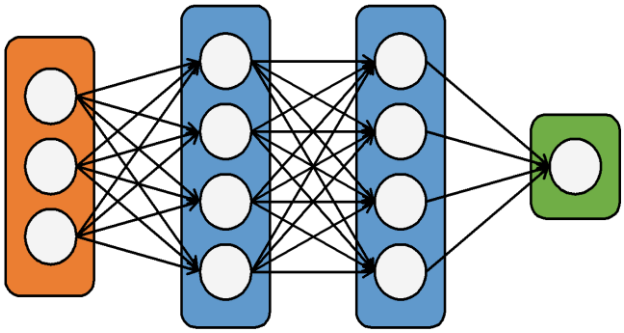


Fig.2 Contents of neural network [2]

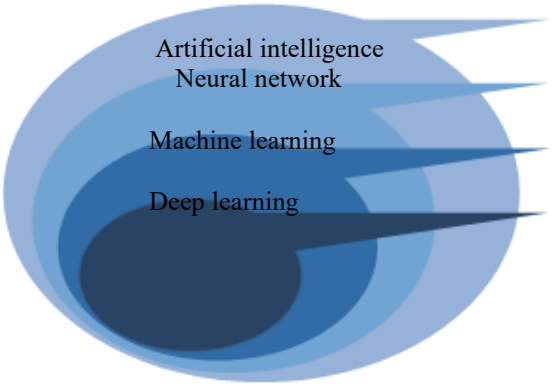


Fig.3 Contents of artificial intelligence [2]

Training of neural networks

In order to train neural networks, it is firstly fed with large amount of data. At same time, the network must be informed how the output should look like.

For example: to train network to identify the faces of well-known actors, the system has to process a variety of photos of actors, non-actors, masks, statues, animal faces and so on, each individual photo should described by a comment which accurately describe it, like the name of the actor or in other hand an indication that it is not an actor but it a mask or an animal.

By providing descriptive information, the model can adjust its internal weightings. Thus, it learns to continuously improve its working method. For example: node A, B, D can tell the node BB of the next layer that photo is for Daniel Craig. On contrary, node C thinks roger Moore that is on the photo as the person on photo is beside the Aston Martin used in James Bond movies.

If the training program confirms that photo is for Daniel Craig, the BB node will reduce the weight of node C and vice versa with A, B, D as their answer were correct.

III. Application of AI in Automobiles

A. Artificial intelligence in fields of mobility and transportation

First of all, we should say that AI will have a great role in this field to solve the problems in this field which are:

(1) Random usage of transportation infrastructure (roads-bridges sea links-.etc.)

(2) Congestion and traffic jams due to high no. of cars in cities and congestion of the means of transportation itself or high cost of equipping of means of transport

(3) Continuous increasing in usage of energy resources for transportation

(4) Massively high emissions from means of transport

It offers for us the autonomous driving cars which act as game changer and have lasting better influence in the future and today among this field.

Business insiders' estimates predict 10 million autonomously driving cars by 2020.

As this AI application widely spreads transportation as a service and mobility as a service offering will also increases.

We are now using a personal car for everything and for many different tasks but in the future we will we will get a specific vehicle when we need it and only when we need it.

The developments of autonomous vehicles passing with several stages:

(1) Drivers only: only warning function is used when the car is leaving lane – blind spot is monitored – when approaching to a wall - …etc.

(2) Assisted driving: a parking steering assistant or lane keeping assistant support the driver

(3) Semi-automated driving: in certain cases, assistants are used to act independently (when parking or traffic jams supports)

(4) Highly automated driving: autonomous driving in motorway and possible following traffic jams independently.

(5) Fully automated driving: autonomous driving in the city and free parking are possible

Autonomously operating vehicles can achieve an intelligent link between different vehicles in use and this contributes in optimizing the customer experience through autonomous driving by predicting the arrival times accurately and developing voice control.

And we can take the door dash company as a perfect example for autonomous vehicles.

They are trying to shorten the delivery times by supplying its customers with foods from restaurants using autonomously driving robots and the deliveries were tested using robots all over cities in USA.

Based on initial experience, the door dash delivery platform was integrated directly on the robot's software with the relevant order information.

The robot called marble can now also deliver multiple orders over short distances.

Applications of artificial intelligence in the design of vehicles for the stage subjected to crashworthiness [5]

Undoubtedly that vehicle industry now gives a great care to reduce the vehicle weight in order to improve fuel economy, reduce emissions and increase vehicle speed and maneuverability.

Great effort exerted in material science to discover new materials instead of conventional steel with lighter aluminum structure that also has a great effect to improve the behavior of the vehicle during crashes.

Automakers can discover the effect of material selection on the crashworthiness using computer simulation.

And here the role of AI bright which can extract the knowledge and the vast amount of data faster than extracting it manually from the simulation not only that but also more convenient for designers and engineers.

In addition, no one can deny that the safety of the passengers is the first thing to take into consideration while converting to new generation of light weighting vehicles.

So, in the event of vehicle collision a crash pulse is generated and propagates through the vehicle, the shape and intensity of the crash pulse wave transmitted to the passenger is directly correlates to the like lines of the severe injury.

The transmission of crash pulse wave can be mitigated through the systematic interaction between all vehicle components dissipating the energy through deformation of the structure.

The automakers now want to know how these innovative light weights will affect the complete vehicle response during collision, they now depend on numerical tools such as: finite element analysis to perform virtual analysis of vehicles that is subjected to various scenarios of crashes before prototyping and production stage.

Here we can see the AI playing an important rule such that artificial neural networks are used to predict the relationship between vehicle mass and thickness using an advanced type of recurrent neural network called long-short term memory neural network is used to predict the crash pulse response on an occupant during the impact faster and easier than conventional finite element methods.

The proposed framework follows the method of virtual design of experiments through the use of finite element (FE) simulations to improve vehicle safety while reducing vehicle mass.

The procedure of the framework is summarized as follows:

1. Problem definition: Generate a finite element model of the problem of interest. Define the input parameters/variables and the output response.

2. Sampling of problem domain: Select combinations of input parameters that are statistically representative of the entire domain of interest and simulate their response.

3. Define AI system: Create an AI architecture that maps the input parameters to the desired output response.

4. Training of AI system: Select data from the sample set to calibrate the AI system. This step is often conducted in conjunction with Step 3 to select an architecture that accurately captures the system response iteratively.

5. Prediction of AI system: Use remaining data for prediction with the AI system. This serves as a blind test and evaluates the ability of the AI system to generalize the problem.

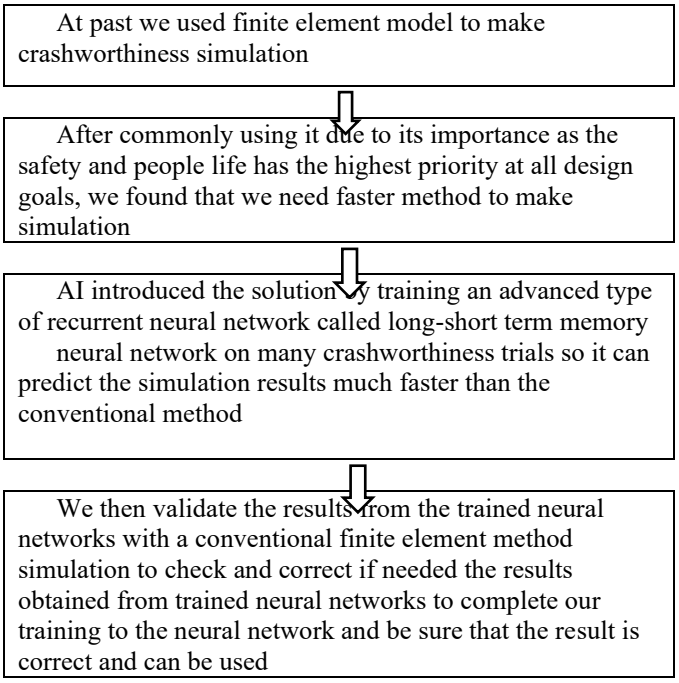
So, we can know that the representation of mass can be directly computed by CAD model and related to the changes in geometric parameters. If CAD model is not available, the mass of vehicle can still be computed through the constructed finite element model.

The crash pulse response that experienced through vehicle occupant is the result of highly non-linear interaction of the various components and structures during deformation.

This deformation is governed by mechanics and physics of solids, which can be determined through a series of partial differential equations.

Fundamentally this response can then be represented by a transfer function, $\sum$ that relates the time series O/P response y (t), (i.e. the crash pulse response) to a time series of me /P X (t) and their corresponding history.

In this application, transfer function is a single mathematical model that describes the deformation behavior of full vehicle in crash worthiness scenario to predict the crash pulse response. Although the time series response can be represented by series of artificial neural network for each increment [6], this would require a no. of artificial neural network and the necessary parameters to be identified



IV. Conclusion

The objective of this paper is to know more about artificial intelligence, its contents, and difference between them, what we can do by using artificial intelligence in all fields especially in automotive field, the capabilities of artificial intelligence and how it improves and make our life easier.

References

[1] www. statista.com (2018)

[2] Understanding Artificial Intelligence Fundamentals, Use Cases and Methods for a Corporate AI Journey 2020

[3] McKinsey (2016, p.8)

[4] Using Artificial Intelligence to Aid Vehicle Light weighting in Crashworthiness with Aluminum (a paper in MATEC Web of Conferences 326, 01006 (2020))

[5] L. Lanzi, C. Bisagni, S. Ricci, Comput Struct 82(1),93-108 (2004).