

ARTIFICIAL INTELLIGENCE IN ELECTRIC CARS (PAST, PRESENT AND FUTURE) SURVEY PAPER

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Abstract: In this research, we answered the questions like "What is A.I. ?", "Why Electric cars were overshadowed by motor cars ?", "How A.I. upgraded Electric cars ?", "What was the common public opinion on smart cars ?", "Pros and cons of smart cars". When we think A.I. in automotive industry, the first thing which comes to our mind is driver less cars. Though people trust A.I. in assisted driving cars, they would hesitate to buy a complete smart car without a driver or a manual control in it. Electric cars are gaining importance in terms of environment and budget, adding A.I. in it will escalate the user experience and strengthens the function performed on and by smart cars.

I. INTRODUCTION

A. Artificial Intelligence (AI) [1]

It is now a well-known term and within the last decade has proven increasingly useful across a wide range of fields including healthcare and health research. But what exactly is AI? Described as **'the thinking machine'** in 1956, the definition we adopt here is that AI is a system giving a practical solution to a problem that currently needs human intelligence to solve.

AI gives practical solutions to problems requiring **HUMAN INTELLIGENCE** to solve. It's demonstrable performance in delivering solutions that rival the performance of human specialists. It succeeds in delivering algorithms and programs that human experts could never produce, or could only produce with a lot of difficulty, time and expenditure.

According to Stamford's 2019 CIO survey of more than 3,000 executives in 89 countries, AI implementations have grown by a staggering 270% in the past four years, and a staggering 37% in the past year alone.

Eg:

- Apple's face ID technology
- Google Assistant, Alexa, Siri
- Facebook, Netflix, You tube

B. STATISTICS OF ARTIFICIAL INTELLIGENCE[2]

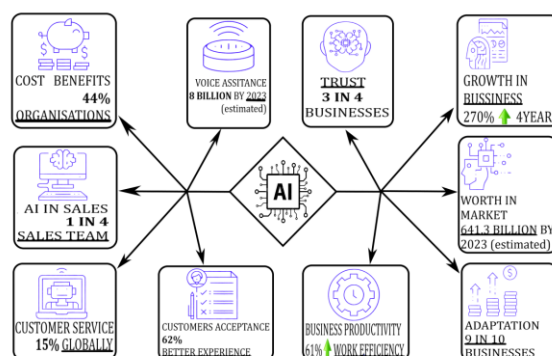


Fig. 1 Statistics of AI

C. Electric cars [3]

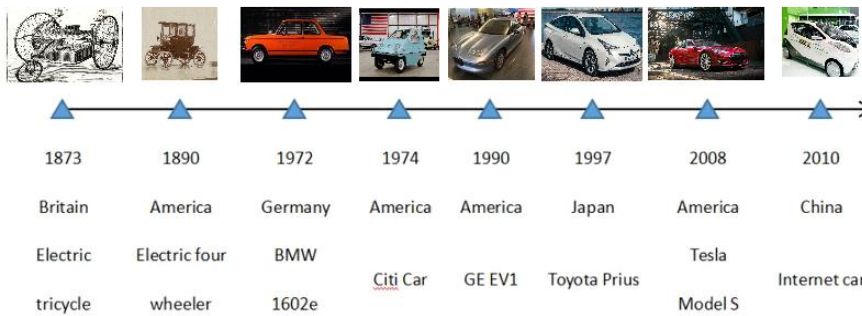
Electric cars work by plugging into a charging station and drawing power from the grid. They store electricity in rechargeable batteries that power the electric motors that drive the wheels. Electric cars feel lighter because they accelerate

faster than vehicles with conventional gasoline engines. A battery is a workshop tool that stores chemical energy for later conversion to electrical energy. Each battery contains one or more electrochemical cells. Chemical reactions take place in these cells, creating a circulating flow of electrons.

EVs are vehicles that are either partially or fully powered on electric power. Electric vehicles have low running costs as they have less moving parts for maintaining and also very environmentally friendly as they use little or no fossil fuels (petrol or diesel). It can be charged by common household electricity. High-voltage electric cars with battery capacities between 30-80kWh, high-power DC charging of 50kW is used.

The major benefit of electric cars is the contribution that they can make towards improving air quality in towns and cities. With no tailpipe, pure electric cars produce no carbon dioxide emissions when driving. This reduces air pollution considerably. One of its most important features is a quiet electric motor that makes it a great tool for reducing noise pollution in cities.

II. EVOLUTION OF ELECTRIC CARS



The cars were first designed to please King Philip in France. These were designed for racing purpose. It then looked like a carriage. Then the seating arrangements were given in it, so that the drivers can enjoy the race. The speed these cars had was not satisfying. Now, they thought of adding power to it. They used both Internal combustion engines and electric engines as the source of their power supply to the cars. Though the motor cars and electric cars were invented almost at the same time, due to some drawbacks the electric cars were overshadowed by motor cars i.e the Internal Combustion Engine. Later, in 1972, almost after 88 years, the use of electric cars is increasing as we come across the problems like environmental pollution and depletion of oil reserves world wide. In the current scenario there is no much difference in the motor cars and electric cars from the consumer point of view. Thus, there is a huge scope for electric cars in the coming future. As we can see here, the electric cars are upgraded and launched in the market regularly due to its increase in demand of consumers.

III. DRAWBACKS OF 1st AGE ELECTRIC CARS [3]



A. **EXPENSIVE** as a luxury.

The electric cars were twice the price of other vehicles. Thus, people choose motor cars over electric cars. They had an alternate in cheaper price so buying a electric car with double of its price was only afforded by the privileged society.

B. **SLOW** compared to gasoline and Internal Combustion Engine (ICE).

It had less speed compared to the other two engines.

C. **NOT RECHARGABLE** the battery could be used only once.

The 1st generation electric car batteries were not chargeable. It could be used only once.

D. **NOT REUSABLE** the exhausted batteries had to be thrown.

As I said the batteries of 1st age electric cars could not be recharged. Thus, it had to be thrown. It was not reuse able so the maintenance of electric cars was also expensive.

E. **BATTERY CHARGING** time was too long.

Even when the rechargeable batteries came in the market, the period taken to recharge a battery was too long. However, people might have felt adding fuel to engine is easier and faster than waiting for the electric motors to charge.

IV. AI IN ELECTRIC CARS[4]

A. **REALISTIC DRIVING** range estimation.

Artificial intelligence (AI) algorithms and controllers can provide a realistic driving-range estimation and optimize energy conservation, which can add extra driving range and reduce consumer “range anxiety.” Access to charging stations and the smart grid can significantly improve the consumer appeal of electric vehicles.

B. **Optimize ENERGY CONSERVATION:**

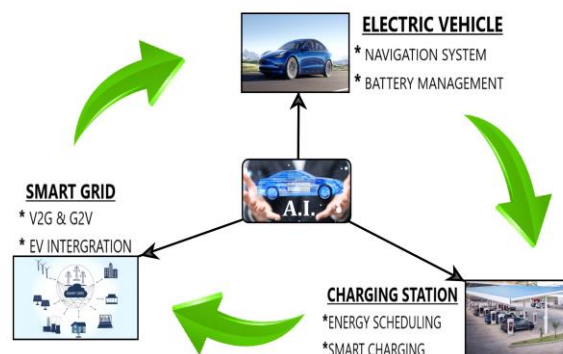
As already said the 1st age batteries were not rechargeable but the electric cars we have now don't just have evolved battery cells but also its easy charging and establishment of charging stations have given it a new standard of transportation.

C. **AI has improved the INFRASTRUCTURE** of electric cars:

AI has improved the infrastructure of electric cars with its battery designs, charging stations, management and even the smart grid. With these developments AI has a great impact on electric vehicles.

- Battery Designs
- Charging Stations
- Management
- Smart Grid

V. USE OF A.I. IN ELECTRIC CARS[4]



A. **ELECTRIC VEHICLE :**

A. I. helps in battery management, navigation of routes, sensors, music control etc.

B. CHARGING STATION :

The use of A.I. has elevated energy scheduling which has updated smart charging and the charging system of electric cars.

C. SMART GRID:

Application of A.I. in Smart Grid provides strong technical support for digital power grid. AI can help save battery energy through Electric Vehicle integration, Vehicle-to-Grid and Grid-to-Vehicle concepts.

VI. CASE STUDY [5]

The ONLINE interview was conducted in September 2020 to January 2021 with 16 members in Switzerland. At the time of the interview, the first author was a PhD student at the Institute for Bioethics and Medical Ethics at the University of Basel. After completing the initial pilot interviews, the research team read the transcripts, discussed the results, and ensured high-quality data collection. Prior Written consent was obtained from all participants before the start of the interview, interviewers briefly explained the purpose of the study, their role in the project, the confidentiality of the interview, and participants were given space to ask questions.

Interviews lasted 40-60 minutes and were conducted in German or English. This allowed participants to choose their preferred language, which improved the quality of the data. All interviews were taped and transcribed verbatim to allow for qualitative analysis. Transcripts were sent to participants upon request for review. Transcripts were then transferred to the qualitative analysis software MaxQDA to support the analytical process. The German text was translated into English by the first author and checked by the last author.

A. DATA ANALYSIS:

Applied thematic reviews were used for data analysis. The aim of this method is to analyze and highlight thematic elements and patterns within the data, to organize, describe and interpret the data set in detail (Braun and Clarke, 2006). Therefore, the transcripts were read in full length and independently analyzed by two of members of the research group. This first step of analysis consisted of open coding to explore the thematic elements in the interviews. Later, the members of the team met to explore and discuss the independent open-ended coding, merge the codes into a combined coding-tree, and sort the identified topics.

B. RESULTS

During the interview, the participants were asked to define their opinion about a self-driving/smart vehicle in their own words, including the basic properties of a car. Analysis of how the participants would define a self-driving car revealed three thematic clusters: the level of self-automation smart cars were seen as having, the pros and cons of smart cars, and the issue of whether smart cars were or could be 'better than human'.

The interview was conducted based on STANDARDS designed by SOCIETY OF AUTOMOTIVE ENGINEERS (SAE). The majority defined such cars as some kind of driving assistance function. The participant defined his three levels: 1) fully autonomous vehicles (SAE levels 4-5), 2) assisted driving (SAE levels 1-3), and 3) impossible.

VII. SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) TABLE [5]

SAE-Level	Description	Driver input
0 No-Automatization	Zero. autonomy the driver performs all driving tasks	
1 Driver Assistance	Vehicle is controlled by the driver but some driving assist features may be included in the vehicle design (Cruise Control)	Attention required
2 Partial Automation	Vehicle has combined automated functions, like acceleration and steering, but the driver must be ready to take control of the vehicle at all times if alerted (Lane Assist)	
3 Conditional Automation	Driver is a necessity but not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	
4 High Automation	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	No Attention required
5 Full automation	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.	

- Level 0 is NO AUTOMATIZATION where driver is performing all the tasks and there is no A.I. involved. Its just a manual driving car.
- Level 1 talks about DRIVER ASSISTANCE where some of the tasks are done by A.I. like navigation or detecting a door is open etc. The control is still there in with the driver.
- In Level 2 PARTIAL AUTOMATIZATION starts. This level is designed considering the cars which has automation in steering wheel. Meaning that the driver can put the car into auto-drive mode but should be ready to take charge in case of emergency. These 3 levels need driver attention i.e the driver must be alert in the driving period. Next we talk about the levels which do not need driver attention.
- In Level 3 CONDITIONAL AUTOMATION, the driver is obligated to monitor the surroundings, but is not obligated to steer. The driver must be in control of the vehicle at all times.
- In Level 4 HIGH AUTOMATION LEVEL allows the vehicle to perform all functions under certain conditions. Drivers may have the option to steer the vehicle.
- In Level 5 FULL AUTOMATION allows the vehicle to perform all functions in all situations. A driver may have the ability to control the vehicle. Levels 4 and 5 are not yet available, but the organization is working on them.

VIII. OPINION OF THE PUBLIC

It was defined by the participants/interviewees.

- Assisted driving (level 1- 3)
- Completely self-driving cars (level 4 -5)
- Not Possible (level 0)

A. Assisted Driving :

An amount of people feel safe to have control over the car. In case of accidents there might be situations where the machine can take wrong decisions. As we use Convolution neural networks (CNN) technology in cars to recognize and process the images. This technology works on pixels. Sometimes it can happen that the machine can misinterpret an object with human and vice versa. This can lead to accidents. In such situations human would like to take charge to escape the situation. This makes some people feel not dependable on technology.

Assisted driving cars have automation button so that the driver can anytime override the control or even give control to the car. With this point, we also know that the self-drive mode is technology based and major drawback of this technology is hacking. In any case if the car is hacked the control goes to the hacker which is harmful. Having an automation button will give back the control to the driver in car. Also, some people would like to use assisted driving cars as they are open to use technology but do not want to completely depend on it and there is a major crowd which is passionate about driving cars. They want to have control over the steering wheel.

B. Completely self-driving :

In this case people compared the automated cars with trains. As there is no one individually controlling the train, the automated cars would also be the same. These intelligent driver less cars would be possible only when the system is strongly integrated to make it accident free. Then the complete decision making is done by the car. Some of the interviewees also said that these cars can be only released on routes/lanes. People gave the opinion that this technology can be good in terms of public transport. The buses, taxis, trains can be replaced by them.

The automated cars can bring the scenario where people need not go to stations to catch a cab/taxi rather the taxis would come to them. Though nowadays we have online cab bookings and this point is similar to it. But the highlight is that the car is still in the control of the driver and the driver can choose whether to take you or not. Whereas the automated cars will be functioned to accept a task whenever it is idle. We can ride the car from our current location and travel to the desired destination. The automated cars will bring organization in traffic. When the majority or all the cars are automated then the cars will follow more traffic rules as they are programmed for it and there is no human intervention in it. In Japan, car accidents are reducing even with the high speed driving is because of their strict traffic lane. Similarly, the automated cars can bring down the accident rates over all.

The cars can be given a fixed traffic speed and lane pattern to follow. The cars can have good speed which must be fixed in all the cars, overtaking unnecessary lanes cannot be possible as it will follow the lane pattern in it. The over all accident rates will be decreased. The Transport efficiency will increase. It raises the question of ownership. In case there is any accident occurring then the question is "who takes the responsibility?" the creator or the consumer. This question is not yet solved that is why these fully automated cars are not in the picture yet.

C. Not possible :

After the interview, some of the interviewees had the opinion that complete automation of electric cars is not possible in the next 20 years. The interview was conducted in Switzerland from 2020 to 2021 "THE COVID" period. The same interviewee's opinion might be different today.

As there is a lot of digitization happening. The world is on the tip of our fingers. The Post Covid has given an echoing raise in IT. People are more dependent and have more trust in technology now. Thus, it cannot be said that fully-automated cars are not possible in future. In fact, this Automation is in very near future.

D. Better than human?:

Many participants agree that self-driving cars can accelerate decisions, because they have more data at their disposal or because they act on reason instead of intuition: man out of control, maybe he react too late in brake system, or the steering wheel moves, especially in the case of a deer accidents as an example. Then you often end up in jail because of your action and we can imagine that an AI will bring car into stationary state is much more objective. Does he have to make these decisions? by itself or must there be explicit rules? So I will trust the car. Really, I think you'll even have to slow down humans. That's why he can interfere and the vehicle can decide where it has control.

However, some may think critically. Some have pointed out that machines can make mistakes that humans do not. Like a plastic bag being mistaken for another object flying towards your car. Passengers in particular may be exposed to such miscalculated unnecessary risk. Another person pointed out that statistical models can be wrong in an individual case. Yes, this example we just mentioned that it is possible for these fact and statistically-based decisions to be better. We don't know yet if it will improve performance in individual cases. Then there is the minority who do poorly. This is often about feeding data to computers can lead to decisions that tend to produce the best results, However, this can lead to disastrous results in some cases.

IX. PROS AND CONS OF A.I. IN ELECTRIC CARS

A. PROS

- **Environment Friendly:**

As we have already talked about it earlier, the electric cars are eco-friendly as it doesn't use fuel so no carbon is emitted.

- **Journey Time Productivity. :**

If level 4 and level 5 cars become the reality then the user can use their journey time productively as they do not need to give any attention to the drive or environment.

- **Better Safety System. :**

With better sensors A.I. detects environment for any occurrence of accidents ,It acts accordingly like Airbags and apply breaks at the right moment ,sometimes also lock the car if required, etc...

- **Knows The Source And Destination:**

For now we manually apply the Navigation in our cars and as said in level 4 and 5 electric cars can have Auto Navigation and handle the routes by themselves for the consumers.

- **Requires Less Focus:**

The assisted cars for now requires less focus from the drivers ,which will be reduced in level 4 and level 5 of electric cars.

B. CONS

- **Drivers May Lose Jobs:**

As the use of AI based cars increases, self automation can lead to many drivers losing their jobs .



For example:

As many Taxi services are planning and working on the production of self automated driver-less cars.

- **Lack Of Trust On Machine:**

Consumer would rather trust a driver ,than a machine which can malfunction or make a wrong decision anytime though it can be efficient at times.

- **Passionate Drivers:**

Driving is not just a profession or necessity but passion to a lot of people , such type of people wouldn't depend on self automation in cars and would choose to have manual control in car.

- **Need More Trial And Error Before It Comes To Market:**

As complete automation is a work in progress, there is a lot of factors which needs to be included in the testing of such cars. Like an AI must be first made familiar to the driving environment and all the possible circumstances that may occur while driving.

- **Prone To Accidents:**

There is a chance that an AI can misread certain environments based on the database it has and can take wrong decisions, which may lead to unusual accidents.

X. CONCLUSION

After this research we can conclude that the smart cars can give good user experience. It is more environment friendly, With all the good point it has, there is still the issue of trust in general public. People would depend upon a driver who has the manual control of the car over a fully automated self-driving car. There is still a chance that people might choose a complete smart car if they can build trust in it and get comfortable to provide the control to the machine. Interview results shows people can define smart cars awareness in terms of level of automation and in relation to the perceived advantages and disadvantages of such vehicles.

Some of the public believe that Self-driving cars are better than humans, but they still want to be able to override or prevent certain decisions. Even if such a wish is unrealistic. Developing legislation and ethical principles governing the introduction and use of smart cars on our roads must ensure that take into account the wide diversity of public views and individual ethical considerations faith in this subject. It is not a reality now but an expected future in automotive industry. There are some questions yet to be answered like " will it be better than human or not ?" And " in case of any accident who is responsible ? manufacturer or consumer".

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