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Smart Cars

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ABSTRACT

Smart cars are a type of smart vehicles which are equipped with advanced technology that enables them to interact with their surroundings and make real-time decisions. Smart cars are designed to improve safety, reduce congestion, and increase mobility. The current evolving automotive landscape concept of a "smart vehicle" has transcended mere transportation. With the advancements in technology reshaping the way we perceive mobility, understanding the essence and significance of smart vehicles is paramount. Smart vehicles are the combination of cutting-edge technologies seamlessly integrated into modern transportation. From autonomous capabilities to sophisticated connectivity features, these vehicles define innovation. These vehicles make use of fancy technologies like the Internet of things (IoT), Artificial intelligence (AI), and high-tech sensors to make driving way better. The paper looks at the benefits, challenges, the futuristic prospects of smart cars globally for the use of humanity.

KEYWORDS: *Smart cars, smart vehicles, Internet of Things (IoT), Artificial Intelligence (AI), sensors, cameras, blockchain technology, Internet of Vehicles (IoV), Machine Learning (ML), computer vision, robotics*

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INTRODUCTION

The concept of a "smart car" or "smart vehicle" has drastically transformed the modern form of transportation, with the advancements in technology and innovation. Smart vehicles use a bunch of fancy technologies like the Internet of things (IoT), Artificial Intelligence (AI), and high-tech sensors to make driving way better. Smart vehicle utilizes technology to enhance safety, efficiency, connectivity, and an overall driving experience. The vehicles are equipped with sensors, cameras, and other advanced hardware that gather data about the vehicle's surroundings and internal systems, which is then processed by onboard computers using AI algorithms to make real-time decisions, such as adjusting the speed, steering, and braking [1].

HISTORY

The smart car's history began in the 1990s as collaboration between the Swiss watchmaker Swatch and Daimler-Benz. The goal was to create a compact, fuel-efficient car that was easy to park in urban areas.

Origins:

- 1972: Mercedes-Benz developed a concept car in response to air pollution and city congestion.
- 1994: Swatch and Daimler-Benz began working on a compact, eco-friendly car.
- 1997: The Smart City-Coupe prototype was developed.

Development:

- 1998: The smart ForTwo went into mass production and became an instant hit
- 2019: Smart became the first car manufacturer to transition from internal combustion engine vehicles to BEVs (Battery Electric Vehicles).

Features: Their features are that they have:-

- Compact size: The smart fortwo is known for its small size and distinctive design.
- Fuel efficiency: The smart fortwo is known for its impressive fuel efficiency.
- Maneuverability: The smart fortwo is known for its small turning radius.

- Technology: Smart vehicles use technologies like the Internet of Things (IoT), Artificial Intelligence (AI), and high-tech sensors.

Smart is a German automotive marque established in 1994. The Smart Automobile Co., Ltd. is a joint venture established by Mercedes-Benz AG and Zhejiang Geely Holden Group in 2019 and aimed at producing Smart-badged cars in China to be marketed globally. The venture is headquartered in Ningbo. The marque was originally known for producing microcars and subcompacts, primarily the Fortwo and Forfour, at Smartville in Hambach, Moselle, France and additionally at Renault's Revoz plant (Novo Mesto, Slovenia), as shown in Figures 1, 2, and 3. It also produces small battery vehicles at a manufacturing plant in China, with distribution, marketing and aftersales activities in Europe handled by Smart Europe GmbH, which is headquartered in Stuttgart, Germany [2].

The name "Smart" was derived from the cooperation of the Swiss company Swatch with Mercedes-Benz: "Swatch Mercedes ART" [3].

The design concept for the marque's automobiles began at Mercedes-Benz in the early 1970s to late 1980s. After brief backing by Volkswagen, the first model was released by Daimler-Benz in October 1998. Several variants on the original design have been introduced, with the original being the "City Coupe" that was renamed the "ForTwo." In late 1982, SMH (makers of the Swatch brand of watches) CEO Nicolas Hayek began developing an idea for a new car using the same type of manufacturing strategies and personalization features used to popularize Swatch watches. He believed that the automotive industry had ignored a sector of potential customers who wanted a small and stylish compact city car. This idea soon became known as the "Swatchmobile." Hayek's private company Hayek Engineering AG began designing the new car for SMH, with seating for two and a hybrid drivetrain [4]. The name Smart was coined by Manfred Gotta.

While the design of the car was proceeding, Hayek feared that existing manufacturers might be feeling threatened by the Swatchmobile, hence his preference for cooperation with another company in the automotive industry rather than directly competing. This would also relieve SMH of the cost burden in setting up a distribution network. Hayek approached several automotive manufacturers, and on 3 July 1991, he reached an agreement with Volkswagen to share development of the new project [5].

By 1993, Ferdinand Piech had become the CEO of Volkswagen, and he sought to immediately terminate the project with SMH. However, Volkswagen had been working on their own "three-litre car": a car that would consume three litres of fuel per 100 kilometres of driving (the eventual Volkswagen Lupo 3L). The concept by Volkswagen was believed to be a better business proposition, featuring four seats and more cargo room [6].

Hayek suspecting that Piech on his ascendancy to the CEO position would seek the end to the agreement with SMH, therefore discreetly began to approach other car companies with Swatchmobile project. He was rebuffed by BMW, Fiat, General Motors and Renault, but finally reached an informal agreement with Daimler-Benz AG, maker of Mercedes-Benz cars [7].

It was on the 4th of March 1994 at a press conference at Mercedes-Benz headquarters in Stuttgart, that the companies joined forces in founding Micro Compact Car AG (MCC), with 49% of the initial capital of 50 million Swiss frans was provided by SMH and the remaining 51% by Daimler-Benz. The company consisted of two subsidiaries: MCC GmbH based in Renningen (a suburb of Stuttgart), which would design the car, and the then unnamed manufacturing plant. SMH Auto SA, owned by Hayek, would design a hybrid electric drive system for the car, while Hayek Engineering would audit the design and manufacturing [8]. The press conference also featured the debut of two concept cars: the "eco-sprinter" and "eco-speedster", styled by Mercedes-Benz's design studio in California [9]. The cars were similar to the eventual Smart City-Coupe, as shown in Figures 4 and 5.

Pre-launch (1994-1997):

Three co-directors were immediately named to head the new company: designer and engineer Johann Tomforde, financial administrator Christoph Baubin from Daimler-Benz, and marketing manager Hans Jurg Schar, who spearheaded the original Swatch marketing campaigns in the mid-1980s. Tomforde had previously created concept sketches of an electric rear-engine, 2-seat, ultra-short economy car in 1972 [10, 11], which formed the basis for the 1981 Mercedes-Benz NAFA concept [12]. Tomforde had been working on the Mercedes City Car (coincidentally abbreviated MCC) project at Daimler-Benz since 1990, which produced the *eco-sprinter* and *eco-speedster* concepts, as well as the *Vision-A* concept, which eventually became the Mercedes-Benz A-Class [13]. A cause of controversy at MCC was the name of the car itself. Nicolas Hayek insisted it retain Swatch in some way: "Swatchmobile", or Swatch Car". Daimler-Benz refused and pushed for a neutral name [14]. The final selection was *Smart*, an

acronym that had been previously used internally by MCC for *S*watch *M*ercedes *Art*.

By May 1994, the co-directors had identified 74 potential sites for the assembly plant. The final site was announced on 20 December 1994: Hambach, France [15]. The purpose-built factory gained the nickname "Smartville." Tomforde in 1995, devised a modular system of assembly for the car, insisting that suppliers design and assemble and even install their own modules onto the final car at the new plant, using their own employees and thus reducing the overhead cost for the parent companies and divesting MCC of the financial and legal liabilities for those parts. A fiscal framework was also provided whereby MCC could share the development costs with the suppliers, rather than having to fund the entire project themselves [16]. MCC secured contracts with suppliers to design and supply almost all parts of the car: seats by Faurecia, interiors by VDO, chassis and door modules by Magna, door panels by Dynamit Nobel, and suspension by Krupp [17]. There was recapitalization by Daimler-Benz by increasing their share of ownership in the company to 81% by 1996 and while SMH had only 19% [18].

The assembly plant was opened on 27 October 1997, with a ceremonial ribbon-cutting by the then-French President Jacques Chirac and German Chancellor Helmut Kohl [19]. Due to the dynamic instability of the prototypes, this prompted Daimler-Benz to postpone the introduction of the new Smart City-Coupe that was earlier scheduled for March 1998 to October 1998. Johann Tomforde was replaced as chief engineer by Gerhard Fritz [20]. Fritz lowered the centre of gravity, widened the track, stiffened the suspension, changed the steering, and added ballast weight to the front of the car in order to increase its stability in emergency avoidance manoeuvres (notably the Swedish "moose test") [21]. The car was successfully launched in nine European countries in October 1998, which did not fulfill Hayek's expectations, and shortly afterwards Daimler-Benz bought out SMH's remaining stake in the company [22]. MCC was now a wholly owned subsidiary of Daimler-Benz (which merged with Chrysler Corporation to become DaimlerChrysler). On 1 January 1999, MCC GmbH changed its name to *MCC smart GmbH*, and by 2000 it became known as *smart GmbH* [23].

Expansion (1998-2019):

The model line was subsequently expanded to include the rear-engine, rear-drive Roadster and a four-door, four-seat supermini aptly named Forfour (the original City-Coupe was renamed Fortwo to fit the new naming scheme). The expansion did not increase profits at the company; Smart GmbH lost nearly four billion euros from 2003 to 2006 [24].

There were plans to increase the company's profitability and integrate its operations with Daimler (at the time DaimlerChrysler). In 2005, Daimler decided against purchasing a 50% share in the Dutch NedCar plant used to manufacture the ForFour, ending its production. A planned SUV called Formore was terminated as the assembly plant in Brazil was being fitted with machines, and the production of the Roadster was discontinued. While in 2006, after the dwindling sales and heavy financial losses, Smart GmbH was liquidated and its operations were absorbed by DaimlerChrysler directly. Until April 2019, Smart operated under the Mercedes-Benz Cars division of Daimler AG, offering the Fortwo Coupe, Fortwo convertible and Forfour hatchback [25].

Geely partnership:

In 2019, Daimler announced the establishment of a joint venture partnership with Chinese automaker Geely [26]. The deal, worth a total of 5.4 RMB (about $830m USD) [27], which involves a new production plant to be built in China, and will start production on a new generation of Smart-branded vehicles. The first concept of this partnership was called Concept #1 in 2021, and was unveiled at the Munich Motor Show. The concept vehicle was built on Geely's SEA platform and features design details of existing Smart models, including a panoramic glass roof, frameless suicide-style rear doors, and a large 12.8-inch (33 cm) touchscreen infotainment system [28], as shown in Figures 6, 7 and 8.

SMART CAR ADVANTAGES

In considering buying a smart car, one needs to look at reliability and inevitability, whether the vehicle is worth it or not, and as well as the pros and cons of the brand. Some of the good features of smart cars are for the driver and others for the world around them. Some of these advantages are:

- Compact size: The size makes it easy and simple to navigate traffic, fit in a parking spot, or slide into a packed garage.
- Environmentally friendly: They use less gas and have fewer transmissions, much better for the environment.
- Less room in your garage: it takes up less room/space in your garage, allowing for additional walking and storage space.
- Reduced noise: They are small and quite on the road. No disturbance to neighbors.
- They have an excellent engineering structure.

- Smart cars receive a 4/5 in reliability, putting it at 10th compared to 32 other car brands. It has an 8% probability of the necessary repair being severe, and users will take their Smart car to the repair shop an average of 0.3 times a year.

SMART CAR DISADVANTAGES

Every vehicle with advantages also comes with disadvantages so as to make the right choice for our lives. Some of these disadvantages are:

- Size: The size is a bad thing for some people. Many people or things cannot fit inside the car, hence making driving much less efficient/comfortable.
- Safety: Smart cars are not as safe as other options. Getting involved in an accident or crash can lead to serious hurt/injuries [2].
- Appearance: To some people smart cars look ridiculous, as they are not classy.
- Storage: There is less room in a Smart car to fit luggage and other items (i.e. has lower storage space), making trips less efficient.

Some other common troubles with Smart cars are also:

- Suspension issues
- Clutch/malfunction failure
- Electrical failures
- Transmission/gearbox issues
- Engine problems

These could force users to pay for expensive repairs in the car's system, particularly on the Fortwo model of the Smart car, sold in massive quantities in the United States [29, 30].

SMART IN-CAR AI

Smart, the premium intelligent all-electric automobile brand has released the details of the Concept #5, built to empower users to explore the outdoors with confidence, style and unparalleled comfort. The Concept #5 is the most intelligent smart car yet. Showcasing a visually stunning interior, cockpit and vehicle interface, the high-tech vehicle also features state-of-the-art generative AI, powering a next-generation in-car assistant. In cooperation with Cerence, the state-of-the-art generative AI will enable drivers and passengers to engage the in-car assistant in fun and conversational chit-chat, leveraging a multitude of sources, to provide accurate and relevant responses to nearly every query imaginable. The highly anticipated Concept #5 will celebrate its world premiere at the Beijing International Automotive Exhibition on April 25 [31].

SMART CARS AND BLOCKCHAINS

The face of motoring is being altered by a diverse array of emerging technologies, as blockchain is joining the likes of the Internet, AI, ML and Robotics in powering the future of transportation by pushing the boundaries in terms of versatility, cost-reduction and autonomy, while introducing unparalleled levels of transparency, trust and security. This new era of digitalization is transforming how vehicles interact with each other and their environment, and can also be used to store and share data securely. Completely autonomous vehicles that can refuel, recharge, and park on their own, even pay for these services are on the horizon. The concept of smart cars, however, goes beyond autopilot. Today's cars are reliant on hardware and software to function, but the cars of tomorrow will equally be reliant on connected infrastructure, where technologies such as AI and smart connectivity will enable car owners to communicate with their vehicles and access information and services.

The blockchain technology is to precisely tackle the anticipated potential for fraud, downtime and mistrust where there is information recording and exchange cum astounding or massive amount of data generated globally. The decentralized nature of certain Distributed Ledger Technologies is ideal for recording and sharing data without the presence of a middle man. For car manufacturers/carmakers the impact of blockchain is not just limited to one or two processes, but touches on each and every interaction in the automobile ecosystem. Some of the ways the Smart Cars of the future will benefit from blockchain technology are: communication, sensor data, Smart contracts and automation, data storage, data sharing, payment systems, fleet management, and security/cryptograhy [32, 33].

With the application of IoT, the Internet of Vehicles (IoV) has become a proven technology with the development of Smart Vehicle, Artificial Intelligence (AI), Cloud Computing, 5th generation mobile networks (5G), 6th generation mobile networks (6G) communications technology. The IoV does not only connect Vehicle to Vehicle (V2V), but also connects Vehicle to Pedestrian (V2P), Vehicle to Road (V2R), Vehicle to Infrastructure (V2I), Vehicle to Network (V2N), and Vehicle to Cloud (V2C) to a network seamlessly and efficiently, on which data sharing is based. So IoV can also be called V2X (where X stands for everything).

Furthermore, IoV can also achieve the purpose of saving resources, green travel, economical and environmentally friendly. IoV perfectly intelligently interacts with vehicle and makes full use of resources

to achieve effective Human-Vehicle-Road collaboration. High-speed moving vehicles make it more difficult to achieve IoV. Therefore, how to establish a dynamic, fast and efficient connection between high-speed moving vehicles and transfer data safely is an urgent problem for IoV. Due to existing technical challenges such as communication security, network complexity and device heterogeneity, IoV needs a decentralized, distributed, low latency data security and heterogeneous network construction to enhance the implementation of IoV. To help solve the above problems safely and efficiently, researchers are proposing introducing blockchains into IoV [34-36].

MACHINE LEARNING FOR OBJECT DETECTION

The most critical aspect of self-driving cars (autonomous cars) is their ability to "see" the world around them. This is achieved through the use of various sensors like cameras, LiDAR (Light Detection and Ranging), and radar to perceive their environment. It is the Machine Learning algorithms that make sense of this data. Machine Learning (ML) enables self-driving cars to recognize and understand objects on the road e. g. pedestrians, other vehicles, road signs, and even animals. This is done through a process called object detection, where the system is trained to recognize specific patterns and shapes [37]. Machine learning is a key technology in smart cars, allowing them to interpret their surroundings, make decisions, and improve safety. ML is used to create self-driving cars, and it also powers other smart cars features like driver assistance systems and personalized voice assistants. ML works in smart cars via data collection, data interpretation, decision making and learning.

The type of ML commonly used to train autonomous cars to drive is deep learning, specifically through the utilization of deep neural networks, such as convolutional neural networks (CNNs), which are effective in processing and analyzing large amounts of sensory data, such as images from cameras and point clouds from LiDAR sensors. Autonomous vehicles utilize AI technologies, such as ML, computer vision, and robotics, to enable cars to operate without direct human control. These AI systems analyze sensor data, make decisions based on environmental conditions, and navigate roads autonomously. Therefore, self-driving cars are a prime example of the application of AI in the field of transportation and mobility [38], as shown in 9, 10 and 11.

Machine learning algorithms can be loosely divided into four categories i.e.

- Regression algorithms
- Pattern recognition
- Cluster algorithms
- Decision matrix algorithms.

The type of regression algorithms that can be used for self-driving cars are [38]:

- A Bayesian regression
- Neural network regression
- Decision forest regression.

CONCLUSION

Smart vehicles epitomize the fusion of automotive excellence with digital innovation, poised to revolutionize our driving experiences and notions of mobility. Technological advancements promise to deliver transportation solutions that are safer, more efficient, and environmentally friendly as a result of the alternative to fossil fuel-driven engines. They also feature sophisticated energy management systems and regenerative braking mechanisms that enhance battery efficiency and environmental sustainable. Safety and security aimed at drastic reduction of traffic accidents via advanced driver-assistance systems (ADAS) cum stringent cybersecurity protocols to safeguard user data and privacy from digital vulnerabilities. Regardless of the obstacles towards the attainment of and intelligent transportation ecosystem, the ultimate goal remains a transformative global impact.

More information about smart cars can be found in the books [39, 40].

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Figure 1. Smart ForTwo

Source:https://en.wikipedia.org/wiki/Smart_Fortwo

Figure 2. Smart (marque)

Source:https://www.google.com/search?sca_esv=c05c11496cd8066e&sxsrf=AHTn8zqcDrwKYW2FFHdr9LCaXWquhO68w:1739269223363&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcxArq68_wc6NXOnGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwiJtOjhsruLAxX9ENAFHY9OJXMQtKgLegQIEBAB&biw=1036&bih=539&dpr=1#vhid=BRtWlEwbmhSEgM&vssid=mosaic

Figure 3. Smart ForFour

Source:https://www.google.com/search?sca_esv=c8c50fbbd33c26eb&sxsrf=AHTn8zq0hswIL1AzSeSfqWsM5n4ABgCoA:1739327126603&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcx-Arq68_wc6NXO-nGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwis5Z28ir2LAxXHQkEAHd68PPcQtKgLegQIDxAB&biw=1036&bih=539&dpr=1#vhid=tc4bekbi_dgUjM&vssid=mosaic

Figure 4. Smart fortwo electric drive Generation lll

Source:https://www.google.com/search?sca_esv=c05c11496cd8066e&sxsrf=AHTn8zqcDrwKYW2FFHdr9LCaXWquhO68w:1739269223363&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcx-Arq68_wc6NXO-nGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwiJtOjhsruLAxX9ENAFHY9OJXMQtKgLegQIEBAB&biw=1036&bih=539&dpr=1#vhid=nTPc58hSZQPthM&vssid=mosaicr

Figure 5. Mercedes Smart Car

Source:https://commons.wikimedia.org/wiki/File:Mercedes_Smart_Car_%286255871754%29.jpg

Figure 6. Smart Roadster

Source:https://www.google.com/search?sca_esv=c05c11496cd8066e&sxsrf=AHTn8zqcDrwKYW2FFHdr9LCaXWquhO68w:1739269223363&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcx-Arq68_wc6NXO-nGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwiJtOjhsruLAxX9ENAFHY9OJXMQtKgLegQIEBAB&biw=1036&bih=539&dpr=1#vhid=lQwDltSx3H-fVM&vssid=mosaic

Figure 7. Smart-1st-Generation.jpg

Source:https://www.google.com/search?q=images+on+smart+cars+coupe+by+wikipedia&sca_esv=c8c50fbbd33c26eb&udm=2&biw=1036&bih=539&sxsrf=AHTn8zp6TB6f5cOQ7P3PEJe4Zp0h_fuhUg%3A1739327151243&ei=rwasZ7fGDtCshbIP9Y-G-Ag&ved=0ahUKEwj32f3Hir2LAxVQVkEAHfWHAY8Q4dUDCBE&oq=images+on+smart+cars+coupe+by+wikipedia&gs_lp=EgNpbWciJ2ltYWdlcyBvbiBzbWFydCBjYXJzIGNvdXBlIGJ5IHdpa2lwZWRpYUjbfFCBCVilLnABeACQAQCYAcsCoAH5C6oBBTItNS4xuAEMyAEAAEBmAICoALxAcICBBAjGCeYAwClBgGSBwUxLjAuMaAH8wM&sclient=img#vhid=5HiqkuCdCMCntM&vssid=mosaic

Figure 8. Smart 1

Source:https://www.google.com/search?sca_esv=c8c50fbbd33c26eb&sxsrf=AHTn8zq0hswIL1AzSeSfqWsM5n4ABgCoA:1739327126603&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcxArq68_wc6NXOnGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwis5Z28ir2LAxXHQkEAHd68PPcQtKgLegQIDxAB&biw=1036&bih=539&dpr=1#vhid=KM3oxN1kZeZ5iM&vssid=mosaic

Figure 9. Urban Smart Car PNG

Source:https://www.google.com/search?sca_esv=c05c11496cd8066e&sxsrf=AHTn8zqcDrwKYW2FFHdr9LCaXWquhO68w:1739269223363&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpAdk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcx-Arq68_wc6NXO-nGlA3Ez9ZCbRp2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08kP2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwiJtOjhsruLAxX9ENAFHY9OJXMQtKgLegQIEBAB&biw=1036&bih=539&dpr=1#vhid=wUdmI2XWOQP6sM&vssid=mosaic

Figure 10. Smart Key

Source:https://www.google.com/search?sca_esv=ec4e1a3f479b83b9&sxsrf=AHTn8zo7U6FDZf5EsITwNv9arn0Kf3pmPw:1739271262070&q=images+on+smart+cars+by+wikipedia&udm=2&fbs=ABzOT_CWdhQLP1FcmU5B0fn3xuWpA-dk4wpBWOGsoR7DG5zJBr1qLlHFB6ZBcx-Arq68_wc6NXO-nGlA3Ez9ZCbR-p2q5Xyuflpa2GIzOHuZ2yzzMHg4BFls1Q1XqBjTzV74o4K81DBjBKhJ6GtbuuAtdtv4gK08k-P2cI91gduUJ3HOw0B6Wx7tgJmBNgQn2ChU7QvJCHiM&sa=X&ved=2ahUKEwi4qPmturuLAxVhLdAFHTn0DjQQtKgLegQIEBAB&biw=1036&bih=539&dpr=1#vhid=YrPo72w2RvOhmM&vssid=mosaic

Figure 11. Smart 3

Source:https://www.google.com/search?q=images+on+smart+cars+coupe+by+wikipedia&sca_esv=c8c50fbbd33c26eb&udm=2&biw=1036&bih=539&sxsrf=AHTn8zp6TB6f5cOQ7P3PEJe4Zp0h_fuhUg%3A1739327151243&ei=rwasZ7fGDtCshbIP9Y-G-Ag&ved=0ahUKEwj32f3Hir2LAxVQVkEAHfWHAY8Q4dUDCBE&oq=images+on+smart+cars+coupe+by+wikipedia&gs_lp=EgNpbWciJ2ltYWdlcyBvbiBzbWFydCBjYXJzIGNvdXBlIGJ5IHdpa2lwZWRpYUjbfFCBCVilLnABeACQAQCYAcsCoAH5C6oBBTItNS4xuAEMyAEAAEBmAICoALxAcICBBAjGCeYAwCIBgGSBwUxLjAuMaAH8wM&sclient=img#vhid=13qKEwyLcJdNM&vssid=mosaic