

FLYING CAR RELATED TECHNOLOGY TRENDS

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ABSTRACT

Flying vehicle-related technology development is progressing rapidly. As autonomous vehicles begin to be commercialized, interest in the development of flying vehicle technology is increasing. Recently, some countries have launched services that utilize flying car technology along with self-driving cars. The automobile industry is undergoing rapid change by combining IT technology with automobile technology. The center of this change is the flying car-related technology that will be integrated onto the car of the future. Flying vehicle technology will be combined with autonomous vehicle technology to develop into a tool for more convenient human life. This paper examines the trend of flying automobile technology in relation to the flow of automobile technology.

Keywords: Flying Car, VTOL, Flying Car Technology Trend, PAV.

1. INTRODUCTION

The era of self-driving cars, where cars come to pick up people and take them to their destinations, is approaching. A number of automobile companies and IT companies, including Google, are participating in the development of autonomous vehicles. The era of self-driving cars will become a future that everyone is familiar with. And now, a new means of transportation that goes beyond self-driving cars is attracting attention. After IT companies such as Google and Uber took the lead and showed interest in flying cars, interest in flying cars is growing, especially in the United States. Flying car is a concept that has recently emerged and there is no fully agreed definition yet. "Is a flying car a car or an airplane?" It is also ambiguous to answer these questions. Flying cars can run on the road or fly if necessary. Flying cars do not require a wide horizontal runway like airplanes, and are expected to take off and land by lifting the aircraft vertically. It can be used like a car on the road and can fly in the sky when necessary [9]. Many companies such as Airbus and Rolls-Royce of the UK are jumping into the competition to develop technology related to flying cars



Fig. 1. Flying car [12] (Photo: Terrafugia)

GM unveiled the Cadillac flying car and electric shuttle concept car at CES 2021. At CES 2021, the world's largest ICT exhibition, GM said, "GM's future mobility concepts of flying cars and electric shuttles are means of transportation that can confirm GM's direction for the next five years." Beyond the era of autonomous vehicles, we have now entered the stage of technology development for the era of flying cars [1, 2, 3, 11].

Flying cars, unlike self-driving cars, fly in the sky, so there are many more problems to be solved. In addition, global standards and definitions related to technology for flying cars have not been established. This paper intends to examine the technology trends related to these flying cars.

2. FLYING CAR RELATED ISSUES

There are many problems to be solved in order for flying cars to be commercialized in the form of flying cars that are operated on the road and take off into the air when necessary [3, 4, 5]. Some of these issues are as follows:

(1) Technical issues

There are many technical problems with flying cars. Ultimately, only when flying cars become popular it will be able to achieve the goals of traffic congestion and convenience. It is important to develop technology that can lower the price of flying cars. Of course, if flying cars become popular and mass-produced, the price is expected to be lowered naturally. Technology to reduce noise generated by flying cars is also emerging as a problem to be solved. In addition, it is expected that popularization can be accelerated only when sensor-related technology development to ensure safety for operation and technology related to autonomous flight capable of flying without human intervention are developed. In addition, it is important to develop battery-related technology for a long flight. Only when these technical problems are resolved people will be able to use them safely.

(2) System improvement and infrastructure establishment

In relation to flying cars, optimistic predictions about the operation of aerial vehicles are predicted when the VTOL (Vertical Take-off and Landing) type of technology is introduced. On the other hand, in order to settle as a convenient means of transportation with the introduction of flying cars, the government's active policy change is necessary.

It is necessary to build a dedicated space for PAV (Personal Air Vehicle) for vertical take-off and landing in the city. It is also essential to establish a place to charge the PAV's electricity. It is also necessary to enact systems and laws in parallel with the establishment of such infrastructure.

Most countries have so far established systems and laws centered on automobiles, a means of transportation. A work must also be done to make these systems and laws fit the environment of the flying car, a new means of transportation.

It is expected that it will take time for the construction of infrastructure for flying cars and the work of enacting systems and laws. If flying cars are commercialized, there is a possibility that traffic jams on the ground will occur in the sky. It is also essential to develop a system that can efficiently manage and control such traffic jams in the air. Flying cars are expected to make human life more convenient as a new means of transportation along with autonomous vehicles.

3. FLYING CAR DEVELOPMENT TREND

Recently, many companies are participating in the development of flying car technology. In addition, recently, not only automobile companies but also light airplane manufacturers are investing in related technology development. Uber recently sold Uber LEBATE (air taxi) to Joby Aviation. There are these changes, but the big trend is that related companies are increasing their investment. Companies that participated in the development of flying cars and launched prototypes are as follows. The following Table 1 is the status of the flying car development.

Table 1 Flying Car Development Company [6]

Nation	Company	Model	Explanation
USA	Joby	Joby S4	<ul style="list-style-type: none"> - aim to develop a fully-charged 'electric flying car'. - developing technology to enable vertical take-off and landing. - Aviation's 'Electric Vertical Takeoff and Landing (eVTOL)' planes are being tested.
China	Ehang	Ehang 184	<ul style="list-style-type: none"> - one-person drone, less than 100kg, 25 minutes and 50km driving, drone call taxi test operation in Dubai - made of lightweight material and weigh only 200 kg. Top speed is 100 km/h
Netherlands	PAL-V	Liberty	<ul style="list-style-type: none"> - mass production flying car with foldable propellers, use flight engine, a non-electric, require a runway of 200m or longer, Pilot qualification required, the maximum flight speed is 160 km/h. maximum driving speed is 180 km/h
China	Terrafugia	The Transition	<ul style="list-style-type: none"> - A flying car company acquired by Geely Motors, a combination of a light aircraft and a sports car. possible to switch between driving/flight mode in 1 minute, two passengers, maximum flight distance is 643 km, maximum flight speed is 160 km/h

3.1. JOBY AVIATION

Joby Aviation is a company that has received investments from Uber, Toyota, and Intel, and is accelerating the development of flying cars. Joby Aviation aims to develop a fully-charged 'electric flying car' with zero emissions. In addition, the take-off and landing method is developing technology to enable vertical take-off and landing. Joby Aviation's 'Electric Vertical Take-Off and Landing (eVTOL)' plane, which is preparing to use an air taxi service, is being tested. These test flights are being conducted in collaboration with NASA.



Fig. 2. Joby Aviation Flying Car (Photo : Joby Aviation Homepage)



Fig. 3. Joby Aviation Flying Car (Photo : Joby Aviation Homepage)

3.2. TERRAFUGIA INC.

Terrafugia is a flying car startup founded in 2006 by five MIT graduates. It was sold to Geely, China, and commercialization has progressed rapidly thanks to the sponsorship of its parent company.

The flying car being developed by Terrafugia has a structure that turns into an airplane when the wings are spread out, and a car that can run on the road when folded. It also combines electric vehicle and propeller-driven aircraft technology as drive technology [7, 8, 9].

The Terrafugia Transition can switch from flying to driving in less than a minute, taking off and landing at small airports or highways. Currently, it is a flight-only aircraft and can only be operated by pilots.



Fig. 4. Terrafugia's Transition Flying Car (Road Driving Mode) [6]



Fig. 5. Terrafugia's transition flying car (flying mode) [6]

3.3. PAL-V

PAL-V is a flying car company founded in the Netherlands in 2001. The flying car has folding wings for two people. The PAL-V Flying Car can be switched from driving mode to flying mode in 5 to 10 minutes.

The PAL-V Liberty drives on the road with three wheels and has a unique helicopter-like shape. It can run about 1200 km over land and can fly up to 500 km in the air [9, 13].



Fig. 6. PAL-V Liberty (Source: PAL-V) [9, 13]

3.4. SAMSON

Samson Sky is a flying car company based in Oregon, USA. Samson's flying car "Switchblade" is made of lightweight carbon fiber and is designed to drive and fly with the performance of a maximum output of 190 horsepower even with 1.6-liter V-type four-cylinder gasoline engine for automobiles. Take-off and landing are possible if only a runway of about 500m is secured. The maximum speed on the road is about 200 km/h. Transformation from a car to an airplane takes about 3 minutes in the form of retractable left and right wings and tail. The total length is about 6.2m, and the width is about 8.2m. It can fly at a maximum speed of about 305 km/h. The body is made of carbon fiber [14].



Table 2 shows the development status of major companies related to flying cars, products developed and products under development. There are "car + aircraft" type and "drone + aircraft" type at the types of flying cars, In the case of the "drone + aircraft" type, there are cases where the driving function like a car is lacking or does not exist. This type is being developed with a focus on flying in the form of an aircraft. On the other hand, in the case of the "car + aircraft" type, it can be driven on the road like a car. While it has convenient functions such as road driving, if you want to use it as an airplane function, a certain length of take-off and landing space is required rather than vertical take-off and landing.

Table 2 Development status of major flying car companies [10]

Company		Car + Aircraft			Drone + Aircraft type		
		Terrafugia	Pal-V	Samson Sky	Ehang	Volocopter	Joby Aviation
Product		Transition	Liberty	Switchblade	Ehang 184	Volocopter2X	S4
Nation		USA (China)	Netherlands	USA	China	Germany	USA
flying car related	road driving	O	O	O	N/A	N/A	N/A
	vertical take-off	X	X	X	O	O	O
	autopilot	X	X	X	O	△	
	electric motor	√	√		√	√	√
	gasoline	√	√	√			
	maximum speed	161km/h	180km/h	322km/h	100km/h	100km/h	
	flight distance	644km	500km	724km	41km	27km	241km
number of seats	2	2	2	1	2	4	

Recently, flying car companies and governments around the world are paying attention to flying cars as an alternative to solving the traffic problem. Dubai in the United Arab Emirates (UAE) is in the early stages of testing a drone taxi service designed by German Volocopter. After these tests, they are aiming for a real service in the not too far future. Dubai is the most noteworthy city in the flying industry.

The part that the Dubai Road and Transport Authority is working on the most is the technical test for the flying car business. Dubai, located in the desert region of the Middle East, has a high average temperature and climatic characteristics such as sand wind blowing from the desert. Therefore many tests are being conducted for the safe operation of flying cars [9].

4. CONCLUSION

We took a look at technology trends related to flying cars. For humans, automobiles have long been established as a convenient means of transportation. These cars have reached the stage of completion as they evolve into autonomous vehicle technology.

In addition to self-driving car technology, research on flying cars that will make people's lives more convenient is being actively conducted. The development and perfection of flying car technology is expected to bring people closer to the world they live in.

However, there are too many problems to be solved in order for the flying car to be commercialized and used. It seems that the time will come when these problems can be safely and conveniently used. These problems are common problems faced both nationally and globally, and they can be solved by mutual cooperation. And, these problems seem to take a lot of time for people to adapt to these environmental changes, as a convenient means of transportation used by people is moving from land to the air.

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