FanWing

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1 The concept, FanWing

The FanWing is a propulsion-system for aircrafts using horizontal rotor blades, rotating as a radial turbine to increase the speed of the airflow and thereby generating lift and thrust. The FanWing concept was patented by Patrick Peebles in 1997. Moreover, the idea with spinning wings was already invented in the 1930's but the concept then failed after a crash and it was quite different from Peebles invention.

2 Operating principle

The front part of the wing is, compared to the usual fixed wing construction, now replaced by a horizontal rotor cage which covers all the span of the aircraft and approximately up to 50% of the wings chord.

According to the rotors large length, the whole wingspan, is in operating conditions now accelerate air with a large intake of air along the whole wing.

With the air flow passing through the rotating fan, it's now inside the rotor cage is now building up a low-pressure vortex that "pumps" the air through the fan and accelerate the flow towards the trailing edge to produce thrust (see figure 1) . By stirring this large amount of air, the low-pressure zones increase the CLmax [1] and thereby also the lift.

Approximately 2/3 [2] of the rotor diameter exceeds the top of the wing just after the leading edge. The speed of rotation of the rotor is low, about 1200 RPM [1] (wind tunnel test) in any case, compared with an ordinary shaft engine propeller aircraft in cruseing speed operates around the double.

By speaking of engines, the FanWing which is powered by at least 2 engines that are located inside the rotor cage at the tip of each wing.

A planetary gear mechanism is adapted to permit changes in the angle of each single blades of the rotor. This makes it possible to variate the thrust and the lift of the aircraft. Furthermore, if this is used differentially on the FanWing it also allows the pilot to control the aircraft in roll and in yaw by adapting the velocity of the airflow at different cords of the wing.

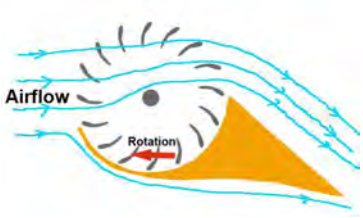

Fig. 1 . The fan cage, where the velocity of the airflow increases with help of the fan towards the trailing edge.

3 The prototypes

FanWing, the society of the inventor of this technology, build several prototypes in order to improve its technology [3]. The second version of a short-take-off-and-landing (STOL) prototype flyed for the first time in 2008 with these following features: Weight: 6[kg], Rotor Span:1.6[m], Flight Speed: 29[km/h], take-off length: 1[m] roll without payload, MTOW: 12[kg]. In the last version (2011), they used twin tail configuration to avoid the strong down-wash flow directly behind the wing and exploits the up-wash from the wingtip vortices. Thanks to this technology, the the FanWing is able to reach speeds of over 70[km/h] but still can be stable between 20 and 30[km/h]. Moreover, figures calculated from on-board logging demonstrate an increase in lift efficiency of between 10 and 15%.

Fig. 2 . FanWing prototypes: 2008 version (left) and 2011 version (right) [3]

4 Advantages and drawbacks

Here is the Advantages and disadvantages of using a fan wing instead of the conventional fixed wing.

4.1 Advantages

- The FanWing generates a lot of lift and can therefore take off and land in a much shorter distances than a fixed wing.
- It have a good maneuverability at low flight velocities and good stability in turbulence, insensitive to wind directions.
- Higher cruise efficiency than a helicopter and is more silent, good for discretion or less disturbance.
- Very good heavy lift capability, up to 5 times more than a helicopter.[2]
- It is cheap and could be a good compliment for helicopters in rescue operations and surveillance.

4.2 Drawbacks

- Low speed, currently the maximum speed of the fan winged aircrafts is around 70-100[km/h].
- The throttle can directly affects the pitch. This means increased throttle can decelerate the aircraft.[4]
- In case of a power-failure the FanWing can still glide if the rotors can auto-rotate, but the glide ratio is quite low.
- There can be a problem with defrosting the rotor when flying in icing conditions, it is not yet investigated or solved.

5 The SOAR Project

The SOAR project is the main project around the FanWing technology. This European project began in 2013 and ended in 2015. It was driven by 3 groups: FANWING LIMITED (Patrick Peebles is the director, UK), INSTITUT VON KARMAN DE DYNAMIQUE DES FLUIDES (Belgium) and UNIVERSITAET DES SAARLANDES (Germany) [5]. The aim of this project was to investigate the technical and environmental performance characteristics of the open-fan wing technology through wind tunnel test and computational modeling [6]. For example, they modified the shape of the blades to increase their performances. We can see in the figure 3 that the CLmax is over 6 which is quite impressive for an aircraft. The experimental data of the project was also used to create a non-dimensional performance model which is combined with a business model in order to identify potential new and existing markets for various FanWing payload and speed designs. Thanks to this study, they decided to focus on the design of 2 full scale aircrafts: A transport aircraft with about eight tons of freight capacity and a passenger aircraft for 60-70 passengers.

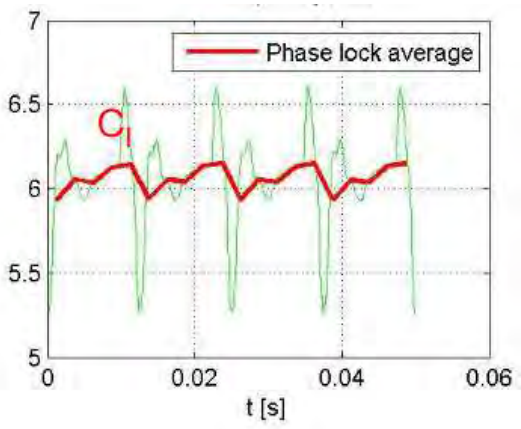

Fig. 3 . Lift coefficient results of the SOAR project team [1]

6 Future

6.1 Application

Due to the several advantages of FanWings, such as low noise, low emission, high handling, FanWing can be used in many approaches. Here are some examples.[3]

- Short distance transport, such as transporting the sick to hospital in case of emergency.
- Rescue, such as delivery the goods or looking for the missing, because FanWing has a high load capacity and low speed flying ability.
- Amphibious usages, the FanWing has a high duration and stability in turbulent. So it can work well both on the ocean and the land.

6.2 Development

Although it has been proved that the FanWing perform well in modeling test, it is still a great challenge to transform a model into a commercial passenger aircraft.[6] It still takes time to make more sufficient wind tunnel experiments to understand the force on the aircraft and the aircraft's performance. Besides, electrical motors will be used in FanWing to prove its low noise and stability. Furthermore, the FanWing still needs to enhance its properties in many way.It's expected that the FanWing can reduce its take-off distance to 100[m] and it's velocity can up to 180[km/h].

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