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High-velocity helicopter concepts

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TMAL02, Linköping University, 2017

1 Introduction

What are some differences between a helicopter and a high-velocity helicopter?
In this report we'll be taking a look at some different aspects of a high-velocity helicopter that differentiates it from a regular helicopter. The main topics include drag, propulsion, and lift.

Fig. 1 . Picture of the Sikorsky S-97 Raider. Utilizing a coaxial main rotor and an aft propeller as well as retractable landing gears. *Photo courtesy Lockheed Martin*

2 High-velocity helicopters

High velocity helicopters have potential in a large amount of use cases. Military applications such as reconnaissance and troop movements. Also for civilian uses where speed is of the essence, for example air medical services, where minutes could mean life or death. However, these high-velocity helicopters are not widely used today, and there are some different reasons for that. High speed travel introduces some design difficulties, mainly in regards to drag, propulsion and lift. These three points will be discussed in detail below.

2.1 Drag

Since regular helicopters fly relatively slow the drag does not become a very big problem. When designing and creating a helicopter for high velocities it becomes one of the most important aspects of the aircraft. If the helicopter produces too much drag, any sort of high velocity flying becomes too difficult, or too much of a power waste to be worth the cost.

There are different types of drag. Parasite drag is created from the components that protrude into the airflow, like the landing gear, doors etc. The fuselage itself is also a source of parasite drag.

There is also drag created by the blades passing through the air. This is known as profile drag. Profile drag remains relatively constant at different speeds, only increasing slightly as the speed increases.

Features such as landing skids, sponsons, and components such as search lights and cameras can be removed or integrated into the fuselage to reduce drag. This in addition to a more streamlined fuselage can together significantly reduce drag.

If we compare a fixed wing aircraft and a helicopter rotor, the lift generated is according to the same principles. With more lift, more drag or resistance is produced. The fixed wing of an aircraft would produce balanced drag, as both wings are traveling in the same velocity. However in a helicopter the rotors are moving in two different directions, which makes it challenging to manage. If we have a fixed wing for a high velocity helicopter the drag could be balanced, and we could generate vertical lift as well.

2.2 Propulsion and Lift

The forward thrust for helicopters is generated by the main rotor, which also generates the lift. The helicopter can only pitch down so far before the lift force becomes lower than the weight of the helicopter, and its height starts to decrease.

This is solved by separating the lift generation and forward thrust generation. For example the Sikorsky S-97 Raider [1] in Figure 1 uses a coaxial main rotor and a propeller on the tail. The coaxial main rotors remove the need for a tail rotor. Similarly, the Airbus Racer [2] uses one main rotor and two pusher propellers in a box wing design.

Torque - If we consider the torque of a helicopter, as the rotor generates lift, reverse torque acts on the helicopter. This results in a spin of the helicopter fuselage in the opposite direction of the rotor. To overcome this problem a vertical rotor is fixed at the tail of the helicopter. This tail rotor generates thrust in the opposite direction. Because of this the torque is balanced out, but it introduces a new problem. The helicopter will be pushed sideways and this has to be adjusted for by the pilot. However the tail rotor takes up to 6 percent of the engine power and to reduce this power waste the vertical tail rotor could be replaced with a vertical stabilizer. With this the torque could be managed and the power supply could be reduced for high-velocity helicopters.[3]

3 Conclusion

The model of the helicopter has been remodeled in future for the high velocity helicopter. By adding wings the drag has been stabilized, which makes it better than the old model. The tail rotor is used in a helicopter for pitch control and it takes 6 percent of the engine power, without producing any lift. However in a high-velocity helicopter it also generates forward thrust alongside stability. By this model the drag is balanced and the stability problem of the helicopter is solved for high velocity. In new model mostly the X-shape blades are fixed, so that the noise could be reduced. The tail rotor neutralizes the entire torque produced in helicopter which results in more power to forward lift.

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