URBAN RAY

Urban Ray - Bachelor Theses

1. **Development of a CFD model of the Urban Ray drone to determine the optimal drag polar as well as the optimal lift-to-drag ratio (glide ratio) of the complete vehicle, including both hover and cruise rotors.**

   The Urban Ray drone is an electric vertical take-off and landing (eVTOL) aircraft with a separate lift-and-cruise configuration. Its propulsion system consists of a total of ten ducted propellers: the eight rotors situated in the horizontal plane provide the necessary thrust during the hover phase, whereas the other two, located in the vertical plane at the tail of the vehicle, propel the drone forward during flight.

   This unconventional design enables a controlled manoeuvrability without the need for any other control surfaces. However, the aircraft undergoes a decrease in efficiency during the cruise phase due to the presence of "holes" in the horizontal plane, whose axes are perpendicular to the air flow. In order to optimise the aerodynamic performance of the vehicle, a CFD model has to be developed. The efficiency and performance of whole aircraft, including both hover and cruise propellers, have to be analysed according to several parameters such as flight speed, angle of attack, rpm and twist angle of the rotor blades.

2. **Development of a CFD model to analyse and optimise the efficiency of the hover rotors of the Urban Ray drone during the cruise phase considering angles of attack up to 90˚.**

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   This unconventional design enables a controlled manoeuvrability without the need for any other control surfaces. However, the aircraft undergoes a decrease in efficiency during the cruise phase due to the presence of "holes" in the horizontal plane, whose axes are perpendicular to the air flow. In order to optimise the aerodynamic performance of the hover rotors during the cruise phase, a CFD model has to be developed. The efficiency and performance of the rotors have to be analysed according to several parameters such as flight speed, angle of attack, rpm and twist angle of the rotor blades.

3. **Development of a CFD model to analyse and optimise the sound level of the hover rotors of the Urban Ray drone during the cruise phase considering angles of attack up to 90˚.**

   The Urban Ray drone is an electric vertical take-off and landing (eVTOL) aircraft with a separate lift-and-cruise configuration. Its propulsion system consists of a total of ten ducted propellers: the eight rotors situated in the horizontal plane provide the necessary thrust during the hover phase, whereas the other two, located in the vertical plane at the tail of the vehicle, propel the drone forward during flight.

   This unconventional design enables a controlled manoeuvrability without the need for any other control surfaces. However, the aircraft undergoes a decrease in efficiency during the cruise phase due to the presence of “holes” in the horizontal plane, whose axes are perpendicular to the air flow. These gaps might also have a negative impact on the overall noise emissions of the drone. In order to optimise the design of the hover rotors for an improved acoustic performance during the cruise phase, a CFD model has to be developed. The noise emissions of the rotors have to be analysed according to several parameters such as flight speed, angle of attack, rpm, twist angle of the rotor blades and interaction among noise sources.

4. **Empirical determination of the main annoyance factors associated with the sound power of the Urban Ray drone during all flight phases as well as their qualitative effect on the human perception of noise.**

   Noise emissions play a crucial role in the social acceptance of delivery drones within urban areas. Moreover, it is essential to properly understand how the human ear interprets sound due to its varying sensitivity to different frequencies of the spectrum. In general, sound waves at high frequencies are considered to be more annoying compared to sound waves that have the same amplitude but a lower frequency.

   At Urban Ray, we aim for reducing the level of annoyance to a minimum. Hence, we are optimising our propeller design to make noise emissions as pleasant as possible without jeopardising the efficiency and the aerodynamic properties of the vehicle. Empirical measurements of noise emissions during all flight phases are necessary to validate our design and provide valuable data for further improvement.

   This thesis focuses on obtaining experimental noise measurements for different rotor designs and comparing them to the current state of the art. In addition to this, conclusions regarding the main annoyance factors associated with the noise levels (e.g., influence of frequency, amplitude, distance, rpm or overlap according to the human perception of noise) must be also drawn.

5. **Development of an algorithm that predicts the optimal number of landing platforms for the Urban Ray drone within an urban area as well as their most suitable locations, based on demographic factors and scalable for any city size.**

   Urban Ray provides a hight-tech yet simple solution for the increasing demand of package deliveries within urban areas. The combination of an innovative drone design and scalable fully-automated landing-and-storage platforms upgrades the efficiency and flexibility of the conventional logistics system.

   An optimal distribution of landing platforms has to be tailored to any city, according to several parameters such as population density, available space or existing courier services. However, finding a unique adequate solution for each city separately is economically unviable. Therefore, our goal is to develop a general algorithm that predicts the optimal number of landing platforms suitable for a city, based on demographic parameters and scalable for any city size. This approach will provide the first step towards the optimal solution, saving valuable computation time and economic resources.