Electric Flight Safety

Disconnecting a Battery During Flight

With rising demand for sustainable transportation driven by government targets, the aviation industry is also seeking ways to reduce it's emissions. The first full-electric aircraft already exist, but a replacement for passenger flights is yet to be found. An electric passenger aircraft will require high-density batteries which will need to be safely managed by a Battery Management System (BMS). The scope of this project is to find out what this BMS needs to contain to operate electric flights safely and how this can change the cockpit user-experience.

The data that is read from batteries; voltage, current, pressure, capacity & temperature, can be used to determine the safety of the batteries in their current state. Lithium-ion batteries are susceptible to thermal runaway, where the battery can reach temperatures up to 200 ^{0}C and even explode. This poses a big risk to aircraft and should be prevented at all cost. The State of Safety (SoS) is a metric that indicates the safety of a battery on a range from zero to one by considering all data that influences the safety. Using the SoS will help determining the moment a battery is replaced for a new and safer one. If anything occurs during a flight, when the battery can not be replaced, the battery will need to be disconnected. This is to ensure the problem does not affect functioning batteries. These controls & data should be communicated to the cockpit and inform the crew through a user-interface (UI). In addition to literature research, insights from an interview with an experienced airline pilot and a visit to an electric flight school helped form the information basis to provide a recommendation for the application of the BMS.

The batteries can deliver large amounts of data at the same time and pilots are not capable of observing this manually. Therefore, the BMS should support the pilots. With thresholds checks the BMS can notify the flight deck about any changes in the batteries, e.g., rising temperature or a voltage drop. It is important for the UI in the cockpit to clearly communicate any updates. To encourage this, the BMS should have four states: Charging state, Steady state, Error state and Emergency state. For charging, the BMS has a separate state where all pre-flight & charging information can be displayed. Once disconnected, the BMS can move between the other three states depending on the data values it reads. In the steady state, a general overview is provided, while caution notifications appear in the error state. In the emergency state, warning messages could be combined with automatic disconnection of a battery module.

Based on this outline different UI designs have been created that serve as an example for what the BMS UI could look like. From these designs prototypes can be constructed that are suitable for usability testing with pilots, which can provide a useful insight. As development progresses, battery innovation should be observed and involving pack developers will help to understand the battery system that needs to be managed.