AIRBUS URBAN MOBILITY BATTERY REPLACEMENT VEHICLE

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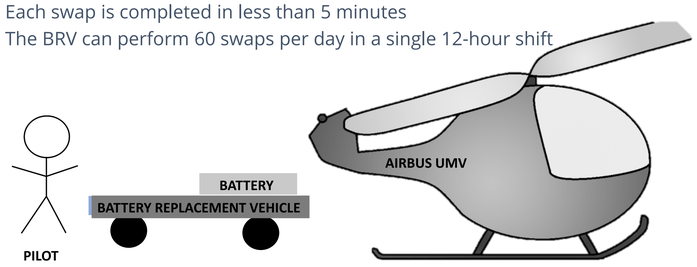
39

Problem Statement

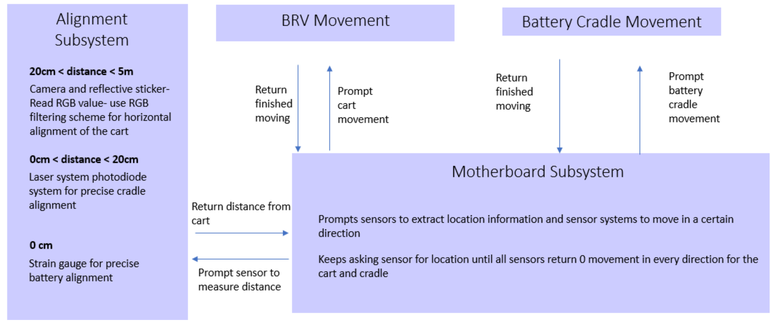
One of the biggest limitations for urban aerial mobility (UAM) vehicles is the battery life of the vehicle. One proposed solution is to implement charging stations where a battery replacement vehicle will swap out the old battery for a charged one.

Concept of Operations

- The battery replacement vehicle is a ground vehicle
- A trained operator pilots the BRV
- The cart is driven to the vehicle, when it is close enough the operator initiated the battery swapping sequence
- The cart auto docks with the UMV, removes the discharged battery, and turns around
- The cart loads the charged battery
- The cart then transfers control back to the operator
- Each swap is completed in less than 5 minutes
- The BRV can perform 60 swaps per day in a single 12-hour shift

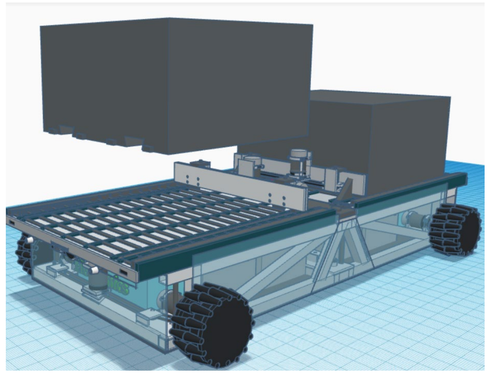


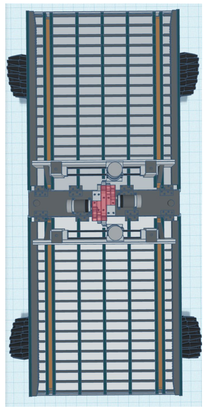
Sensors and System

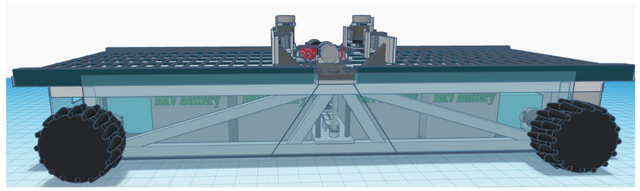


Structural Design

- 4 wheeled cart with a steel Chassiss
- Supports 2 batteries
- Mecanum Wheels for flexibility- powered by electric motor



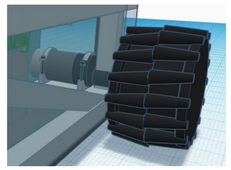




On the top left is an isometric view of the BRV. The two large blocks represent the charged and uncharged battery. The top right is an aerial view of the BRV. You can see the 4 Mecanum wheels flank the sides of the vehicle. In the middle you can see the device that latches onto the battery and draws it out of the UMV, and the devices that pushes the charged battery into the UMV. On the bottom is a side view of the vehicle. It gives you a better view of the wheels and the device that latches onto the batteries.

Propulsion Design

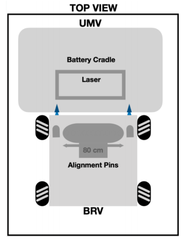
- Each Mecanum wheel is directly powered by a geared electric motor
- In addition to moving forward, reverse, and turning, the BRV can move laterally left or right

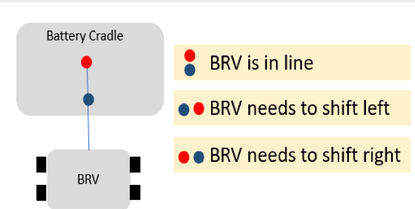


Alignment Subsystem

3 step Alignment Subsystem

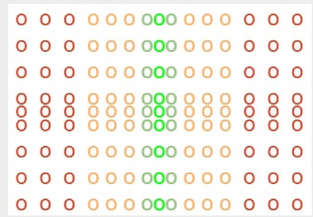
1. First uses long range alignment for parallel alignment of cart
2. Then uses a 2D array of sensor lights for battery cradle alignment
3. Finally uses alignment pins and strain gauges for precision





Shown on the left is the concept for parallel alignment of the cart. A camera at the front of the cart determines the location of 2 colored stickers. The cart moves left or right based on the relative location of the stickers

Shown on the right is the 2D photodiode array. There are 9 rows of 15 diodes with varying distance between them. As you get closer to the center, the distance between the diode decreases for more precise alignment. Lasers on the battery cradle cause the analog reading from the photodiode to increase. Any value above 200 registers as aligned. 9 multiplexors are used to select which photodiode is being read.



Future Work, Acknowledgements, and References

Due to COVID-19 we were not able to build the actual vehicle. Therefore we have outlined our detailed design, completed the sensor code, and simulated the design using Matlab/Simulink. The next step would be to complete a physical build of the BRV.

Faculty: Susan Murphy, Whitney Thomas, Industry: Evan Frank, Devin Charles

[1] Cassinis, Riccardo & Tampalini, Fabio & Bartolini, Paolo & Fedrigotti, Roberto. (2005). Docking and charging system for autonomous mobile robots

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