Alexander le Besq Alexander Terp Andreas Hjorth

First manual flight without camera

UAV must be a quad copter rotor construction	The drone has four propellers and is therefore a quad copter
UAV Camera must be controllable and time synced by the UAS, max capture rate is 1 Hz	
UAV must fly at 15m Above ground	The drone was able to fly 15m above ground level
UAV must fly at a speed between 10-15 m/s	A max speed of 10.36 m/s was achieved while test flying, thus we know it is able to achieve the goal
The UAS must be able to perform a programmed monitored flight in a 100x100m area	
UAV must have autonomous takeoff and landing with a Weight of max 3 Kg	Current weight is: - 1190 with no battery - 1670 with battery (takeoff weight)
The UAV must be able to take-off and land autonomously	
Operational procedures must be available and followed at all times: flight-planning, preflight, flight, contingency, emergency post-flight	For the first test flight after implementation the operational procedure/checklist was used to good results.
All project documents, source etc. must be available at a git repository either shared with the teachers or public. The repository must contain a license statement (BSD 3-clause is recommended).	

The UAS design and construction should consider tech ethics and value sensitive design principles.
This is described on page 4. To summarize, our values are safety and privacy, with norm features such as high visibility LEDs and a stable structure is implemented for these values.

The UAS design, construction, production, operation, scrapping should aim to be sustainable in the sense of low resource consumption
The main construction material of the drone is wood, The wood sort is not known, but optimally it would be a highly sustainable and regrowable sort such as bamboo or ash. The centerpiece brace for our drone is currently printed in PETG, which is a “toxic” non-reusable plastic, so instead for further design iterations the material would be changed to PLA, which is recyclable. The weight of the drone is fairly high, resulting in a higher consumption of power during flight. This ensures safety since it is less prone to heavy winds and will remain more stable. Most of the extra weight is due to using heavy M5 bolts for the center assembly, which can easily be swapped out with something smaller or wood pegs.

Privacy concerns for a camera drone should be addressed.

The UAS should to the extent possible conduct the operation fully autonomously. For safety purposes a remote pilot must monitor and be able to intercept the flight following defined operational procedures.

The UAS post-processing of images must be able to perform robust color based segmentation of images: Classification of object shapes based on feature descriptors, Putting camera observations on a map using information about camera, UAV Position and orientation obtained from flight log.

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Value sensitive design

Values:

Safety, Privacy

Norms:

- Safety
    - High visibility
    - LED's for visibility in low light environments
    - Easy for animals such as birds to see and avoid
- Privacy
    - LED's alerting people to the presence of the drone.
    - Flight path will avoid residential areas as much as possible (if possible)
    - Photos with people detected in them will either be deleted or edited automatically (if that's possible)

Design requirements

- High visibility
    - Must be visible from 100 meters
- LED's
    - Blue LEDs
    - 5mm (30 mA)
    - Togglable from controller
- Easy animal visibility
    - 350x350mm drone frame
- Appropriate geo fence parameters

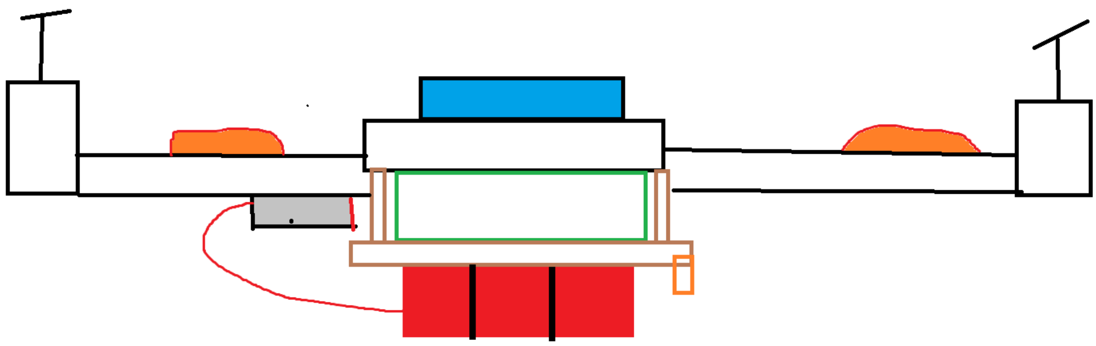
- Course specific specifications
    - UAV must be a quad copter rotor construction
    - UAV Camera must be controllable and time synced by the UAS, max capture rate is 1 Hz
    - The UAS must be able to perform a programmed monitored flight in a 100x100m area
    - UAV must fly at 15m Above ground at a speed between 10-15 m/s
    - UAV must have autonomous takeoff and landing with a Weight of max 3 Kg

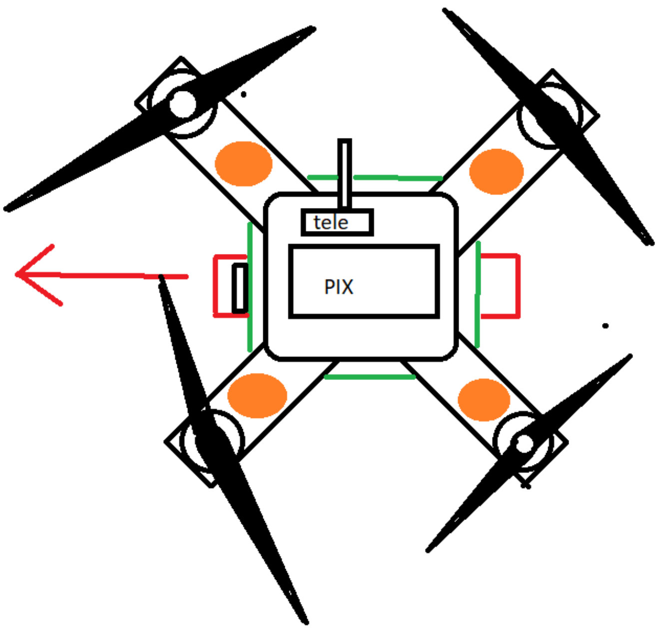
Layout

Early on it was agreed upon that the drone would follow the x-drone formfactor due to the symmetrical roll and pitch axes it would provide, which objectively looked better and had some unique problem solving that needed to be done, since the main material that we use needs to be wood.
4 main components need to be laid out for the beginning of the drone construction.

1. Pix hawk flight controller
2. Battery
3. Raspberry PI
4. Power distribution board

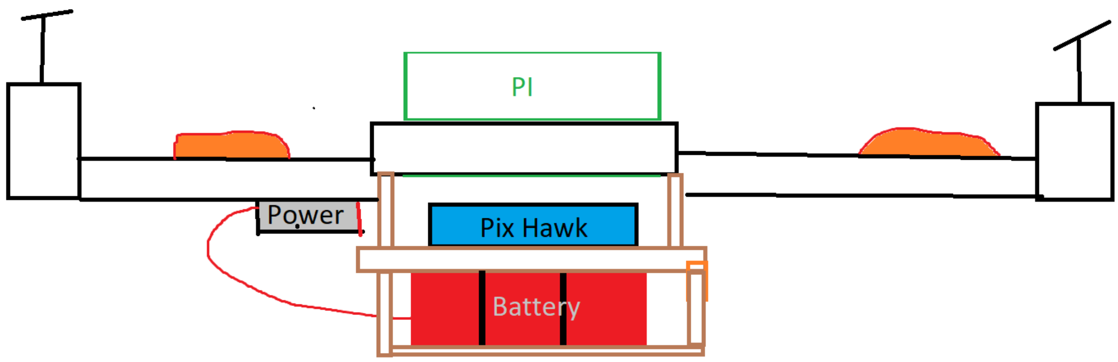
We decided to go for a stack configuration. We started out with having the Flight controller at the top, with the Raspberry PI beneath and the battery at the bottom, with the power distribution board mounted behind for easy cabling. The configuration came out as seen below:





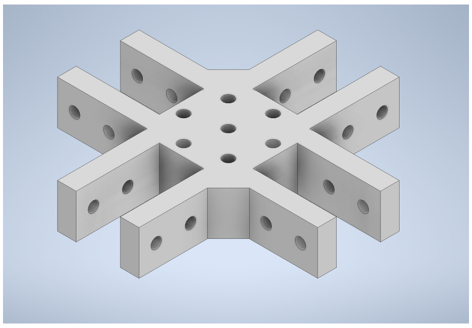
The problem with the design is that the Raspberry PI and battery consumed a lot more space than was planned for, this coupled with the close proximity between the battery and PI leading to errors, resulted in us needing to change the design.

The position of the Raspberry PI and pix hawk flight controller is switched, allowing for a more central placement of the Pix hawk, while also being able to mount it such that interference from the battery doesn't effect the sensitive sensors. Other than the position change the battery now also gets additional support from a wooden floor, allowing for more stability and safety. Thus the configuration that we designed around ends up as:



Materials:

- **Wood**
    - 4 220x21x21 (Arms)
    - 4 141x89x6 (Layers)
- **3d prints**
    - Centerpiece inventor



- **Miscellaneous**
    - M5 bolts - 50mm (very heavy)
    - M5 nuts
    - M3 bolts - varies (10 - 35 mm)
    - M3 nuts
    - M3 offsets - 30mm
    - M3 inserts - 6mm