Professional Drone, Hybrid Power Pack

Pro 3&4 project draft - morten@hih.au.dk, August 2017

Document history		
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1 Introduction

Large drones are currently being deployed as tools for aerial photography, rescue search operations, packet & pizza delivery etc.
The project is build upon a pre-project, by a group of BDE students, done in the fall of 2015. (Their documentation is available)
The goal is to build a generic ***"hybrid power pack"*** capable of extending the flight range of an industrial drone, to app. 60 minutes.

Currently an expensive DJI s1000 drone has been bought. A mock-up including a combustion engine, a brushless-DC motor for power generation, and some very large standard rectifiers has been build. No successful flight has been done, and the current project only shows that the project seems feasible.

The energy density presented by current available and rechargeable battery technology is between 0.36 - 0.857 [MJ/Kg], where gasoline has an energy density of 46[MJ/kg]
This is believed to present an opportunity to build a gasoline powered "power-pack" that can extend the range and flight time of commercial drones, above a certain weight class.
See: https://en.wikipedia.org/wiki/Energy_density

The goal is to build a working compact hybrid power-pack, using a gasoline-powered combustion engine, and an electric generator, combined with controller electronics and software.

2 Technology / inspiration

The proposed system has a combustion engine driving an AC generator, that could be made from a BLDC motor. This gives a 3 phase generator system, as shown in figure 1.

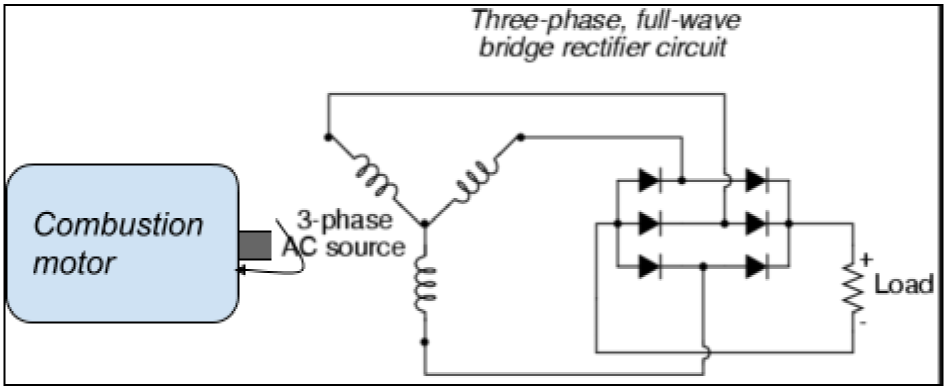


Figure 1 - intended system, generator + motor

The DJI drone has eight 400[W] BLDC motors, allowing a total power draw of up to 3200 [W]. Using a 22.2[V] battery, this gives app 140[A] of current. If you want to produce app. 3000[W] @ 22 V, from an AC generator a lot of current is drawn, and this may waste several hundred watts of energy in a standard bridge rectifier.

You could consult some of the literature and information below for inspiration and knowledge gathering
Active rectification:
https://en.wikipedia.org/wiki/Active_rectification
http://www.linear.com/product/LT4320

Generators and BLDC:
https://forum.sparkfun.com/viewtopic.php?t=15451

3 The customers

Hans Jessen Møller - lecturer at BDE
Jan Møller Nielsen - workshop mananger & drone pilot

4 Deliveries

1. Technology analysis, covering relevant areas
2. A test-stand, capable of providing a load, similar to a drone. (Perhaps just a powerful resistor)
3. A flight-ready prototype of the power pack, including
    a. Combustion engine w motor controller (motor controller can be purchased, or built as a separate project, if necessary)
    b. A suited compact and efficient generator
    c. An efficient rectification and voltage stabilization system

4. Test documentation, proving the powerpack is safe for flight-experimentation on the purchased drone

Pro 3&4 puts emphasis on the Development-process, thus it is essential that you focus on how you manage and execute the project.
We expect the team to use their skills to design Hardware and software, and to utilise their theoretical background. We do not encourage mechanical development and design, though few simple and rough mechanical parts might need to be build, during the project.

The project must be developed according to the EUDP process, see eudp.dk

5 Requirements and constraints

The Hybrid Power Pack - HPP, are to fulfill the requirements below.

5.1 Available components, to which the system must be compatible:

1. The drone is DJI S1000 http://www.dji.com/product/spreading-wings-s1000
2. The onboard flight controller is http://www.dji.com/product/a2
3. The current battery-pack allows app 10 [min] flight is 22.2[V] 16.000 [mAh], type: http://droner.dk/batteri-tattu-16-000-mah-6s

5.2 Functional requirements

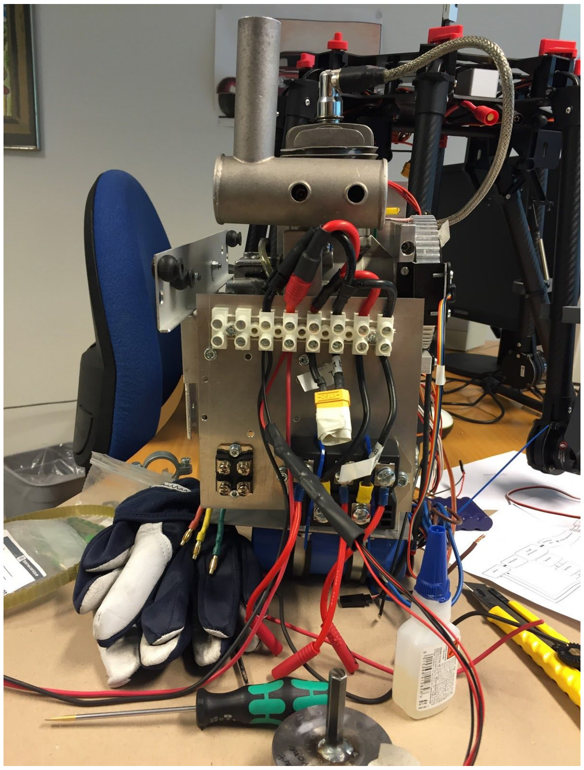
1. The HPP must be voltage compatible with a standard battery-pack, for the DJI drone.
2. The HPP must be started either electrically, or mechanically, by hand.
3. The HPP must have sufficient storage capacity to land the drone safely, if the combustion engine fails.
4. The HPP should contain a basic log functionality, to be able to asses the performance of the system.

5.3 Design constraints

1. Components selection should be done to achieve an optimal balance of low weight, low cost and good performance.
2. Use the available mechanical components, listed in ***4.1***, as far as possible, and focus on hardware/software/system design
3. You should select a suited microcontroller platform to ensure control of the HPP system.
4. PCB’s and hardware design, for the flyable prototype should be mounted on a designed PCB, not breadboard. Jens Mortensen can produce PCB’s

6 Limitations

1. You are not allowed to fly the drone, yourselves, a pilot certificate is required. Ulrich Bjerre and Jan Møller Nielsen has the required certificate.
2. The drone is expensive, so consider building some mock-up and testbenches for load simulation and motor testing



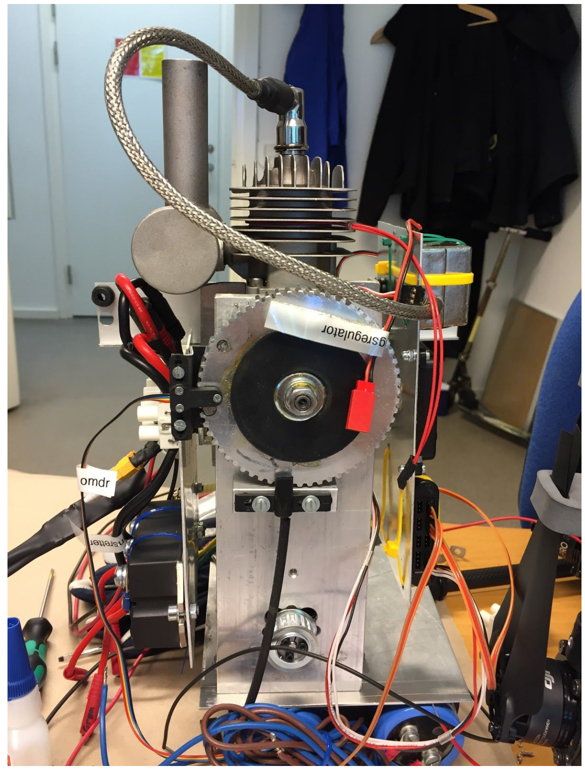


Table 1 - existing engine / generator mock-up