The “Delta”-Drone

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Task

Development of an endurance low cost drone with 25 kg MTOW and 5 kg payload with **thermal engine**

Configuration Issues

Drone should have **all-weather capablity**:

- Cruise speed 110 km/h minimum because of possible strong headwinds
- Agile, gust resistent
- 6 to 10 g g-load capability
- Internal heating
- Deicing system, if possible

Minimum climb rate requires at least 1.5 kW peak shaft power for climbing, about 500 W shaft power for horizontal flight (first estimations)

Thermal engine: Brake specific fuel consumption at low power pretty high (typical), therefor consumption/flight hour almost independent of shaft power at cruise power

Configuration Issues II

-> no reason to go for extreme lift/drag

-> as much fuel as possible to take with is much more important

-> empty weight as low as possible

-> low structural weight -> low wing span (designed several versions to get a “feeling” for structural weight of different wing spans)

-> large internal volume for payload and fuel tanks

-> requirements completely different from electric version !

-> important: payload bay and fuel tanks should be located in c.g. for practical purposes ! (2 wing tanks, payload bay in the middle between)

-> “flying wing” with thick wings -> Delta-design ?

- Studied drag versus thickness of different airfoils, drag acceptable with somewhat laminar airfoil due to large Reynold numbers

Configuration Issues III

-> studied stability of flight modes for different Delta-configurations , dutch-roll-mode especially

-> “winglets” as vertical stabilizer and winglet

-> studied c.g.-shift sensitivity

-> studied measures for reducing danger of flow separation at wing tip area at large attack angles → dogtooth

Engine Issues

Trade-off engine weight vs. Brake Specific Fuel Consumption (BSFC)

Problem 1: BSFC's for engines hard to get by, studied a lot of literature, quite a lot of talks

Problem 2: model engines have lifetimes ~100 operating hours (~ 2 flights), reliability ???

Problem 3: UAV-engines are mainly modified model aircraft engines (expensive, lifetime ?)

Problem 4. No maintenance on long flights possible

-> go for industrial engines only -> limited choice, heavy

-> use 4-stroke because of BSFC: Stihl, Honda, Makita, Husquarna,…

-> only "survivor": Honda GH50 because of minimum required power

Engine Issues II

disadvantage 1: very heavy engine (~5kg)

disadvantage 2: floating carburator, but we want to develop a fuel injection system anyway

Advantage 1: Fuel consumption at cruise ~250g/h (very good !, compensates for weight)

Advantage 2: Almost no maintenance, enough oil for long flights

Advantage 3: Expected operating time ~3000h

Advantage 4: is used in large quantities around the world (spare parts, maintenance people,…)

Advantage 5: inexpensive and nothing fancy, proven Honda-”quality”

Advantage 6: torque characteristic fits propeller char. well, expect good altitude performance

Engine Issues III

Engine test stand with generator, electronic load etc.

Fuel injection system underway, fuel control philosophy based on lambda-measurement (broadband-type)

-> automatic leaning at cruise power

-> automatic fuel reduction at altitude

-> adapts to temperature, throttle position and rpm’s

Engine issues IV

Developed pitch-adjustable propeller hub -> too heavy to be of use

Tracker configuration because of:

- No landing gear, belly landing, bunjee take-off
- Deicing system in wing leading edge possible
- Internal heating possible
- Surface air cooling possible (reduces cooling air momentum drag)
- Cowling issues

Material

Because of low weight and low cost, wood construction with water resistent glues

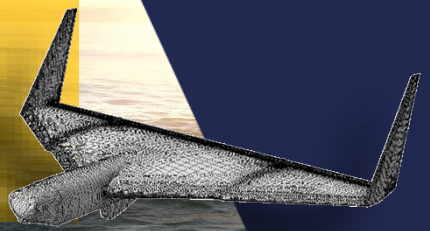
One aerodynamics test model with electric engine, several flight test days

First “series” model´with fuel engine under way

Specifications

- MTOW 25 kg
- 2.56 m span, winglets demountable
- Dry weight ~15 kg (currently)
- +/- 10g at MTOW
- 2 wing fuel tanks, 7 liters each (~10 kg fuel max.) (in c.g.)
- 30 liter payload volume (in c.g.)
- 50 ccm 4stroke single cylinder engine, 1.6 kW peak, forced air-cooled, fuel injection system, intake air preheating
- Wooden propeller, 22”*12” or 24”*12”
- Wing deicing system, internal heating system
- Double redundancy in servos (4 for elevons, 2 required)
- Low gust sensitivity (low dca/dalpha)
- Fuel consumption ~250 g/h
- Wooden airframe with cover
- Best glide ratio about 12
- Calculated MTBF 1000 hours

Thank you for your attention!



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