A solar-powered hand-launchable UAV for low-altitude multi-day continuous flight

Philipp Oettershagen[1], Thomas Mantel, Amir Melzer, Stefan Leutenegger, Konstantinos Alexis[2] and Roland Siegwart

Abstract— **Abstract. Idea for this paper:**

- Conceptual design, realization/integration, development of onboard systems, flight testing and verification of conceptual/preliminary design =¿ Complete cycle including all steps can be shown here. - Demonstrations -¿ rather basic control approaches chosen, i.e. this platform will be the basis for further research in control, guidance & navigation, mapping and will go towards the applications of XXX - solar-powered, hand-launchable 5m-class Unmanned Aerial Vehicle with multi-day continuous flight capability combined with payload capacity for long-endurance SAR and inspection missions. Questions: - This paper = engineering paper, rest is then BASING upon this paper (use it as a ref). Is this OK? Is the chance that this will be accepted big enough? -¿ Yes, focus on "complete cycle" here, with more details in papers XXX to YYY

- We ware special : mission applications possible, long endurance, combination

I. INTRODUCTION

(a) Background - Purpose&applications&advantages of solar-powered UAVs in general - Recent interest in HALE solar-powered UAVs -¿ Disadvantages? Or just lead to LALE UAVs as alternative - History/Preceeding research in solar UAVs (very brief) - recent papers in the same category. LALE solar UAVs. Then show that no similar solar-uav has been made?

(b) this paper - Conceptual design, realization/integration, development of onboard systems, flight testing =¿ Complete cycle including all steps can be shown here. - Based on previous work at ETHZ/ASL (don't go into details) - LALE solar powered UAV, for use in Applications XXX,YYY,ZZZ, towards multi-day endurance, with advantages of XXX - Demonstrations -¿ rather basic control approaches chosen, i.e. this platform will be the basis for further research in control, guidance & navigation, mapping and will go towards the applications of XXX

Direct contributions of this paper: 1) conceptual design by us 2) platform realization (hardware, avionics/electronics) by us, 3) estimation by us, rather basic pid control 3) tested/verified in extreme scenarios

——- LITERATURE —-

Other sUAVs (non-LALE) - Zephyr, Solar Impulse 1&2, pathfinder, helios & all NASA. Solara 50&60 new, then the stuff that facebook bought. Other LALE-sUAVs: [1] "Solar Powered UAV: Design and Experiments", S. Morton, IROS2014 [2] SoLong Design report, 2005, but manually flown [3] SkySailor & co.

Recheck: [a] A.J. Colozza: Preliminary Design of a Long Endurance Mars Aircraft, AIAA Paper 90-2000

II. CONCEPTUAL DESIGN

REFs: [1] Leutenegger@JIRS. [2] PhD Noth. - requirements and constraints. - market survey of basic technologies. Ref to Noth and so on? No, not here, but mention the underlying technologies briefly in the separate subchapters. - Aerodynamic considerations: Introduction to basic static level flight modelling of power consumption and stuff. Main REF to Noth and CO. - generalized results (a) t_excess vs lat and mbat and stuff and (b) SoC margin w.r.t. cloud coverage factor and turbulence factor - Specific results (airframe results) for our requirements: wingspan, size, weight (as a result from the last section).

III. DETAILED DESIGN AND REALIZATION

(a) real hardware / Airframe design - Structure / how realized - CAD Model of - whole plane - structure in wings - avionics installation &implementation - Energy System: Bats&Solar Power - weight distribution table (single parts, or better per component?) (b) Propulsion - Propeller. Motor. - Test bench measurements? (c) avionics + Overview Flowchart of components and interaction. - sensors and drivers - autopilot / Pixhawk - gps & stuff (d) payload - VI Sensor [ref to VI-sensor paper; ref to Leutenegger thesis?] (e) comparison to conceptual design.

Onboard state estimation & control - State estimation -¿ REF to stefan&Amir paper - System Identification & Modelling - Control using PID, outer loops TECS & L1 (Ref to OMLAS MED paper, also saying that there is future technologies which are being developed). - Full pre-flight verification in HIL

(f) preliminary / low level results - control: - SE&Control: PID performance over various trim points. PID computational requirements (low!) - state estimation

IV. EXPERIMENTAL RESULTS

[make this large, cause this is the main contribution?]

- Power System - 12hrs battery powered flight -¿ power efficiency - 12hrs sensor flight -¿ with mppts for sure - 24hrs

*This work was supported by a number of project partners and generous individuals, see http://www.atlantiksolar.ethz.ch/

All authors are part of the Autonomous Systems Lab, Swiss Federal Institute of Technology Zurich (ETH Zurich). Leonhardstrasse 21, 8092 Zurich, Switzerland.

[1] Corresponding author, philipp.oettershagen@mavt.ethz.ch

day/night flight - mapping missions in ICARUS. REF to Separate paper??? Yes, but only once both are accepted.

Other (TBD) - Meteo planning? Nope. only mention as side note. - Regulations? Nope. only mention as side note.

V. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word acknowledgment in America is without an e after the g. Avoid the stilted expression, One of us (R. B. G.) thanks . . . Instead, try R. B. G. thanks. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

REFERENCES

[1] G. O. Young, Synthetic structure of industrial plastics (Book style with paper title and editor), in Plastics, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 1564.