Aerial Robotic Systems, LLC

"LT Quadcopter" Concept Paper

Contact

ARS, LLC
Noel Simmons

516 W Virginia St
Lewistown, MT 59457
406.366.4638
noel@aerialroboticsystems.com

ABSTRACT

As an organization, Aerial Robotic Systems (ARS) has a long-standing dedication to developing a customizable, safe and efficient UAS with cutting-edge advancements in payload capacity and flight duration capability. The ARS team is comprised of qualified professionals with extensive experience in aircraft manufacturing, software development and marketing. At present, ARS has completed a prototype gas-powered quadcopter and is prepared to move forward on the next stages of our organization's Development Plan.

The current "LT Quad" model is a four engine VTOL UAS suited for multi-role missions, both autonomous and human controlled, requiring rapid turnaround and extended loitering times in the working environment. The LT does not require down time for charging or the need for extensive ground support. Quick-release mission modules affixed to the hardback allow full mission customization, and can be configured to receive flight data and telemetry from the flight control unit and telemetry module respectively.

While the current industry standard for UAS flight times tops out at 35 minutes, the LT Quad can achieve mission durations up to 4 hours utilizing the entire fuel capacity. Fuel requirements can be varied to achieve several parameters, namely gross weight restrictions, desired total mission length, and safety margin for flight time given variable weather conditions. For the UAS Payload and Flight Duration Challenge, we anticipate the fuel loading and time aloft to be representative of the following:

Empty Weight (lbs)	Payload (lbs)	Fuel Load (gal)	Gross Weight (lbs.)	Flight Time (min)
26	10	**3.1613**	55	**89.92**
26	15	**2.3294**	55	**66.26**
26	20	**1.4975**	55	**42.60**

Figure 1:LT Quad Flight Time/Fuel Load

Our current LT prototype cost less than $20,000 to build and develop, and complies with all requirements and limitations outlined in the UAS Concept Design Specifications. With a design optimized for efficiency and versatility, the LT will have a tremendous positive impact on public safety and communications technology, while remaining relatively low-maintenance and economical to produce.

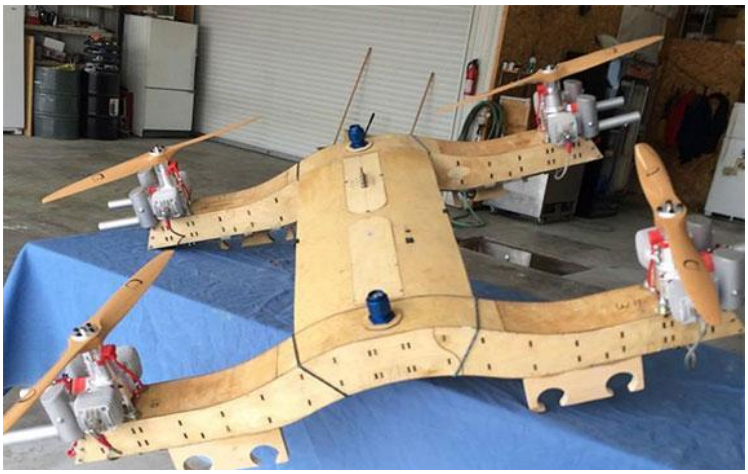
Aerial Robotic Systems
"LT Quadcopter"
Project Description

ARS LLC.

Noel Simmons

516 W Virginia St
Lewistown, MT 59457
406.366.4638

noel@aerialroboticsystems.com



Prototype V2.5

INTRODUCTION

Aerial Robotic Systems, LLC started with the goal of addressing the challenges facing current UAS technology; namely, the limitations current energy sources place on payload and flight time capabilities. The majority of VTOL UAS models currently available use batteries as an energy source, resulting in limited flight range and duration, slow turnaround due to long charging times, and limited charge-discharge cycles. The team at ARS has mitigated some of these and other shortcomings of battery technology by developing a gas-powered quadcopter capable of long-range flight, greater payload capacity, and greater in-flight stability than its battery-powered counterparts. The LT Quad has been designed with the working pace of a Part 135 Aircraft in mind. Four hours of flight time and a 10 minute turn and burn (recovery, refuel and launch) keep the mission on track. The demanding tempo of surveying central Montana's 10,000,000 acres of cropland[2], or of being the persistent watchful eye over wildland firefighters, dictates the robust design.

CONSTRUCTION SPECIFICATIONS

The selection of the construction medium for the LT was decided after much consideration. The LT's airframe is manufactured from aircraft Finnish Birch plywood laminated with Aeropoxy. Wood Composite was selected based on the need for jig-less construction. No molds or tooling were required. Therefore, when the prototype design needed to be changed, there was no loss of investment due to scrapped tooling. Wood composite allows for scaling of the original

design, again without the need to build new tooling. This organic composite has historically been proven to absorb the severe harmonic vibration of the propeller slipstream, has excellent fuel resistance, does not have a fatigue life, is non-conductive, transparent to RF, waterproof, weather resistant, and is very stable throughout a wide temperature range. High-stress joints and attachment points of the LT's organic composite airframe are doubled with 2424-T3 aluminum sheet stock or machined billet. All this makes the airframe of the LT capable of 1000's of hours of flight time with minimal maintenance.

Construction of the LT airframe and engine mounting utilizes industry standard aircraft construction techniques as defined by AC 43.13-1B[1]. All engine and prop bolts are safetyed with safety wire. Other hardware utilizes the MS35333-XX lock washer. Engine control-rod end bearings are safetyed using the double nut practice. Wire bundles are sheathed in nylon snakeskin, properly supported, and protected with grommets throughout the airframe, in accordance with AC 43.13-1B[1]. The use of grounded shielded cable for Sbus data ensures uncorrupted data to the various modules and mission packages.

Multi-mission roles are achievable on many levels. The wide varieties of mission packages are attached to the LT's hardback by a series of 16 K1000-4 nut plates on a 2" spacing longitudinally and a 10" spacing laterally. Modules need to be designed with a center of gravity not to exceed 13.125In/Lbs. moment arm from the XY center of the hard back.

The fuel for the engines is tanked inside the engine booms. Each of the two fuel tanks holds 2.2 gallons of premixed pump gas. Filling is done through an AN-16 bulkhead fitting installed during tank construction, allowing the AN924-16 hex nut to be safetyed and sealed. Tank venting is done though the fuel cap by a machined poppet valve inserted into the corresponding AN818-16 nut acting as a fuel tank cap. Fuel tanks are epoxy sealed and internally baffled with structural bulkheads to prevent sloshing and fuel starvation when in prolonged adverse flight attitudes. There are two header tank portions of the fuel tanks that are isolated using aluminum hinge stock and stainless steel hinge pin. This keeps the anti-sloshback mechanism functioning properly even when stored empty in harsh saltwater environments. Engines are attached using AN4H-5A bolts, and safety wired in accordance with AC 43.13-1B[1] directly to the fuel tank booms above the

corresponding header tank. Fuel filtration and pumping ports are integral to the header tank portion of the fuel tanks. Fuel tanks are each attached to the hardback by four AN3H-6A bolts safety wired to each other, in accordance with AC 43.13-1B[1].

The avionics suite of the LT is a standard Pixhawk with custom software enabling the use of our proprietary Engine Control Unit (ECU). The flight controller and ECU are paired to the pilot's handheld radio via telemetry, regardless if the flight is autonomous or hand flown. Telemetry is handled via the FrSky X4R and X9d plus. Sbus protocol is used to conjoin the Pix, ECU, and X4R. Wireless telemetry for flight plans and updates is handled directly with the Pixhawk utilizing existing serial port radio kits. The LT's avionics suite also includes a flight termination system or "kill switch" to end flight if the pilot deems it necessary; power to the four independent ignition systems is immediately cut with an instant reduction in power and immediate simultaneous shut down of the engines. Additional avionics features include the ability to update flight plans wirelessly directly from a laptop running Mission Planner software. First person viewing of the flight is accomplished by off-the-shelf micro-cams. This simple avionics suite provides the LT with the capability to match this contest's requirements of autonomous flight, manual flight, hovering, and loitering over a georeferenced point.

DEVELOPMENT PLAN

The next steps for ARS will be to upgrade the LT airframe, improve the performance of the avionics suite and continue with software development. This will include consolidating the separate modules into a proprietary Integrated Circuit Board (ICB). The ICB will have an environmentally sealed housing allowing the DOF Sensors to function properly. Additionally, the upgrade to the avionics suite includes 3D-vision obstacle avoidance and ground safety systems. The next engine purchase will incorporate a PTO shaft from the back of the housing allowing for starter/generators for remote starting and continuous power supply for mission packages. The ECU will be updated to control the power output/input from the starter/generators. With these updates the LT will be an extremely useful and safe alternative to Part 135 Aircraft. We also plan to update our current LT prototype airframe to include a more secure engine attachment method and the addition of landing gear, and to continue radio telemetry software improvements currently being developed by the ARS team.

WORKS CITED

1. Acceptable Methods, Techniques, & Practices: Aircraft Inspection, Repair & Alterations. AC 43.13-1B/2A, US Department of Transportation, Federal Aviation Administration, September 1998.
2. "Montana 2015 Agricultural Statistics." National Agricultural Statistics Service, USDA, 2015. Accessed 28 January 2018.

NOEL SIMMONS

Chief Technical Officer

516 W Virginia St ~ Lewistown, MT 59457 ~ Phone 406.366.4638 ~ noel@aerialroboticsystems.com

With 20 years' experience as an aircraft manufacturer, Noel Simmons has built, test-flown and provided advanced pilot training in over 40 experimental aircraft. Simmons has a dynamic knowledge base of machining and mold-making with both CNC mill and lathe, and experience using Solidworks, GibbsCam and other machining software. He is an A&P-IA with a Commercial CFI, EAA tech counselor, EAA flight advisor and Part 107 Drone Pilot.

EDUCATION

Associate of Aircraft Maintenance **June 1999**

Colorado Aero Tech

- Received Airframe & Powerplant Maintenance License

PROFESSIONAL EXPERIENCE

Chief Technical Officer **2015-present**

Aerial Robotic Systems; Lewistown, MT

- Lead designer for UAS Development Company dedicated to innovative commercial applications of aviation technology. Principal enterprise has been conceptual prototyping work on the "LT," a quad-engine gas powered VTOL UAS capable of a dramatically increased payload capacity and flight duration. Specific design strategy focuses on improved safety mechanism protocols with the goal of flexible responsiveness to user specifications, enhanced communication capabilities and optimal working efficiency

Machinist **2008-16**

Self-employed; Lewistown, MT

- Designed injection molds and molds for composite layup for 100+ parts including RC helicopter tail rotor blades and bearing guides, Aircraft Flight Controls, lightweight fairings, intake ducting
- Proficient in SolidWorks, GibbsCam, 3D laser scanning
- Used HAAS Vertical milling machine to produce fixtures and parts using diverse materials (aluminum, cold-rolled and tool steel, brass, bronze, carbon, Ren Board, plastic, wood)

Custom Sport Aircraft Manufacturer **1998-present**

Self-employed; Lewistown, MT

- Two decades experience manufacturing experimental aircraft for private individuals and organizations
- Experience with ABS and resin-based 3D printing and prototyping
- Extensive work with systems integration including instrument panel design and engine management, microprocessor controlled electrical systems, full digital autopilots and multifunctional displays
- Proficient in piston aircraft systems, power distribution busses, digital interfaces (RS-232, ARINC 429, RS 485,) design and application of fuel systems, composites, plastics and sheet metal, weight and balance calculation
- Developed the critical path assembly strategy for RV aircraft which reduced overall construction time by over 750 man hours
- Implemented quality controls resulting in majority of completed aircraft logging 250+ hours flight time in the first year without manufacturing issues
- Managerial oversight of five employees; cash flow and customer expectation management; EPA, OSHA and FAA relations

Aircraft Construction Mechanic **1998-99**

Accipiter Aviation; Eerie, CO

- Entry level aircraft fabrication and Phase 1 test piloting

Diesel Mechanic **1997-98**

5-Star Truck Repair; Commerce City, CO

- Supervisor for two-bay diesel repair shop servicing Class 7 & 8 trucks and trailers

Petty Officer Third Class **1993-97**

United States Navy

- Received training and experience in catastrophic fire suppression, flight deck operations, ejection seat inspection, oxygen and cabin pressurization systems; familiarity with all EA-6B system integrations
- In charge of technician quality assurance as Collateral Duty Inspector; 1995-97
- Served as AME shop supervisor and Liquid Oxygen Depot supervisor; 1997

QUALIFICATIONS/CERTIFICATIONS

- Total Flight Hours: 2653.5
- Current Medical 2nd Class
- Certificates
  - Airplane Single-engine Land
  - Commercial Pilot
  - Certified Flight instructor
  - Small UAS
- Ratings / endorsements
  - Instrument
  - Tailwheel, High Performance, Complex
- A&P with Inspection Authorization (IA) License
- EAA Flight Advisor/Tech Counselor

CARL H. LEWIS

Marketing Director

522 W Erie St ~ Lewistown, MT 59457 ~ Phone 702.272.4521 ~ pork@aerialroboticsystems.com

Carl Lewis brings extensive experience in sales development, operations management, networking and consultation to Aerial Robotic Systems. As Founder of Management Systems International, a sales consultancy, he built sales operations in over a dozen countries, oversaw training of nearly 200 associates and worked to develop direct sales opportunities for clients with a wide diversity of products. After retirement in 2004, he moved into the staffing business; first working with i3 Solutions in Denver, CO, then moving on to open his own staffing agency, (SnowWalker, LLC), which continues to thrive after a decade in business. Having spent the bulk of his working life creating sales and consultancy organizations, Lewis brings to the table a broad network of technical consultants and business associates and a diverse understanding of direct sales marketing.

N. CHANDRA SEKHAR, PhD

Software Developer

18/7 JP Road ~ Newpet, Kuppam-517425, Chittoor, India ~ Phone 91.955.097.9218 ~ chandra2sekhar2000@cdeec.in

Chandra Sekhar has more than a decade of experience in Electronics & Embedded System Design & Development. With a truly unique approach to the proprietary ECU and Pixhawk coding software, Sekhar brings Aerial Robotic Systems an engineering skill set that includes development, robotics, prototyping, electronics design and embedded firmware.