Custom Small UAV Lab

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March 20, 2008
I. Statement of Problem

Current development and research in the field of Unmanned Aerial Vehicles (UAVs) represents an accumulation of knowledge and experience in a wide variety of engineering disciplines. The cost and size of hardware required for the development of UAVs has dropped over the last decade. These low cost and miniaturization trends have greatly advanced the feasible space for micro (6 inches wingspan) to low cost aircraft (8 feet wingspan) and a working balance of the two properties; while each is still capable of providing some utility to the user.

The Air Force is continually funding research projects focused on the advancement of Micro Aerial Vehicles, in applications such as battle damage assessment, low altitude imagery (seeing under a tree), and autonomous rendezvous with larger aircraft. Each new application comes with many challenges that need study and characterization.

There are various institutions that currently need a facility that can rapidly produce research aircraft in a low cost and rapid fashion while maintaining its complexity. Universities and small companies are looking for the production of unique one time developments of small aircrafts in order to assist in research, teach through implementation, or their cost constraints. Universities typically have timing constraints due to the high rollover of researchers and small companies typically use planes as tools in operations and are only in search to purchase the product.

II. Proposed Project and Purpose

Universities and small companies with small aircraft application needs could be fulfilled through the use of a custom design facility aimed at providing low cost rapid response complex systems. Many systems today, especially seen within internet databases, are the emergence of self improving capabilities solely through its system use. An engineering example is NASA’s Jet Propulsion Laboratory (JPL). JPL has a facility called Team X, described as integrated concurrent engineering, which links to a database that holds the sorted information of all conceptual designs and most of JPL’s actual missions and designs. Using Team X a customer will be capable of developing a conceptual study of a space mission in a manner of hours. Each conceptual design adds to the new feasibility regions to the database to be used in future designs.

In order to reach the customer needs in a rapid fashion requires a database management system that links all performance and design parameters to all analytical and computer-aided design software through graphical user interfaces. This allows for one design change to be updated through all software instantly. In essence, every state is a design state. The facility needs will require rapid prototyping machinery and subsystem test sections in case the designs push previous design envelopes. It is important to note that the initial products designed will take a significant amount of time to process because many components and 3D designs will not be modeled and accounted for in the main database. This drawback can be mitigated through the purchase of COTS parts to COTS
systems for database entree purposes. Examples of database entries would include platform, servos, electric motors, materials, radio, and so on.

III. Predecessor

The Team X facility is located inside JPL’s campus in Pasadena, California. Team X’s website states that their product outputs include exploration architectures, systems, payloads, instruments, and technologies for Earth, lunar, asteroid, comet, planetary, astronomy and physics missions. The Team X facility is parsed through workstations, with each station having a subsystem aimed at meeting specialized functions of the system, i.e., structures, thermal, power, computing, attitude, trajectory, schedule, and cost. The work-stations are networked to each other and all have access to a networked version of Excel, which is utilized to show the design state of the project. The facility also stores historical data so the design specialists can easily interpolate solutions from previous designs. Each workstation has software useful to each design specialist, and he or she can easily update his or her design in order to soothe system level conflicts until a correct balance is found. Team X can run multiple design sessions in order to choose the best design layout.

IV. System Functions

Input/Output Requirements:

System

• Input
  o Customer requirements

Design Subsystem

• Input
  o Aerodynamic specifications
  o Controls specifications
  o Structures specifications
  o Electrical specifications
  o Testing feedback

• Output
  o Aerodynamic design
  o Design simulation

Manufacturing Subsystem

• Input
  o Full design
  o Components (GPS, sensor, camera, etc.)
• Output
  o Untested product

Testing Subsystem
• Input
  o Untested product
• Output
  o Performance feedback (wind tunnel, components, flight)

System
• Output
  o Final product

V. Technology

The Product (Aircraft)

The competitive electronic industry in such areas of cellular phones, laptop computers, televisions, and video game consoles are the driving force behind the miniaturization of electronic commercially available components. Unmanned Aerial Vehicles (UAVs) and toy airplanes in definition differ with respect to the aircraft providing utility to the user. In order for the facility to attract a large group of the small UAV users, the facility shall be capable of producing aircraft position, orientation tracking, and imagery capability and combinations thereof. The technology making small UAVs possible and financially feasible is through the uses of Microelectromechanical Systems (MEMS), found commercially off the shelf. Such components now available are miniature cameras, Global Positioning System (GPS) devices, accelerometers, magnetometers, gyros, horizon and other sensors. These small sensors can be integrated into small packages to make Attitude and Heading Reference Systems (AHRS) or Inertial Measurement Units (IMU), which are also becoming commercially available in small assemblies.

Technology for the Lab Facility

Integrated Concurrent Engineering (ICE) is used to design various aspects such as aerodynamics, controls, structures, and electrical. ICE consists of state-of-the-art networked workstations, a supporting data management infrastructure, interactive graphic displays, computer modeling and simulation tools, historical database repositories, and a shared project model that the design team updates. Components and new products information could also be updated independently through the database entry methods.

Testing equipment includes hardware in the loop, flight simulation, and wind tunnel testing systems. Rapid prototyping machines are used to build the components. The facility is also equipped with an assembly facility to assemble the components to build the final product.
VI. Life-cycle Considerations

- Cost of the System - $10 million
- Life-span – 10 years
- System components - $3 million, 5 years

VII. Projection Project Planning

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