Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2003 and Spring 2004

1.0 Information

1.1 Project Title

The Colorado Micro Air Vehicle (CMAV) Project

1.2 Project Customers

The project team

2.0 Background and Context

One of the most prominent trends in the aeronautical industry today is the movement towards Uninhabited Aerial Vehicles (UAVs). Technology has advanced to the point where humans are no longer required to be present in the plane in order to achieve flight and accomplish its desired goals. In removing the pilot, the risk of loss of human life is removed from the scenario.

A specific subset of the current UAV trend is microUAVs, or Micro-Aerial Vehicles (MAVs). DARPA (Defense Advanced Research Projects Agency) defines MAVs to be less than six inches in maximum dimension and less than a hundred grams. Due to the greatly reduced size, MAVs have the potential to be more versatile and less expensive to manufacture and operate. The size requirement of the MAV mandates a functional simplicity. However, high level functionality can be achieved through a cooperating fleet of MAVs. At the same time, the creation of this fleet would cost on the same order as the development of one, while achieving the functionality of a full-size aircraft. A group of MAVs can be used for remote sensing applications, chemical spill detection, electronic jamming, reconnaissance, and many other tasks.

Current MAV technology has progressed to the point of being remotely piloted using standard RC technology. In addition, limited control systems have recently been implemented by academic and corporate teams. The overarching goal of this project is to take the next step in progressing towards a fully self-contained and autonomous vehicle. Within that context, the project group has defined two main areas of focus: on-board attitude and location awareness and on-board processing and storage of flight data.

3.0 Objectives

3.1 Overall Objective

Our project proposes to conceive, design, fabricate, integrate, test, and verify a MAV platform that takes the next step toward a self-contained MAV by incorporating on-board processing and storage capabilities and a system for position and attitude awareness.

3.2 Flight Regime

3.2.1 Objective

The MAV must maintain stability at flight speeds between 10 and 20 mph with maximum gust velocities no greater than 5 mph. The maximum flight altitude will be at least 50 feet. Flight duration should be at least 10 minutes. The wing design will be experimentally simulated and verified.

3.2.2 Discussion

We have chosen modest flight conditions in order to simplify the aerodynamics and further focus on other aspects. **All subsequent objective sections are dependent on the development of a successful flight platform, thus this section is of *critical importance*.**

3.3 Position System

3.3.1 Objective

The position system will be a commercial off the shelf system that will determine absolute position to precision based on currently available technology that can be implemented on a small scale.

3.3.2 Discussion

The position system is not being implemented to fly the aircraft, but rather to support the future development of a self-contained vehicle.

3.4 On-board Processing

3.4.1 Objective

The on-board processor will be already existing to maintain adequate scope for this project. The processor must be capable of data acquisition, data storage, and on-board control. On-board control simply entails actuating the position of the control surfaces through servos and regulating the propulsive system. The processor must also interface with a communication system, which will be utilized in remotely piloting this non-autonomous vehicle.

3.4.2 Discussion

The CMAV team has neither the time nor skills base to develop an on-board processing system from the ground up which necessitates an OTS system. This arrangement facilitates the future development of an autonomous platform, though one will NOT be implemented on this project.

3.5 Flight Software

3.5.1 Objective

The flight software will provide an interface to the servos and the motor speed control. It will provide an interface to the communications hardware and implement a communications protocol. A health and status report on servo positioning, motor setting, battery voltage, and attitude sensors will also be generated. It will receive control input from a human pilot on the ground.

3.5.2 Discussion

This is required to interface the various electronic subsystems and the ground user.

3.6 Servos

3.6.1 Objective

The individual servos will have a mass no greater than 10 grams. They will have the greatest torque rating for commercially available servos under the specified mass requirement. There will be two or three depending on the control surface arrangement.

3.6.2 Discussion

This is necessary to position the control surfaces with the appropriate force.

3.7 Communications

3.7.1 Objective

The communications system will provide two-way digital communication with one or more outside receivers. The transmitter must maintain downlink up to a range of 1000 feet. The uplink transmitter (ground station) must be able to transmit up to 2000 feet to ensure aircraft recoverability. The on-board communication system must weigh no more than 20 grams. The uplink and downlink data rates will be the highest for a transceiver that meets the stated weight requirement.

3.7.2 Discussion

The initial application would be two-way communication with a ground receiver. Future applications could include communication with multiple ground stations or additional aircraft.

3.8 Ground Software

3.8.1 Objective

Ground software will present information on health and status (per 3.5.1) from the aircraft in a useful way. It will transmit control information back to the vehicle.

3.8.2 Discussion

The ground software will be the interface for a human pilot to remotely control the vehicle.

3.9 Attitude Determination

3.9.1 Objective

The attitude determination system will provide attitude measurements in three axis. It will be an OTS system.

3.9.2 Discussion

The aircraft must have a system to determine its attitude in order to provide input so that a control system could be implemented in the future.

3.10 Launch/Recovery

3.10.1 Objective

The CMAV will be launched either by hand or low speed takeoff. Recovery will be performed by gliding to a passive landing.

3.10.2 Discussion

The aircraft needs to be launched into stable flight and recovered without damage.

3.11 Integrated Flight Vehicle Dimensions

3.11.1 Objective

The MAV will be the smallest achievable size possible based upon commercially available parts that will still fulfill the requirements outlined in the above requirements.

3.11.2 Discussion

Having a small aircraft is beneficial for such reasons as versatility, low observability and portability. The aircraft will be operated with fewer restrictions from the FAA regarding collision avoidance.

4.0 Anticipated Engineering Expertise

Technical Expertise	**How Applied**
Mechanical Design	Develop conceptual and detailed solid 3D models of the device components
Aerodynamic Analysis	Design of airframe and verification of flight qualities
Propulsion Design	Design and verification of propulsion for vehicle
RC Piloting	Test and verification, i.e. flight testing
Communication Design	Communication subsystem
Software Engineering	Ground systems, avionics, flight software, controls
Control System Design	Real-time control subsystem
Mechanical/Composite Fabrication	Part machining/construction
Electronic Design/Fabrication	Analog and digital electronic subsystems
Test Hardware	Verification of the project
Web Design	Documentation and public interface

5.0 Resources

5.1 Facilities

The project will have access to the Senior Design Lab and the Aerospace Machine Shop. The group will be able to access Computational Fluid Dynamics software through the Center for Aerospace Structures to supplement aerodynamic design. The composite design and manufacture will require the use of cold storage space, a curing environment, and a controlled setting for fabrication/finishing.

5.2 Additional Advisors

Dr. Brian Argrow

Cory Dixon – aerobotics

Phil Nies – composite design and manufacture

Computer Science faculty - TBD

5.3 Funds

Each senior project team receives a baseline $4,000 budget. Additionally, a grant was awarded to the group by the Engineering Excellence Fund in May of 2003 in the amount of $5,871.