A brief History of Unmanned Aircraft
Technological Background

Dr. Bérénice Mettler
University of Minnesota

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Lecture Outline and Objectives

Outline

- Overview

Readings and Material
Introduction and Overview

- Technological background of unmanned aircraft
- What are the particular challenges—and opportunities—of small-scale unmanned aircraft
- System’s perspective with a focus on dynamics and control
Historical Overview

Early attempts

Figure: Sperry aerial torpedo, 1918

Figure: Curtiss remote control airplane
Historical Overview

Highlights and Lessons

Early Challenges
- Auto-stabilized vs. remote control
- Development of gyroscopic stabilization and autopilot
- Servo actuators
- Wireless communication

Early Applications
- Gliders
- Target
Early Technology

Figure: Early navigation sensor: Sperry’s gyrocompass

Figure: Autopilot: Sperry fly-by Paris, 1914
Roll, yaw and pitch gyros were used to provide inertial reference and provide the control inputs needed to maintain the roll, pitch and yaw and steer the rocket on a desired flight path.

The gyro outputs were fed to the control vanes.
The V-2 is one of the first systems that embodies the components necessary for autonomous flight. In particular, the implementation of feedback stabilization and gyroscopic guidance.

Full, inertial navigation, where the gyroscopes are coupled to accelerometers, came with Draper (today's Draper Lab). Draper Lab was the main designer of the Apollo guidance system and ballistic missiles.

The first era of autonomous vehicles is dominated by missiles.
Drivers of today’s

Since about 2000 several technological

- Computational
- Microelectromechanical systems (MEMS), e.g., inertial sensors
- Affordable due to the widespread use in automobiles, smart-phones, computers, etc. (economy of scale)

Grown into complex hybrid systems combining electrical, digital, mechanical, aerodynamic components.

High-level of autonomy, robotic aircraft.
## Challenges and Opportunities

### Challenges

- Miniaturized aircraft
  - Small payload limits type and quality of sensors
  - Wind magnitude can be as high as airspeed

### Opportunities

- Design does not have to accommodate for crew:
  - Wide range of airframe types and configurations
  - No concerns for human physiological limitations and piloted handling qualities
  - Design can emphasize task requirements
Effective guidance and control laws: exploit maneuverability, reject/disturbances

Detailed understanding and modeling of the flight mechanics
System’s Perspective

What it means?

- Mathematical model of all components and aerodynamics
- Integration of the components into a overall model
- Simulation and analysis of the overall system behavior and performance
- Insights can be used to modify characteristics of individual components
System’s Perspective

Example General System Architecture

Note

- Components can also include software, e.g. flight control laws
- …
For images and historical background see [1].

L.R. Newcome.  
*Unmanned aviation: a brief history of unmanned aerial vehicles.*  