AR.UAV

Teleoperation of Quadcopter using Windows Phone

Final Presentation

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Problem

- Monitoring and patrolling parking lots

  Purpose

  - Prevent break-ins, theft, and parking infractions
  - Remote surveillance of many different locations

  Problems

  - Time consuming and inefficient
    - Wasted time and resources
  - Cameras provide limited view and non-mobile
  - Surveillance infrastructures costly

Proposed Solution

Teleoperation of aerial vehicle to monitor parking lots

- Increase monitoring
- Work from anywhere
- Extremely mobile
- Easy to use
- Increase efficiency
- Deter criminal activity
- Simple relocation/travel

- Intuitive flight controls
- Automated flight to GPS locations / waypoints
- Streaming video from craft to phone
- Image / video capture
- Future → automatic video recognition/evaluation

Objectives

Goals for Project

- Teleoperation with WP
  - Manual controls
  - Accelerometer control
- Video Stream
  - Live stream viewable
  - Capture images & video
- GPS Auto-Flight
  - Select waypoints
  - Determine and follow path between points
  - Save paths
- Easy to Use
  - Phone app easy to use
  - Intuitive flight control
  - Crash prevention (future)

Quadcopter

Pros	Cons
Very mobile	Expensive
Aerial stability	Difficult autonomous flight
Easy to increase payload	Fragile
Less susceptible to cross-winds	Wireless range
Compact system	Battery life vs. weight

Quadcopter Selection

AR.Drone vs. Custom

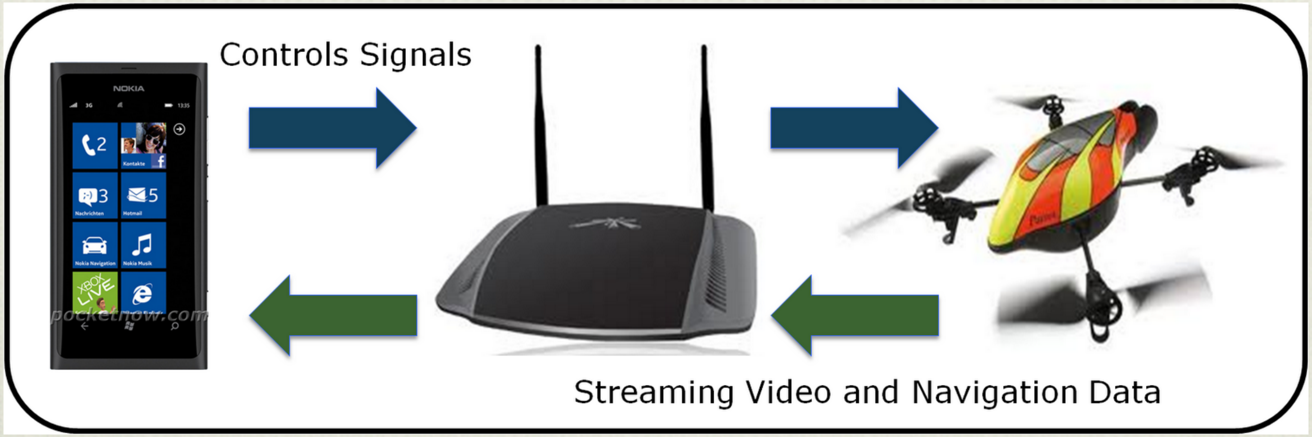
Pros

- Compatibility and warranty
  - Kit preassembled
  - Kernel tested / supported
- Large developer community
- API docs and examples
- Custom apps for evaluation
- Economical parts, many retailers, and direct technical support

Cons

- Cannot customize kit nor parts
  - Difficult to change parts
- Firmware flexibility is minimal
- Changing the kernel is a challenge
- "Outdated" technology
- Difficult to adapt to a system - closed system

System Design



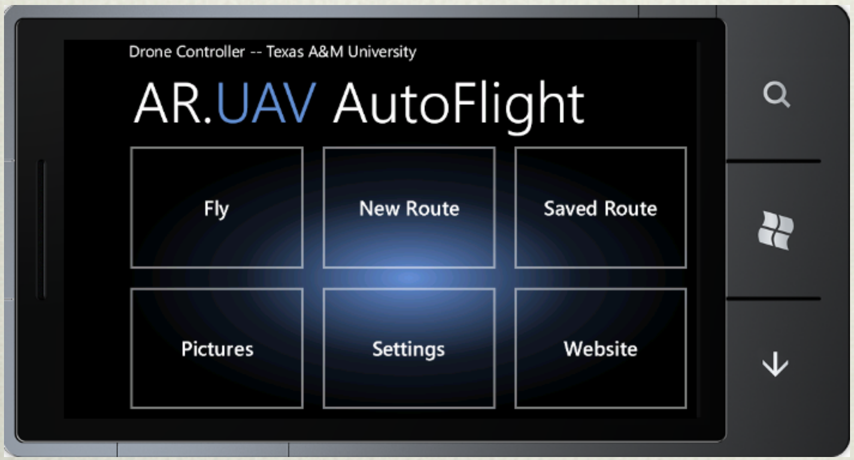
Phone

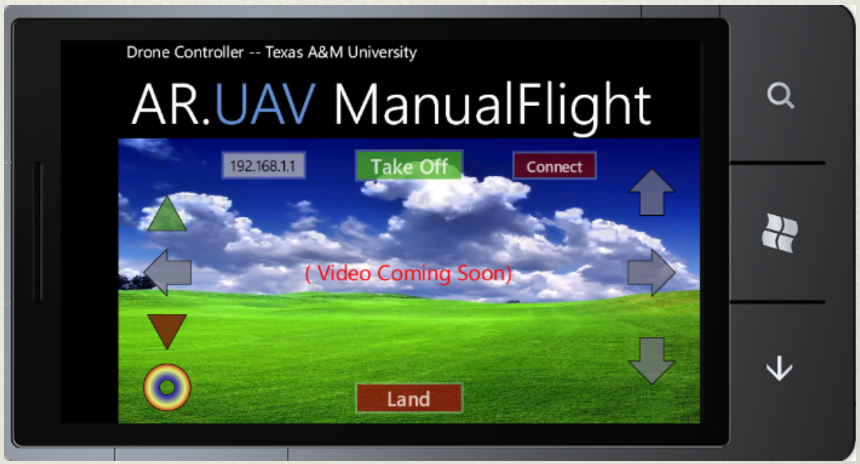
- Connect with drone
- Initialize data connections
- Process input from user
  - Receive motion commands
  - Send movement signals
- Evaluate waypoints
  - Determine path
  - Issue movement commands

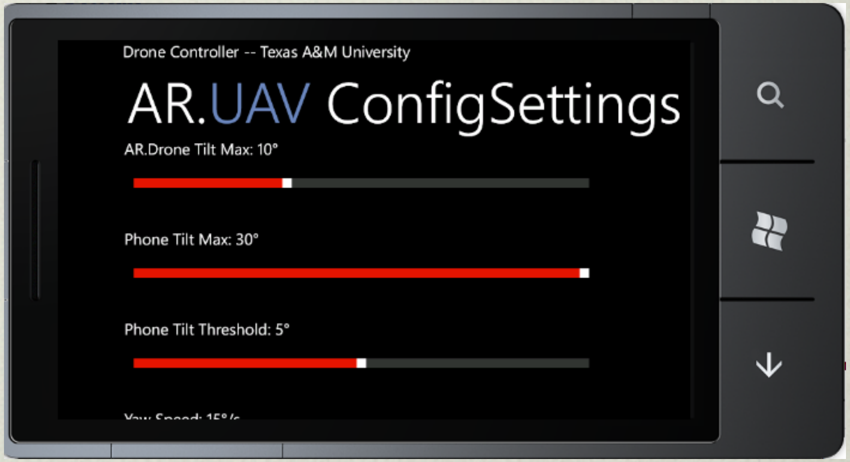
Quadcopter

- Initializes systems
  - Loads configuration data
  - Return responses for connection request
- Process received commands
  - Receive movement
  - Translate to motor control
  - Return flight data
- Maintain system stability

Phone UI Design







Autonomous Flight

AutoFlight Options
- ❖ Select waypoints on map
  - ❖ Can choose saved route
- ❖ Chose path traversal
  - ❖ In order of placement
  - ❖ Shortest path between
- ❖ Drone executes movement

Destination Finding
- ❖ *Convergence*
  - ❖ Determines angle to dest.
  - ❖ Moves forward / back and right / left based on slope of path between points
  - ❖ Repeats many times
- ❖ *Angle reference*
  - ❖ Determines angle to dest.
  - ❖ Rotates to angle
  - ❖ Moves forward each step
  - ❖ In theory: heading updates based on movement angle

Shortest Path (traveling salesman)
- ❖ Locally optimal selection

Evaluation

Validation and User Testing

- Criteria
  - Teleoperation – Met
    - Takeoff, landing, rotation, directional travel (static, accel)
  - GPS AutoFlight – Met
    - Find and select waypoints, choose routes, copter follows path
  - Video Stream – Not Met
    - Stream from copter to phone, quality video, capture and save
  - Easy to Use – Partially Met (more user testing needed)
    - Phone app easy to learn, intuitive flight control, crash avoid.
      - User controls require experimentation (quick learning curve)
      - Flying drone can be difficult – especially outside
      - Need to test with additional demographics

Concerns

Social Impacts

- Environmental
  - Power usage and parts (electronic/battery) disposal
  - Noise pollution
- Health and Safety
  - Collision damage to people or property
  - Weather reliance
- Political
  - Replace jobs of transportation officers
- Ethical
  - Video privacy and surveillance

Production

Social Impacts

- Manufacturability
  - Dependent on the AR.Drone platform (Parrot Inc.)
  - Differences with cell phone hardware
  - Support for multi-platform smartphones and/or PC
- Sustainability
  - Battery life, size, weight, and disposal
  - Firmware updates and compatibility
  - Styrofoam hull and case
- Economics
  - Prototyping cost approx. 3x expected production cost

Team

Roles and Responsibilities

John Brock

- Team lead
  - Task scheduling, route finding algorithms, UI for app, GPS app for 2nd Windows phone, unit testing, website

David Dornier

- Hardware Lead
  - Drone assembly, GPS hardware, purchases, budget, public relations

Alex Perovich

- Software Lead
  - Phone controls – static and accelerometer, drone communication, source control – CodePlex, firmware modifications on drone

BUDGET

Planned		Actual	
Drone (after $ 50 student discount)	$ 250	Planned	$ 593
Battery (x2)	$ 60	Mainboard Replacement	$ 110
Motor (x2)	$ 80	GPS Replacement	$ 60
Propeller Set (x2)	$ 14	FTDI Boards + Cables	$ 40
Gear and Shaft Set	$ 10	Voltage Regulators	$ 4
Central Cross	$ 25	Drone Tool Set	$ 20
Screw Set	$ 4	**TOTAL**	**$ 827 + Shipping**
Router	$ 90		
GPS Module	$ 60		
TOTAL	**$ 593 + Shipping**	**DIFFERENCE**	**$ 234 + Shipping**

Questions?