Utilization of Unmanned System Technology in Transportation Engineering

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Indiana State University
Overview

- Unmanned Systems
  - Laws
  - Capabilities
  - Future
- Transportation Engineering Uses
  - Parking Study
  - Accumulation Graphs
  - Cost Effectiveness
Unmanned Systems
Unmanned Systems

- Fleet at ISU
  - Phantom 4 Pro
- Capabilities
  - Flight time 28 minutes
  - Max Service Ceiling 20,000 feet
  - Max Wind Speed Resistance 22 mph
  - Programmable flight paths
  - Range over 4 miles
  - Object tracking
- Cost of each drone
  - $3000 to $5000
Federal Aviation Administration

- Small Unmanned Aircraft Rule (Part 107), 21 June 2016
- Visual Line-of-sight (VLOS) only
- Maximum altitude of 400 feet above ground level (AGL)
- Minimum visibility of 3 statute miles
Federal Aviation Administration

- Air Traffic Control (ATC) permission required in Class D airspace
  - Airports that have an operating air traffic control tower
  - Notification is required when operating inside 5 statute miles
- Require a part 107 certification for operating in a controlled airspace
- Airspace Authorization
  - Available through internet request
  - 3-4 month wait
- Must yield right of way to other aircraft
Federal Aviation Administration

- Requires Preflight inspection prior to every flight
- No operation over moving vehicles
- May not operate over any persons
- Restrictions may be lifted in near future
Local Restrictions

- Must notify University Police
- Must follow FAA flight rules
Unmanned Uses Within Limitations

- Parking
  - Inventory
  - Accumulation/Occupancy
- Before and after traffic queues
  - Signal timing
  - Other improvements
- Work zone
  - Inspections
  - Traffic monitoring
Parking Study Objectives

- Parking inventory
  - Count the number of spaces in each lot

- Parking accumulation
  - One hour increments on all campus lots
  - Use unmanned systems if possible to collect data
  - Compare cost of traditional vs. unmanned system
  - Create bar graphs showing parking trends in each campus lot vs capacity
Indiana State University

- Terre Haute, Indiana
  - 60,000 Residents

- Indiana State University
  - Enrollment 14,000
  - Campus 435 acres
  - 5 Colleges
  - 30 parking lots
  - 1 parking garage
Campus Map
Parking Inventory

- Determine spaces on campus by type
  - Regular Spaces
  - Handicapped
  - Parking Meters
  - Service
  - Motorcycle
Parking Inventory with Unmanned Systems

- Count in off peak times
- Striping and signage visible
Parking Lots

- 6 Staff
  - 740 Total Spaces
    - 691 Regular
- 6 Student
  - 960 Total Spaces
    - 921 Regular
- 10 Staff/Student
  - 1594 Total Spaces
    - 1552 Regular
- 8 Remote
  - 1605 Total Spaces
    - 1587 Regular
- 1 Parking Garage
  - 590 Total Spaces
    - 572 Regular
- Total Spaces 5498
Parking Inventory Results

- Discrepancies
  - Most lots were off by 2 to 5 regular spaces
  - No accurate count for several years
Parking Accumulation

- Defined: total number of vehicles parked at any given time
- Establish the distribution of parking accumulation over time
- Determine the peak accumulation and when it occurs
- Determine space availability
- Collect vehicle occupancy each hour
- Due to the nature of arrival patterns
  - 7:30 am to 3:30 pm
    - Class schedule
    - Faculty hours
Parking Accumulation

- Preliminary Analysis
  - Always open spaces
    - Handicapped
    - Parking Meters
    - Service
    - Motorcycle
  - Spaces full
    - Regular Spaces
Drone Data
Parking Garage

- Not accessible via drone
- Manual counts
Cost Effectiveness

- **Wages**
  - $12 per student

- **Hours**
  - Large lots require full day counts
  - Drone capture multiple lots per flight

- **Drone Cost**
  - $3000
## Cost Effectiveness

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<th>Method</th>
<th>Hours</th>
<th>Weeks</th>
<th>Cost</th>
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<tr>
<td>Traditional Method 4 Students</td>
<td>512</td>
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<td>Drone Study Student</td>
<td>40</td>
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Drone Study reduced cost by 56.7 percent or 92.2 percent when cost of drone is recouped.
Lesson Learned

- Labeling the pictures
  - Date
  - Time
  - Parking lot(s)
- Multi lots per picture
  - Reducing flights
- Sun angles
  - Shadows
  - Glare
- Drone capabilities
  - Battery efficiency
  - Data storage
- Weather
  - Including wind
Deliverable

- Accumulation graphs
- All parking lots on campus
- Assist travelers in choosing parking based on time of day
Bar Graphs

FACULTY/STAFF LOT 15

Spaces Occupied

- 7:30 A.M.
- 8:30 A.M.
- 9:30 A.M.
- 10:30 A.M.
- 11:30 A.M.
- 12:30 P.M.
- 1:30 P.M.
- 2:30 P.M.
- 3:30 P.M.

Regular Spaces
Capacity
Bar Graphs

STAFF/STUDENT LOT A

Spaces Occupied

- Regular Spaces
- Capacity
Bar Graphs

STUDENT LOT 24

Spaces Occupied

Regular Spaces
Capacity
Bar Graphs

PARKING GARAGE

Spaces Occupied

- Regular Spaces
- Capacity
Future use with Software

- OpenALPR
  - Plate detection system
- Compatible with most cameras
- Create flight plan to collect data
  - Issue tickets as necessary
- Conduct studies on:
  - Duration
  - Turnover rate

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<td>5</td>
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