ARCS

AUTONOMY RESEARCH CENTER FOR **STEAHM**

EVAA Operator Interface Design

ARCS Research Colloquia

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NASA

CSUN | CALIFORNIA STATE UNIVERSITY NORTHRIDGE

RESEARCH STATEMENT

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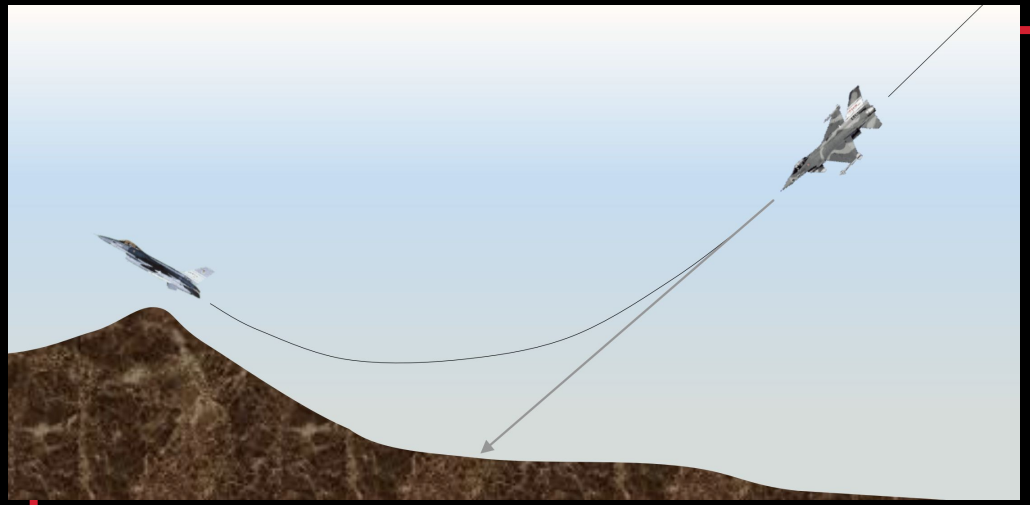
How might we communicate complex AI systems into salient information a human can understand in real-time when it comes to autonomous payload delivery?



LITERATURE REVIEW

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NASA Armstrong's Expandable Variable Autonomy Architecture (EVAA) framework supports multi-level autonomous piloting systems. Will protect against:

- catastrophic piloting faults
- faulty mission planning or execution
- inappropriate flight activities.

Exploring visual communication methods to explain complex AI systems into salient real-time information a human can understand.

Valuable methods for the EVAA framework:

- Testing
- Observation
- Evaluation

IMPROVED GROUND COLLISION AVOIDANCE SYSTEM TEST REPORT — IGCAS EVALUATION AT EAA AIRVENTURE OSHKOSH 2015
PREPARED BY: MICHAEL LAMARR, CHRIS CHINSKE, ETHAN WILLIAMS, CAMERON LAW, MARK SKOOG, PAUL SOROKOWSKI
APRIL 2016

WHY DO WE NEED THE IMPROVED GROUND COLLISION AVOIDANCE SYSTEM?

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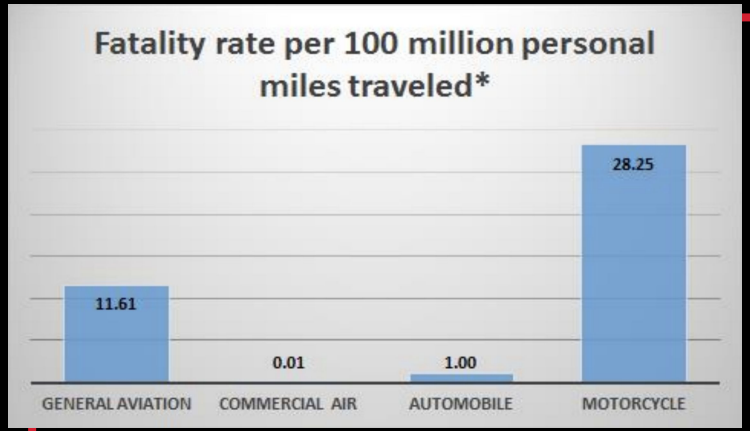
- Controlled flight into terrain **(CFIT) is leading cause of aviation fatalities**
  - Night
  - Weather
  - Spatial Disorientation and loss of situation Awareness
- Enhanced ground proximity warning + terrain awareness and warning systems — **reduced CFIT** for large commercial air carriers
- Problem still remains for **fighter aircraft, helicopters, and general aviation** ≈ 100 deaths/ year (US alone)



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WHAT CAN WE DO?

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- **iGCAS for General Aviation (GA)**
  - Reliable collision avoidance for all aircraft
  - Manual ⟶ automatic versions
  - Tailorable to user's price point
    - Walk-on tablet/phone warning system
      - Downloadable app

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FLOW

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- Runs in background of existing navigation app
- Setup iGCAS for specific aircraft
- Switches to **Viable Maneuver Display (VMD)** (Caution State) near terrain
- Switches to **Avoidance Director Display (ADD)** (Warning State) when impact is imminent
- Switches **back to VMD** once imminent impact is resolved
- Switches **back to navigation** app once clear of terrain

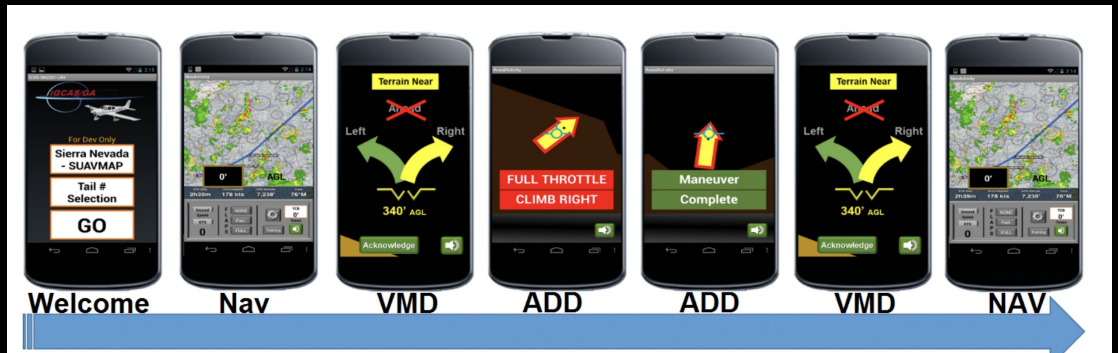

Figure 1: Program Flow

RESEARCH APPROACH METHODS

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- **Assess needs for improvement before adding new features.**
- **Design and prototype mobile interaction visual systems**
  - Visual systems standards to assist autonomous systems (mobile)
  - Social interfaces (elements for UAV so people don’t feel scared)
- **Evaluation of the interfaces**
- **User testing**
  - Scenario-based analysis
  - Using same testing procedure from EVAA report
- **Experiments at Armstrong**

RESEARCH APPROACH METHODS

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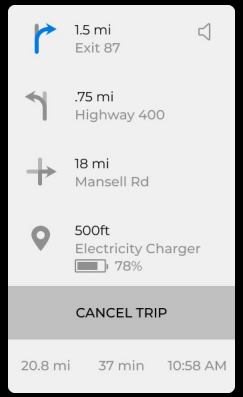
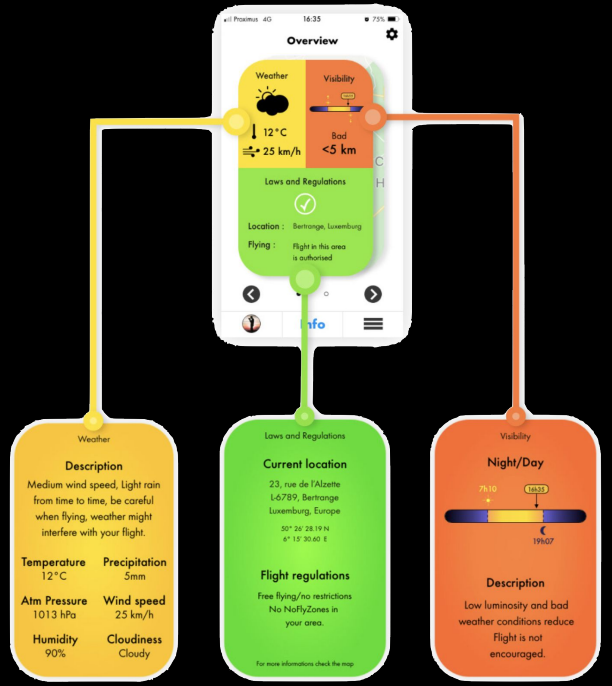
Mission functions:

- takeoff, landing, in-flight route planner, mission planner

Sensors:

- Aircraft state
- Navigation: GPS, Vis Nav
- Physical threats: DAA Radar
- Environmental threats: winds, weather





RESEARCH APPROACH METHODS

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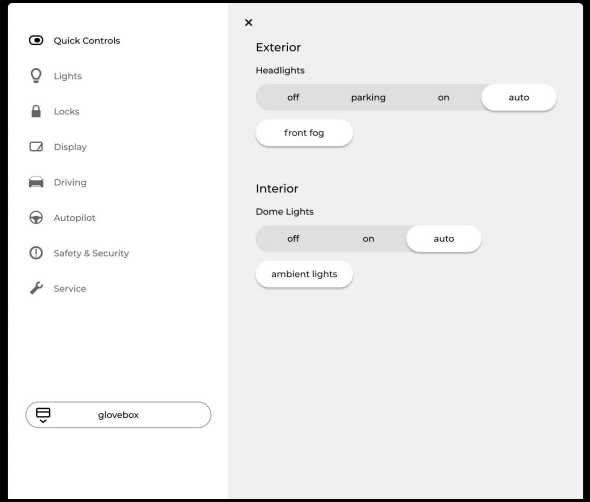
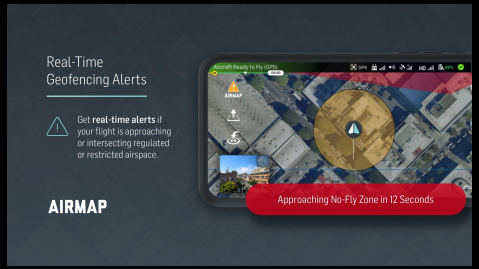
GCAS Cuing

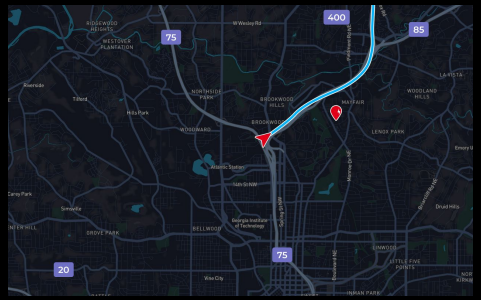
- Viable Maneuver Display (VMD) aircraft directions (left right forward)
- Avoidance Director Display (ADD) clearer view for the pilot to see specific instructions

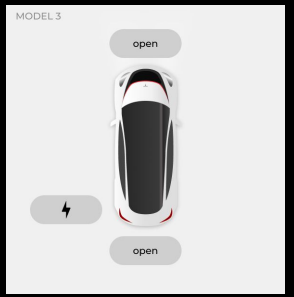
Intent Manager: Autonomy must express its intent to others

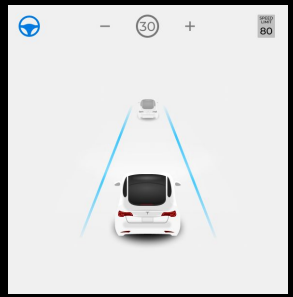
- Voice, lighting, tone











WORKPLAN / TIMELINE

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(April — mid-May)	PHASE 1: REPLICATE EXISTING UI
(mid-May — July)	PHASE 2: ADD (Avoidance Director Display) Improvements
(July — mid-August)	PHASE 3: VMD (Viable Maneuver Display) Improvements
(mid-August — October)	PHASE 4: Dashboard and Navigation
(October — mid-November)	PHASE 5: Using AR — Where's My Drone?
(mid-November — January)	PHASE 6: FUTURE RESEARCH — various display sizes
(January — mid-February)	PHASE 7: FUTURE RESEARCH — Incorporating Helicopter Avoidance Models

*Other possible Improvements before made to public:

- Integrate iGCAS into the PFD or other display in glass cockpit
- Integrate iGCAS into synthetic vision display
- Add more audio on VMD to inform conditions are getting worse
- Add more info on bank angles such as a tick mark or chevrons on overbank and over pitch
- Provide down draft and up draft ambient conditions
- Optional onboarding feature on app
- Fly more scenarios + more of the VMD scenarios to feel comfortable
- Allow a simulation mode for iGCAS

SUMMARY / CONCLUSION

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- iGCAS testing feedback for displays, audio cues, maneuvers, and performance data.
- **Known limitations and more testing is needed** to identify all existing limitations.
  - System matured towards transition to public availability
  - Any changes **shouldn't affect the clarity and simplicity** of the system.