JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Autonomous System Platform > Smart Sensor

Brain Evidence Autonomy Management Interface Design Approach

CDAO

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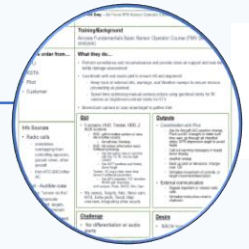
Background: The Chief Digital and Artificial Intelligence Officer, in partnership with the Johns Hopkins Applied Physics Lab, Air Force Research Lab and Air Force Lifecycle Management Center, is rapidly and iteratively modifying existing unmanned airborne platforms to **develop an AI-enabled platform that can perceive its environment, execute surveillance and reconnaissance missions, and communicate targeting data to other platforms – autonomously**
The goal of Smart Sensor is to rapidly develop and deploy an AI-enabled autonomous "brain" (software and computer hardware) that can be put on any unmanned platform based on available size, weight, and power

Approach: We engaged with users early and often in order to drive Human-Centered UI Design, identify requirements, and understand mission goals for the relevant stakeholders



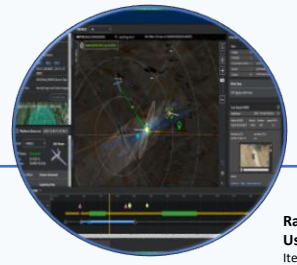
Interviews & Qualitative surveys to collect knowledge, skills, abilities (KSAs), training and demographic information to gain common understanding of current end-user roles and to envision how future end-user role will change over time with the integration of Smart Sensor

Critical Challenges:

(1) Achieve ISR mission resilience in a denied, degraded, or communications limited state through robust AI/Autonomy
(2) Create effective AI/Human shared situational awareness both "in-mission" and "post-mission"
(3) Increase speed and accuracy of multi-sensor analysis despite increased system complexity
(4) Decrease processing time while increasing analytical accuracy/precision
(5) Achieve explainability and trust of AI/Autonomy (regardless of Human-In-The-Loop, Human-On-The-Loop, or Human-Out-Of-The-Loop)

Goal-Directed Task Analysis (GDTA) provide a common understanding state of user tasks, decisions points, and information need to complete decisions

Design Thinking Sessions informed us to how end-users currently carry out operations and what information is needed to optimally perform their tasks



Other Techniques includes
- User Profiling
- Workflow Diagrams
- MBSE OV-5b Diagrams
- User stories

Rapid Prototyping driven by User feedback
Iterative and rapid prototyping to provide users with UI visual context necessary for constructive design feedback

User Engagement:

Visit	End-User, Sample Size	Objective
March AFB	Sensor Operators, Pilots, Mission Intelligence Coordinator, Squadron Intelligence [n=17]	- Identify potential users, associated tasking and informational needs - Validate goal-directed task analysis and associate task/need with User roles - Obtain user feedback on design concept
COCOM PED Organizations	PED Organizations [n=11]	- Identify reporting informational needs
MCB Camp Lejeune	PED Cell (All Source, Geospatial Intelligence, Targeting) [n=22]	- Identify specific user workflow from start to end of mission; Explore level of trust associated with automation level on tasks - Validate task analysis and drafted workflow - Obtain user feedback on wireframe
Langley AFB & Holloman AFB	PED Cell (Screener, Geospatial Analyst, Imagery Mission Supervisor), Pilot and Sensor Operator [n=33]	- Formulate comprehensive understanding of workflow between varying user types - Obtain user feedback on prototype

General Findings & Key Concepts:

Determined perceived trust and comfort level associated with level of automation on operational tasks throughout a mission
- Identified which operational tasks users preferred to maintain manual input and the preferred level of automation for other tasks
- Explored explainability of machine decisions required to promote operator trust

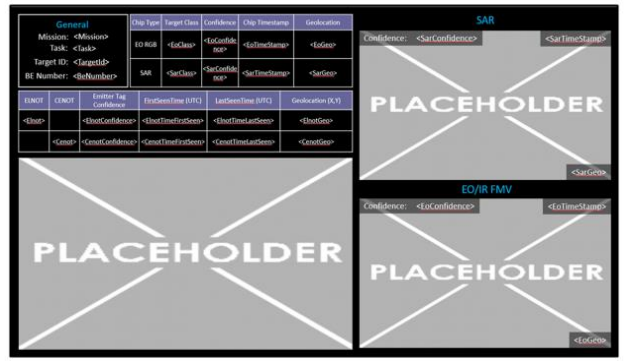
Determined mission-critical tasks and associated informational need for relevant user groups
- Role-based access control (RBAC) with information layout/segregation differentiation between roles to support SA and decision making
- Determined actionable intelligence items and ways to display grouped information to support decision making

Human Centered Design concepts driven by iterative user engagements
- Determined design features to enhance likelihood of machine error detections and provided means for human intervention to achieve mission success
- Rapid retraining AI/ML algorithms via edge-processing with privileged RBAC

Introduction of competency measure (i.e., how competent is machine on the given task) based on traditional confidence associated with probability while accounting for machine training on specified given task

Notional design iterations driven via user feedback given statistical significance:

1. Operator intel report output
Nov 2021



2. Design concept wireframe
Feb 2022

3. Interactive prototype mockup
Jun 2022