

NEXT-GEN LUGGAGE SCANNER OPERATIONS: PROCESSES, INTERFACES, AND TOOLS

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WORK DONE IN CONJUNCTION WITH IDSS



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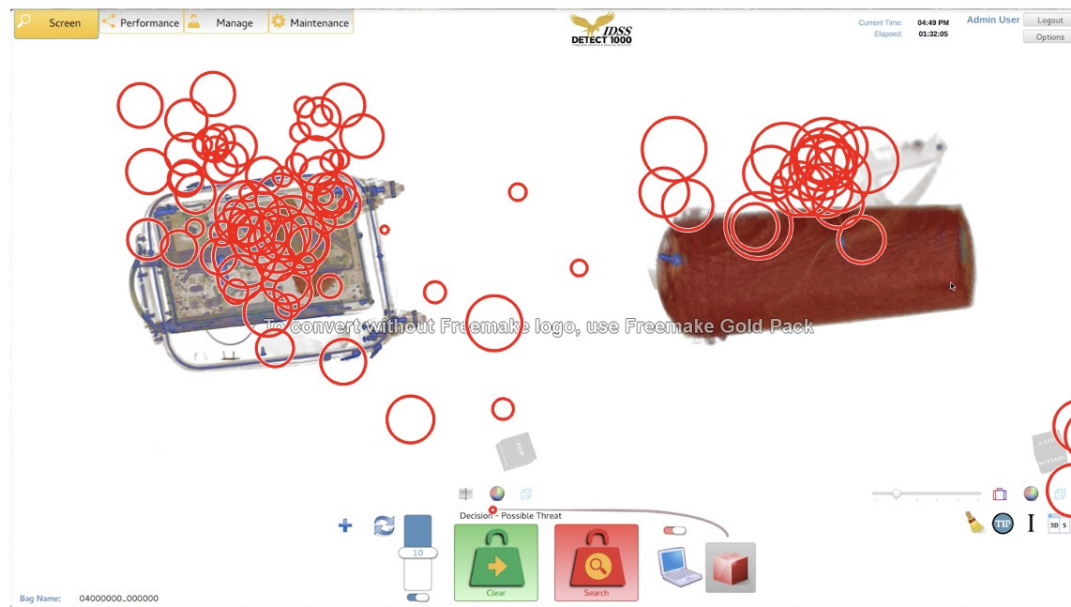
SO WHAT? WHO CARES?

- Mission: *Improve speed and accuracy of bag screening*
 - Venues: Security checkpoint
 - Method: Study current processes and tools
 - Goal: Design and develop better processes, tools, and training materials
- Problems
 - 3D screening has organically evolved from earlier 2D methods
 - Processes and tools appropriate for 2D may need re-design for 3D
- Results
 - Redesigned processes, GUIs, hardware controllers, and training programs
 - Added new tools – including some machine-learning action recommendations
 - * *Pandemic has delayed live testing...*

WHAT WE EXAMINED

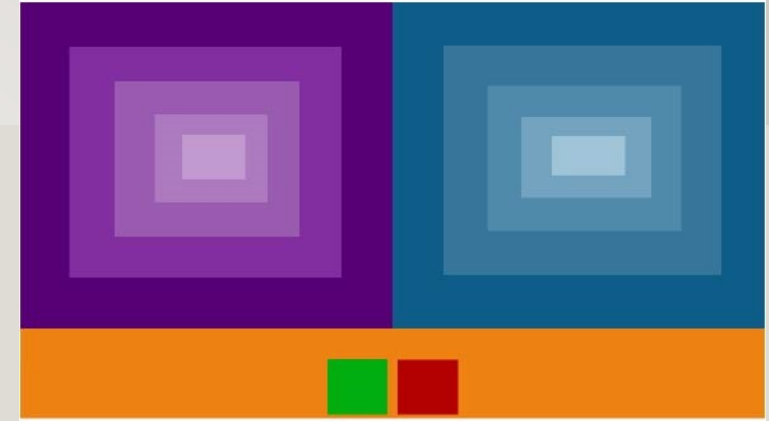
- Qualitative Data: Interviews, contextual inquiries, observations
- Eye movements: Scan-paths, Markov models, etc
- Video: Detailed manual (frame-by-frame) task analyses
- Action Data: Every action performed on >400k bags
- HCI Devices (mouse, keyboard, etc) : Expert analysis and “scanner sandbox”

EYE MOVEMENTS

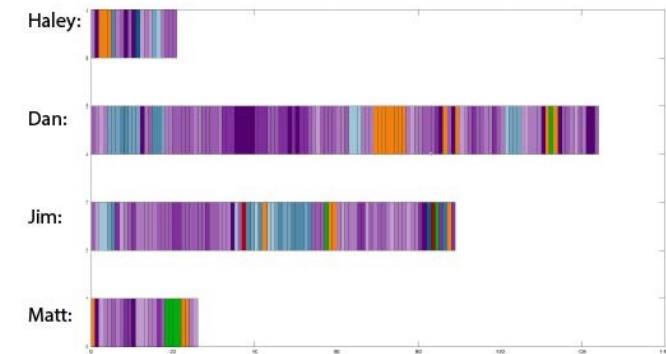


Saccade Maps. The figure shows the results of an algorithm that finds moments of eye fixations within a set of eye tracking data obtained from one individual screening one bag. Each circle shows a separate moment of fixation and the radius of the circle is proportional to time spent on the particular fixation. Currently run using a simple diffusion-based model, a more complex algorithm may be implemented in the future using a Hidden Markov Model (HMM) in order to obtain more accurate data.

Image used to create scarf plots:



Order of agents for every plot:

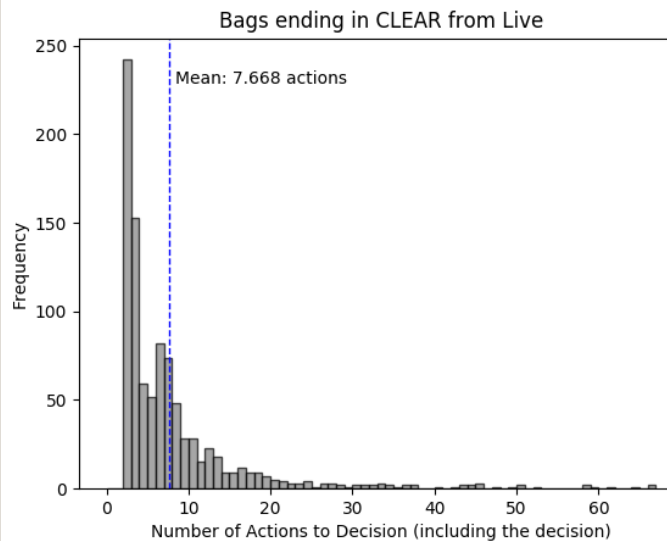
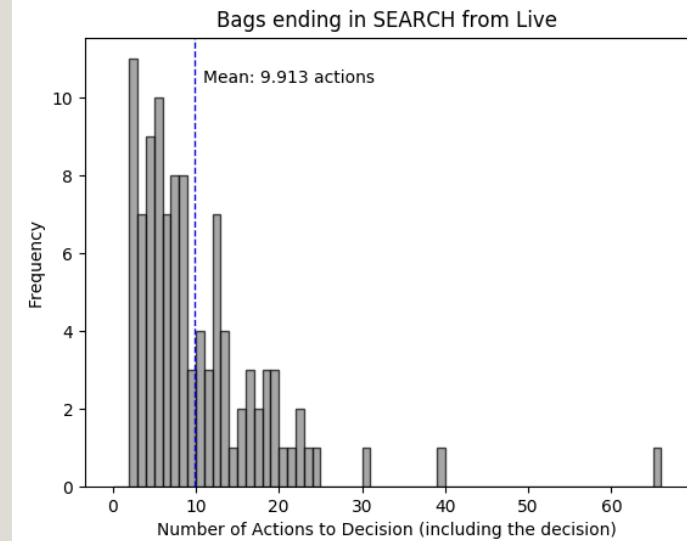
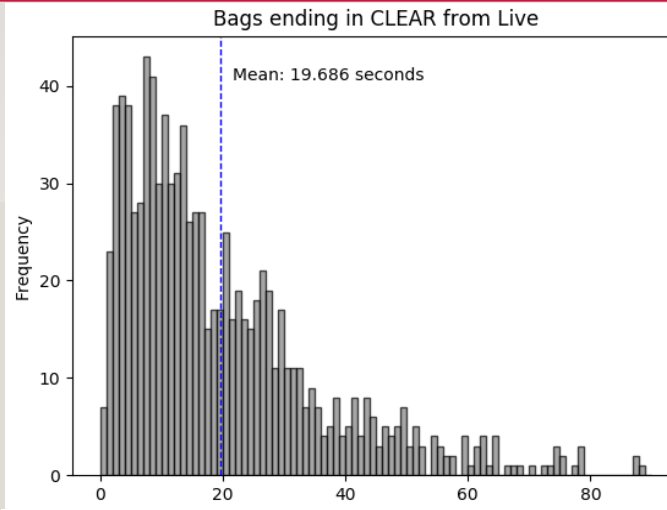
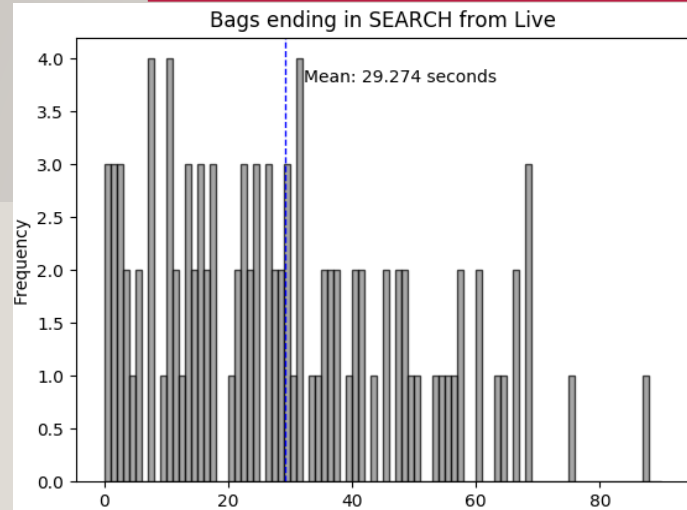


VIDEO TASK ANALYSIS

Number	Actions																
24	Rotate	Clear															
1	Rotate	Mask off	Rotate	Slab	Clear (T)	Clear											
1	Rotate	Mask off	Rotate	Slab	Zoom	Slab	Reset	Slab	Reset	Clear (T)	Rotate	Clear					
1	Rotate	Laptop	Rotate	Laptop	Clear												
1	Rotate	Slab	Reset	Rotate	Clear												
2	Rotate	Slab	Clear														
1	Rotate	Slab	Annotate	Boxing	Miss Nav	Bottle	Search										
1	Rotate	Slab	Reset	Zoom	Rotate	Zoom	Density	Rotate	Screen	Screen	Reset	Zoom	Rotate	Clear			
1	Rotate	Screen	Clear														
1	Rotate	Zoom	Screen	Clear													
1	Slab	Reset	Rotate	Slab	Reset	Annotate	Boxing	Bottle	Rotate	Slab	Reset	Rotate	Annotate	Boxing	?	Search	
2	Slab	Reset	Laptop	Rotate	Screen	Rotate	Clear										
1	Slab	Reset	Rotate	Clear													
2	Slab	Reset	Rotate	Density	Clear												
1	Slab	Reset	Density	Laptop	Zoom	Rotate	Clear										
1	Mask off	Slab	Reset	Rotate	Slab	Reset	Search (T)	Rotate	Reset	Annotate	Boxing	?	Rotate	Search			
1	Mask off	Rotate	Laptop	Rotate	Slab	Laptop	Screen	Rotate	Clear (T)	Clear							
1	Laptop	Rotate	Slab	Annotate	Boxing	Mis Nav	Bottle	Search									
1	Laptop	Rotate	Screen	Rotate	Clear												
1	Zoom	Rotate	Slab	Clear													
1	Threat	Clear (T)	Laptop	Laptop	Slab	Reset	Density	Rotate	Clear								
47																	



SEARCH AND CLEAR TIMES AND ACTIONS



Action	Total Frequency	Average Duration (s)	Average Uses Per Bag
ViewingAreaMousePressed	1718	5.058	2.111
ViewingAreaMouseScrolling_Slab	1437	4.595	1.765
SlabViewClicked	1280	2.592	1.572
NoThreatClicked	1083	10.022	1.330
ViewingAreaMouseWheel	619	0.490	0.760
RefreshClicked	572	0.440	0.703
ViewingAreaMouseScrolling	420	1.338	0.516
SelectingItem	259	1.342	0.318
SlabNextClicked	212	0.379	0.260
ViewingAreaDoubleClicked	198	1.094	0.243
DraggingTransparencySlider	169	2.623	0.208
ThreatClicked	157	7.677	0.193
SlabBackClicked	126	0.545	0.155
ToggledLUTColor	100	1.187	0.123
AnnotateClicked	88	1.271	0.108
BagBarClicked	78	4.233	0.096
UnselectingItem	64	1.637	0.079
ManageTabClicked	58	7.563	0.071
ImageRecallClicked	57	3.397	0.070
RecallImageSelected	45	1.991	0.055
ScreenTabClicked	37	6.937	0.045
RecallDoneClicked	37	3.491	0.045
ToggleShowThreatMask	32	1.690	0.039
NewUserClicked	28	0.030	0.034
ResetClicked	25	0.349	0.031

WHAT WE FOUND AND WHAT WE DID

- Overall search process has variants
 - But a limited number of styles – “Operators have individual sequences in what to look for, having a sequence matters more than what the sequence is.”
 - *Redesigned the GUIs to make all search-styles more effective*
 - *Redesigned the training program/info to speak to these different styles*
- Overall search process has subtasks
 - Mapped all actions required to perform subtasks
 - *Redesigned the GUIs to make all subtasks more effective*
 - *Introduced new tools to make subtasks easier*
- There were patterns of actions
 - Machine learning could be trained to identify developing patterns.
 - *Created a system to make recommendations for next-actions*
- Hardware devices had large impact on performance (HCI)
 - Testing has highlighted some likely winners
 - *Developed control mappings and testing ongoing*