EXPLORING FIELD OF VIEW IN HEAD MOUNTED DISPLAYS FOR MARITIME OBJECT DETECTION

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INTRODUCTION

Maritime *Search and Rescue* (*SAR*) activities involve missions to rescue people that are lost or in danger at sea. Today, still- and video-camera technologies e.g. mounted on drones, are increasingly being used to capture views that may not easily be accessible. To conduct user tests of different image presentations, we implement a *Head-Mounted Display (HMD)* 360° *Field-Of-View (FOV)* simulator to gain new insights into how to improve object detection by operators. Fig. 1. is a computer generated 360° panoramic maritime image. These scenes are often low observability - dark, low contrast, incorrect brightness, reflections off the water, weather – cloud, fog, rain, waves, sea spray. In addition, the objects may be far away and appear small. Objects of interest can include people, boats, ships and aircraft.

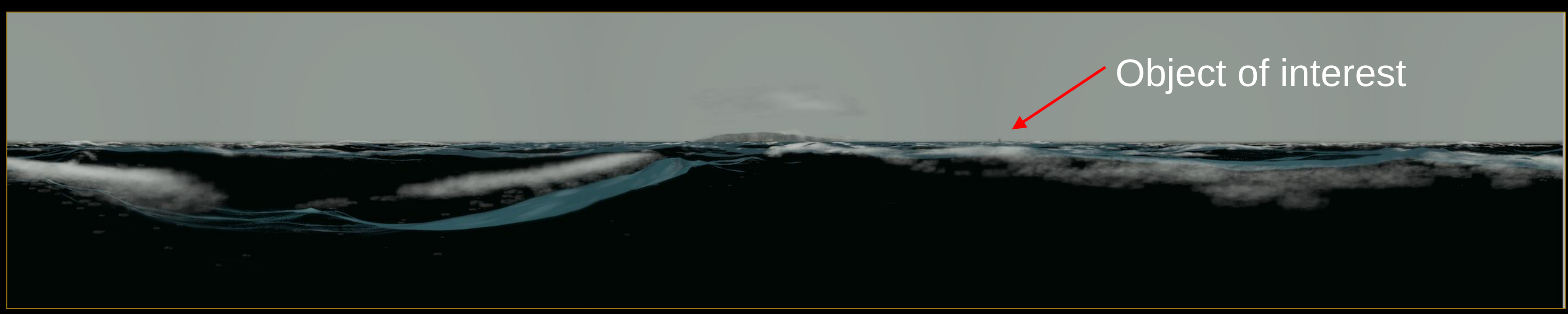


Figure 1. 360° panoramic maritime imagery. Operators perform an object detection task when viewing this imagery in a head-mounted display

AIM

Identify the most effective FOV and image representation (original, Canny, inverse) for object detection when viewing a maritime scene using a Head-Mounted Display.

METHODOLOGY

- 5 maritime images with objects of interest at 1km at random bearings (object represented by 4-6 pixels).
- 15s to detect object of interest.
- Head Mounted Displays:
  - i) HTC Vive[1] (resolution 2160x1200)
  - ii) Oculus Go[2] (resolution 2560 x 1440).
- 45 tests (5 images x 9 representations (3 FOVs x 3 filters)).
- 5 subjects.

Figure 2. User trial at the Curtin HIVE

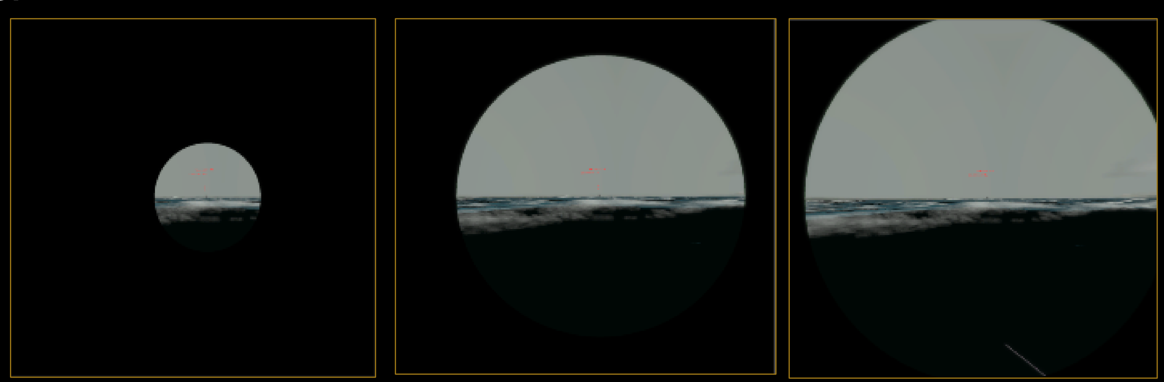
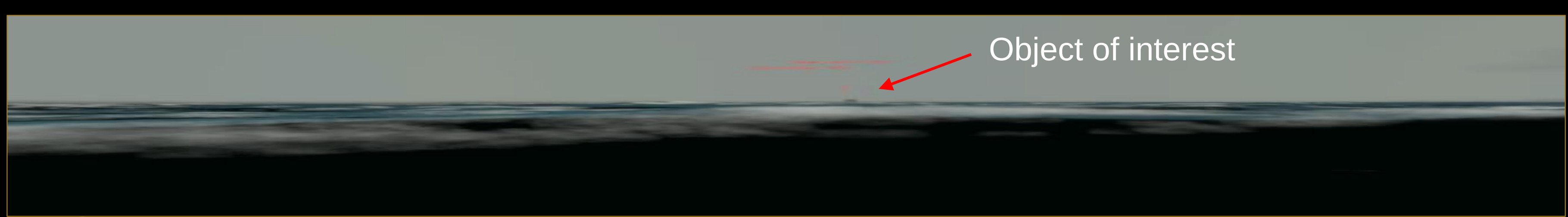
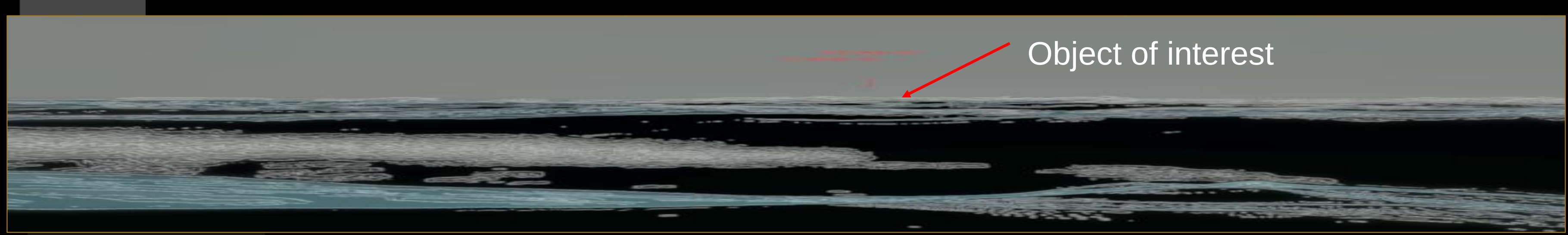


Figure 3. a) 30º FOV; b) 70º FOV; and c) 85º FOV



a) Original image



b) Canny filter

c) Inverse filter

Figure 4. Three image representations of the maritime scene: a) original; b) Canny; and c) inverse

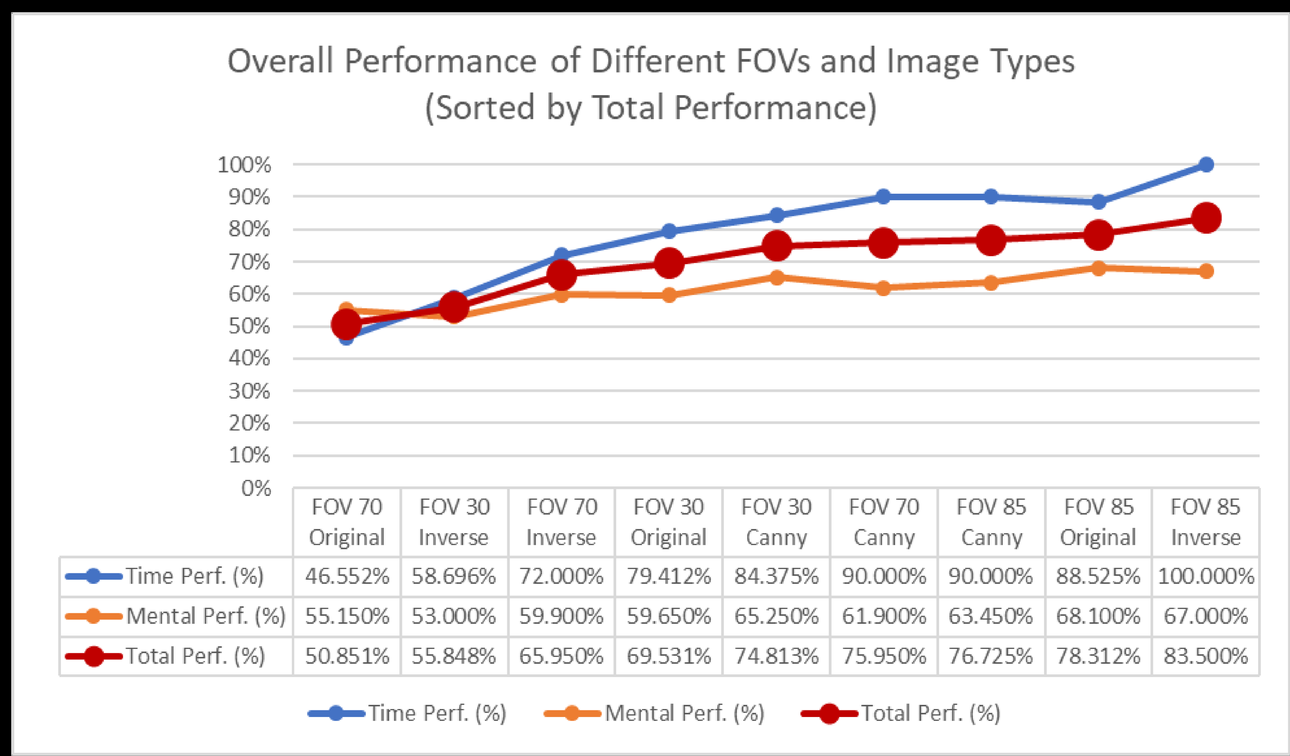
INSTRUCTIONS FOR USING THE DEMO

- Experience the FOV simulator by putting on the Oculus Go HMD.
- One at a time, you will be shown 5 maritime images at different FOVs and image representation.
- Objects of interest are at a distance of 1km at random bearings.
- You have 15s to detect object of interest.
- Indicate to the demonstrator when you have detected the object of interest.
- There are 45 test images altogether (5 images x 9 representations (3 FOVs x 3 filters)).
- If you like, you can give us feedback via a NASA-TLX [1] survey.

METRICS

- Experiments were measured using the *NASA-TLX (Task Load Index)* [1]. NASA-TLX assesses mental demand, physical demand, temporal demand, performance, effort, frustration, time, accuracy and memory.
- High confidence self-perceived mental performance and physical demand were normalised.

RESULTS



	FOV 70 Original	FOV 30 Inverse	FOV 70 Inverse	FOV 30 Original	FOV 30 Canny	FOV 70 Canny	FOV 85 Canny	FOV 85 Original	FOV 85 Inverse
Time Perf. (%)	46.552%	58.696%	72.000%	79.412%	84.375%	90.000%	90.000%	88.525%	100.000%
Mental Perf. (%)	55.150%	53.000%	59.900%	59.650%	65.250%	61.900%	63.450%	68.100%	67.000%
Total Perf. (%)	50.851%	55.848%	65.950%	69.531%	74.813%	75.950%	76.725%	78.312%	83.500%

Figure 5. Overall performance of different FOVs and Image Types

- The wide FOV allowed users to perform the object identification task more accurately and quickly with both higher time and mental performance.
- Users observing the Canny image also performed well, where results for 30°, 70° and 85° FOVs are grouped together towards the right of Fig. 5.
- With the small 30° FOV, time and mental performance were relatively different for each image representation compared to other FOV values, meaning small FOVs are more sensitive to image representation.

DISCUSSION

- Object detection relies on first the peripheral vision to scan the scene and then central vision to perform the object identification.
- Wide FOVs give the user more immediate information to analyse the scene quickly before achieving object identification.
- The Canny image was most successful, isolating areas in the image to improve object detection.
- The inverse image was also successful, offering segmentation of the image into areas; it was lower contrast and had less clutter and noise, for better object detection.

ACKNOWLEDGMENT

We thank Richard Palmer, Ryan Day and Jesse Helliwell (Curtin HIVE) for programming.

REFERENCES

[1] Hart, S. G. and Staveland, L. E., Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research, Advances in Psychology, Vol. 52, 139-183, 1998.

360º panoramic image of the Curtin HIVE (Hub for Immersive Visualisation and eResearch) visualisation facility

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