Rotary Wing DVE Solution
Proof Of Concept
Live Demonstration

Erez Nur, Flare Vision LTD.
erez@flare.co.il

Introduction

- What is the problem
  - – Environmental problem: degraded visual conditions
  - – Human factor dependant
- Contributing factors
  - – Visual conditions
  - – Height above terrain
  - – terrain shape
  - – Surface objects
  - – Aircraft type
  - – Pilot’s Mission

Degraded Visual Environments

Aircraft Induced DVE


Brownout


Whiteout

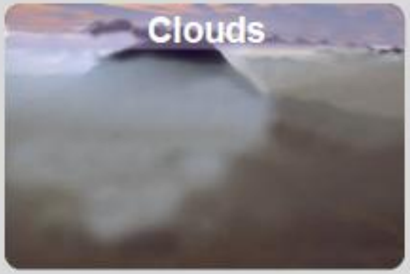
Aircraft Independent Degraded Visual Environments


Smoke


Sand / Dust


Fog


Rain


Clouds


Snow


Smog


Night

© 2008 Michael Yon

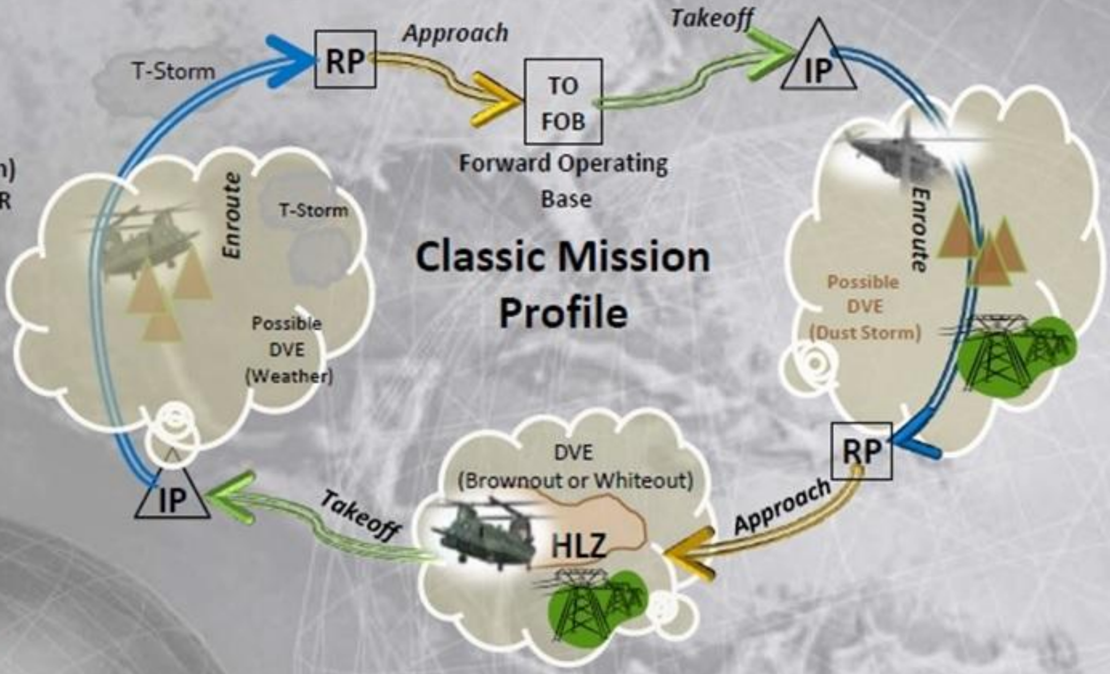

Flat Light

DVE – Reduced visibility of potentially varying degree, wherein situational awareness and aircraft control cannot be maintained as comprehensively as they are in normal visual meteorological conditions and can potentially be lost.

"We own the night,…" but what about the other DVEs?

DVE… More than Just Brownout

Degraded Visual Environment (DVE)



ENROUTE

- Flight Path
- Obstacle Database
- High Res DEM
  (i.e. Buildings/Terrain)
- Ridgelines with MMR
- Tower Detection
  with MMR
- Integrated SVS/FLIR
- Threats
- BFT
- Sensed Wires
- Other Aircraft

TAKEOFF

- Flight Path
- Obstacles Database
- High Res DEM
  (i.e. Buildings/Terrain)
- Ridgelines with MMR
- Tower Detection with MMR
- Integrated SVS/FLIR
- Threats
- BFT
- Sensed Wires
- Other Aircraft

Note: Red indicates the capability gap that cannot be filled without the DVE Sensor

APPROACH

- Flight Path
- Obstacles Database
- Ridgelines with MMR
- Tower Detection with MMR
- High Res DEM
  (i.e. Buildings/Terrain)
- Integrated SVS/FLIR
- Threats
- BFT
- Sensed Wires (thru dust)
- Sensed Obstacles (thru dust)
- Sensed Ditches
- Other Aircraft

LANDING

- Flight Path
- Landing Point
- High Res DEM
  (i.e. Buildings/Terrain)
- Integrated SVS/FLIR
- Threats
- BFT
- Sensed Wires
  (thru dust)
- Sensed Obstacles
  (thru dust)
- Sensed Ditches
- Other Aircraft

HFM-162 R&T work group

- Work group fields of interest
  - Physiological and Perceptual Limitations
  - Human Machine Interfaces
  - Technology: Sensors and Data Processing
  - Risk Management Strategies to Counter Brownout

The Technologies assessed by the NATO Group:

- Analysis of Sensor
  - Radar
  - Laser (LIDAR/LADAR)
  - Passive Electro-Optical
  - Visible Waveband or Low Light Level TV Cameras
  - Passive MMW Imaging Sensor
  - Thermal Imaging Sensor

The Technologies assessed by the NATO Group:

- Human Machine Interface/Display Sub-Systems
  - Head-Mounted Display
  - Symbology
  - Tactile
  - Flight Control
  - Haptic Cueing with Active Sidesticks for Helicopter Operation
  - Dimensional Audio
  - Head-Up Displays
  - Helmet-Mounted Sight and Display

The work group influence on our demo

- Loosing visual is not just an optical issue
- The solution is complicated
  - Technology
  - Human factors
- The “client” will not tolerate failure of any kind (testing method)

The Demo

Development philosophy

- Natural blindness phenomenon:
  - A blind man in his home
  - A bat
- Characteristics of the blind man
- Characteristics of the bat

Blind man – at home

- Knows where he is (fully orientated)
- Knows where everything is
- “sees” the scene in his head

Blind man – at home

- method
  - Knows where he is (fully orientated)
  - Knows where everything is
  - “sees” the scene in his head
- Problems
  - Loss of orientation
  - Scene changes

The bat

- method
  - Uses sonic signaling for “mapping”
  - Acts on real time
- Problems
  - Hectic flight pattern

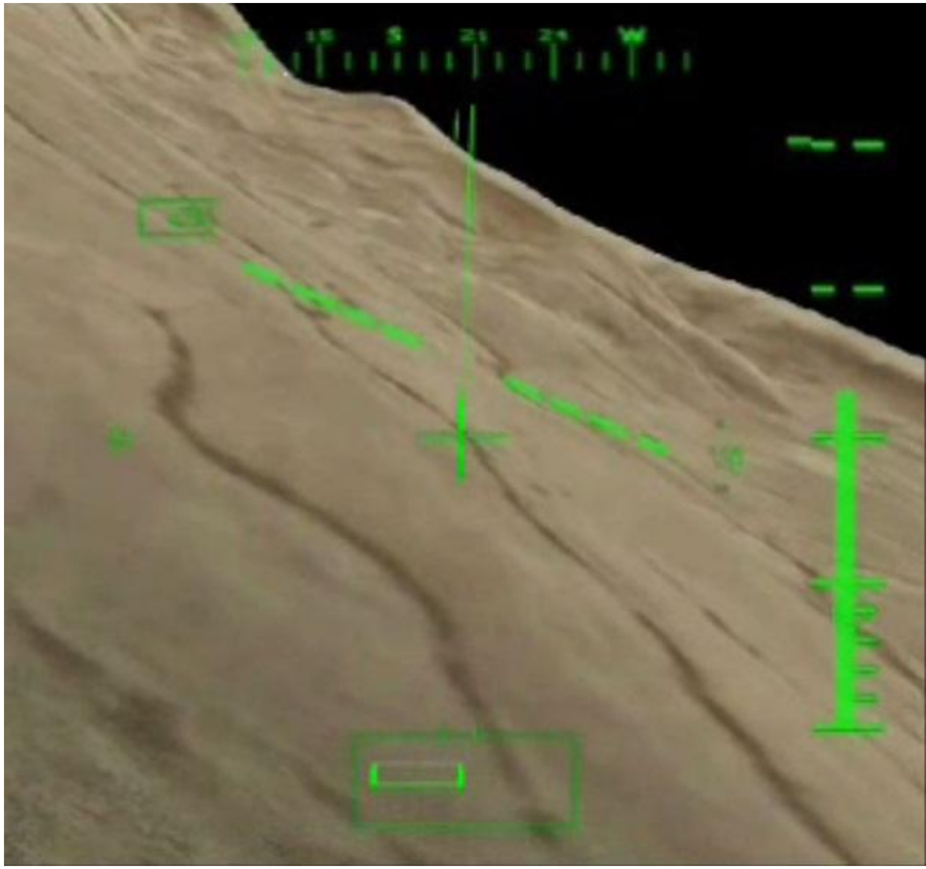
Our vision

- To combine both methods
  - Fly as if you fully “see” the scene
  - Warning of orientation problems in time
  - Embed sensor to gain bat capabilities without loosing the ability to fly “smoothly”

The solution

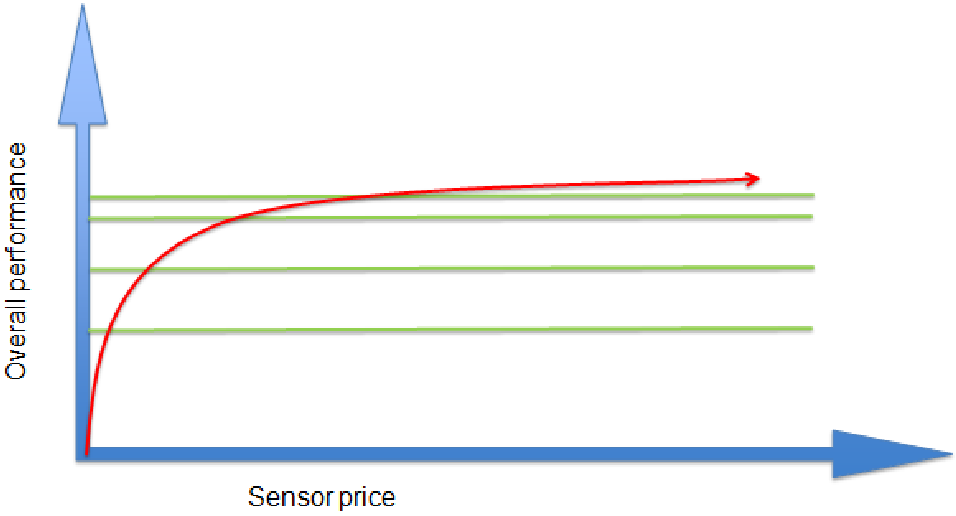
- A good terrain model (DTED + Orthophoto)
- An application (mainly a rendering engine)
- A sensor for unexpected obstacles
- A conformal head mounted display

Rendering



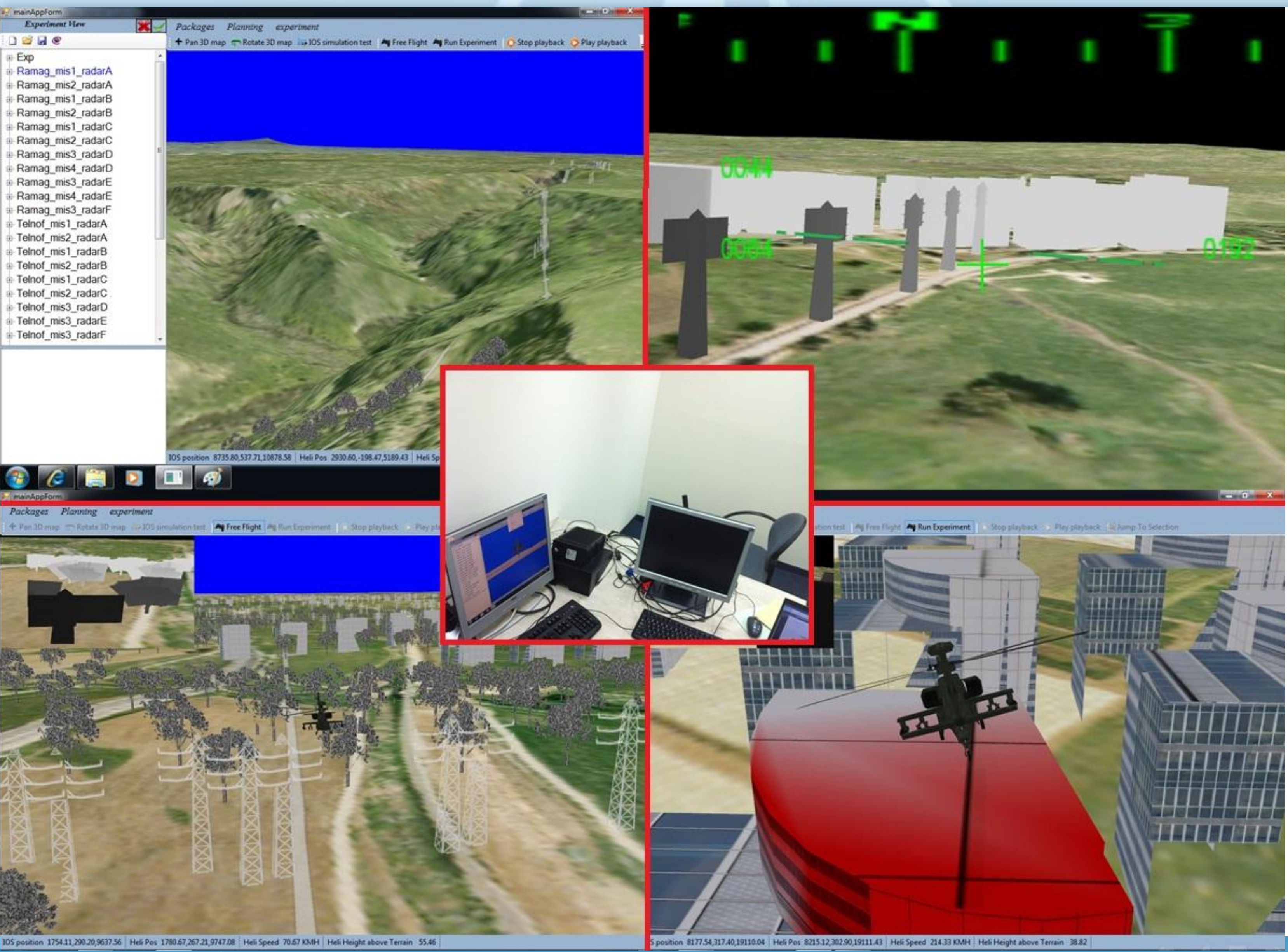
Simulations phases and lessons learned

- So how do we characterize a sensor:
  - Easy
    - 10 miles visual
    - 1 mm accuracy
    - 0 latency
    - 30 Hz
  - And the cost of it ????



Simulations phases and lessons learned

- Simulation of the sensor:
  - We built a simulation
  - We created a terrain DB + obstacles
  - We used created an obstacle free version
  - The pilot flew on the obstacle free DB
  - The simulated sensor sampled the full DB
  - The sensor product was embedded on the pilots view in RT according to sensor charecteristics



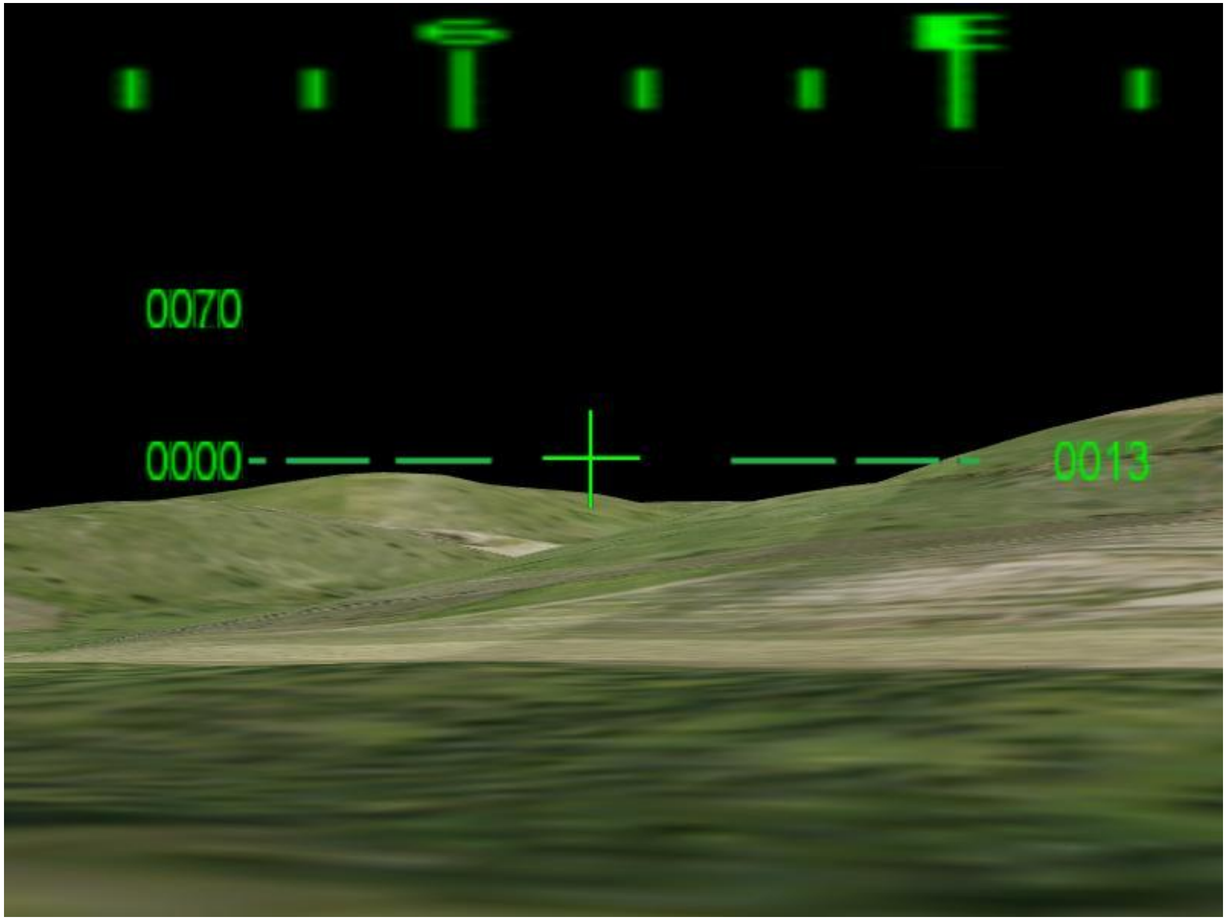
Exp
Ramag_mis1_radarA
Ramag_mis2_radarA
Ramag_mis1_radarB
Ramag_mis2_radarB
Ramag_mis1_radarC
Ramag_mis2_radarC
Ramag_mis3_radarD
Ramag_mis4_radarD
Ramag_mis3_radarE
Ramag_mis4_radarE
Ramag_mis3_radarF
Telnof_mis1_radarA
Telnof_mis2_radarA
Telnof_mis1_radarB
Telnof_mis2_radarB
Telnof_mis1_radarC
Telnof_mis2_radarC
Telnof_mis3_radarD
Telnof_mis3_radarE
Telnof_mis3_radarF

IOS position 8735.80,537.71,10878.58 | Heli Pos 2930.60,-198.47,5189.43 | Heli Sp

IOS position 1754.11,290.20,9637.56 | Heli Pos 1780.67,267.21,9747.08 | Heli Speed 70.67 KMH | Heli Height above Terrain 55.46

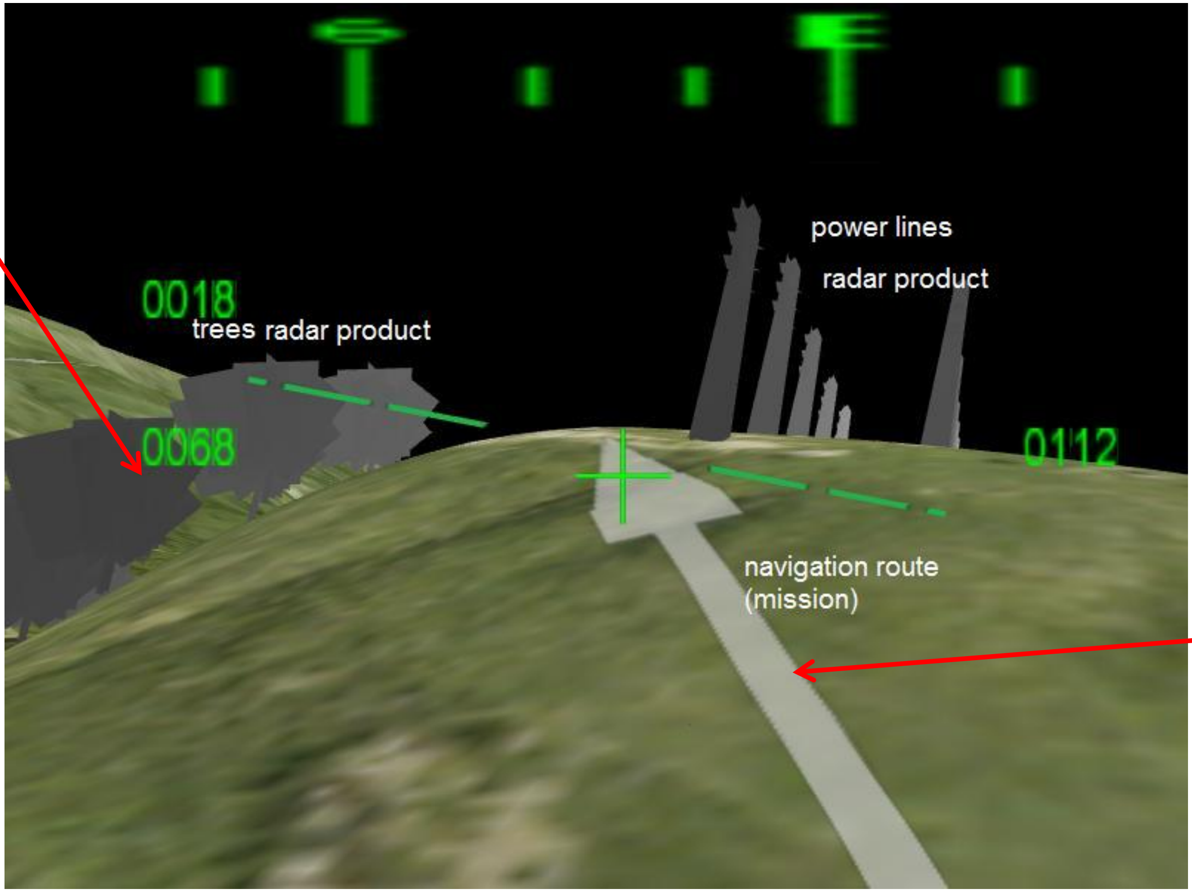
S position 8177.54,317.40,19110.04 | Heli Pos 8215.12,302.90,19111.43 | Heli Speed 214.33 KMH | Heli Height above Terrain 38.82

LAB - Pilot View

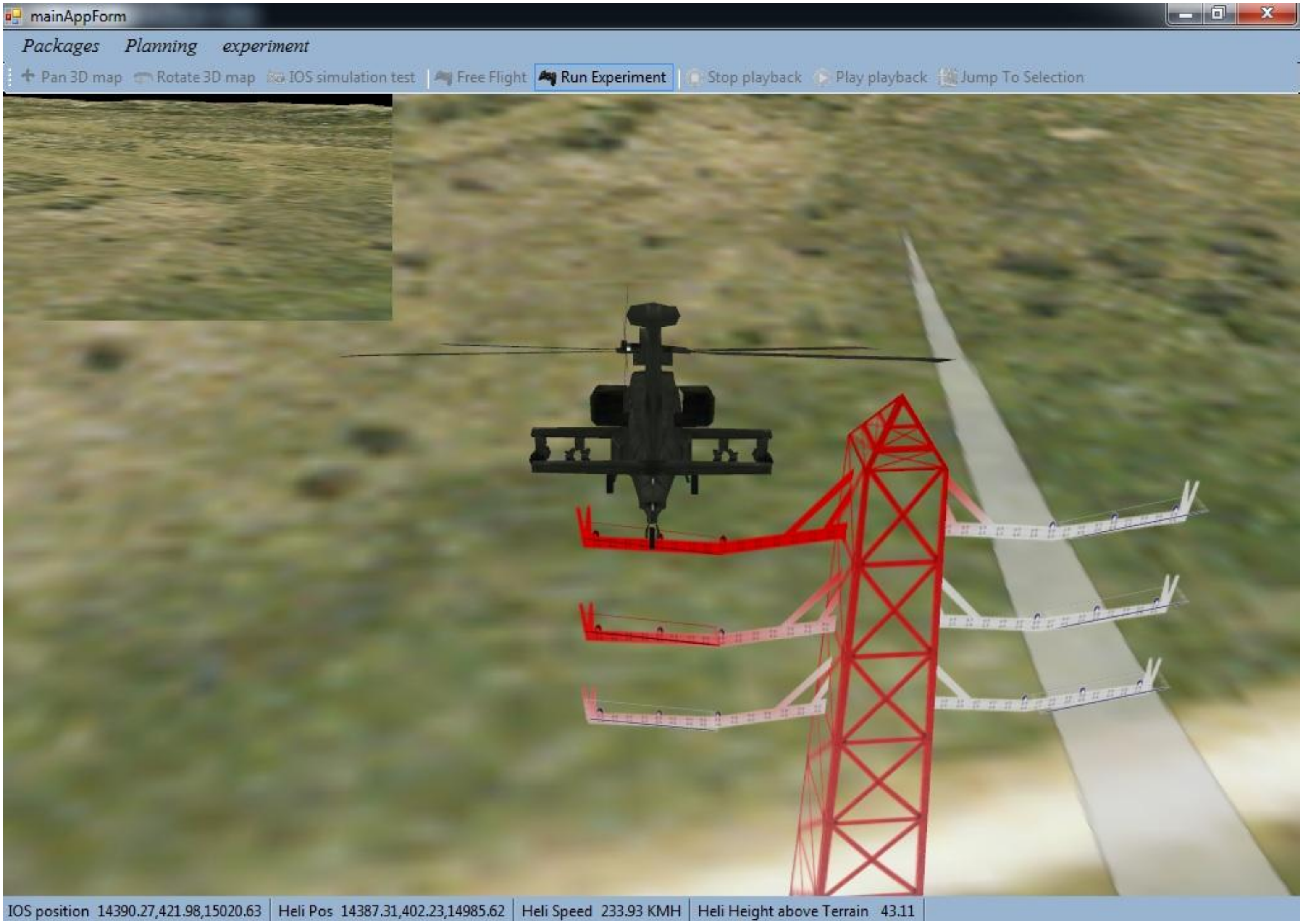


LAB - Pilot View + Immersed Sensor Data

Sensor data



Navigation route



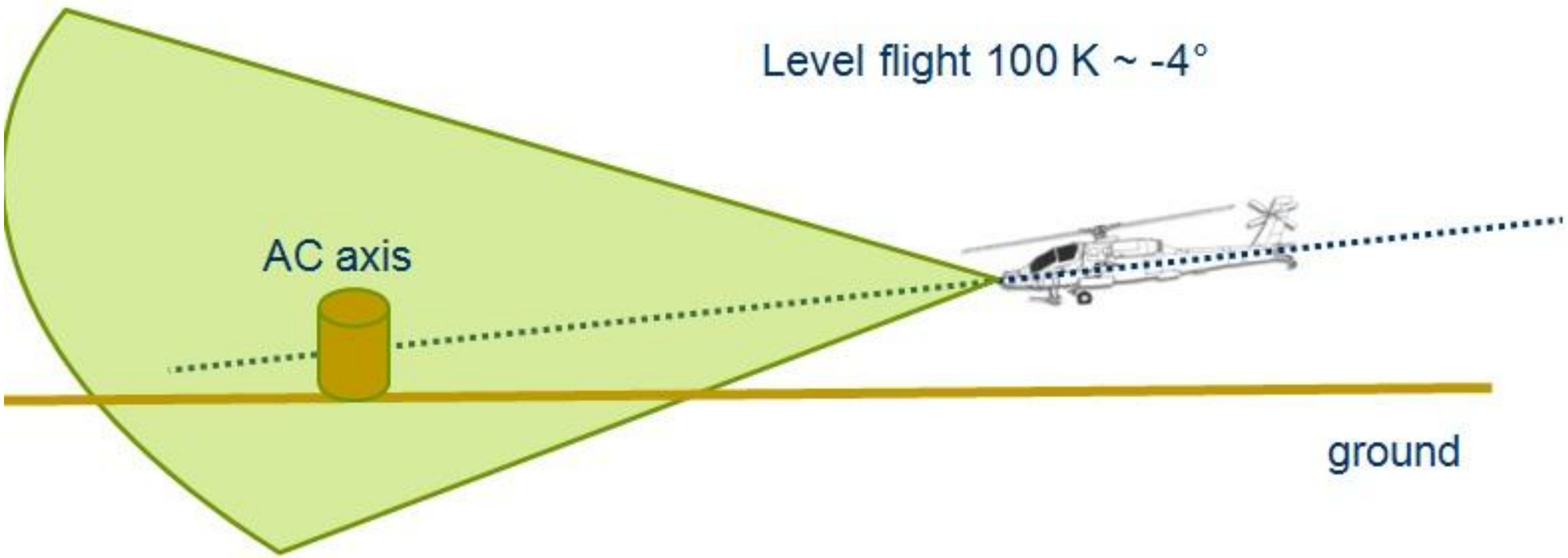
IOS position 14390.27,421.98,15020.63 | Heli Pos 14387.31,402.23,14985.62 | Heli Speed 233.93 KMH | Heli Height above Terrain 43.11

Simulations phases and lessons learned

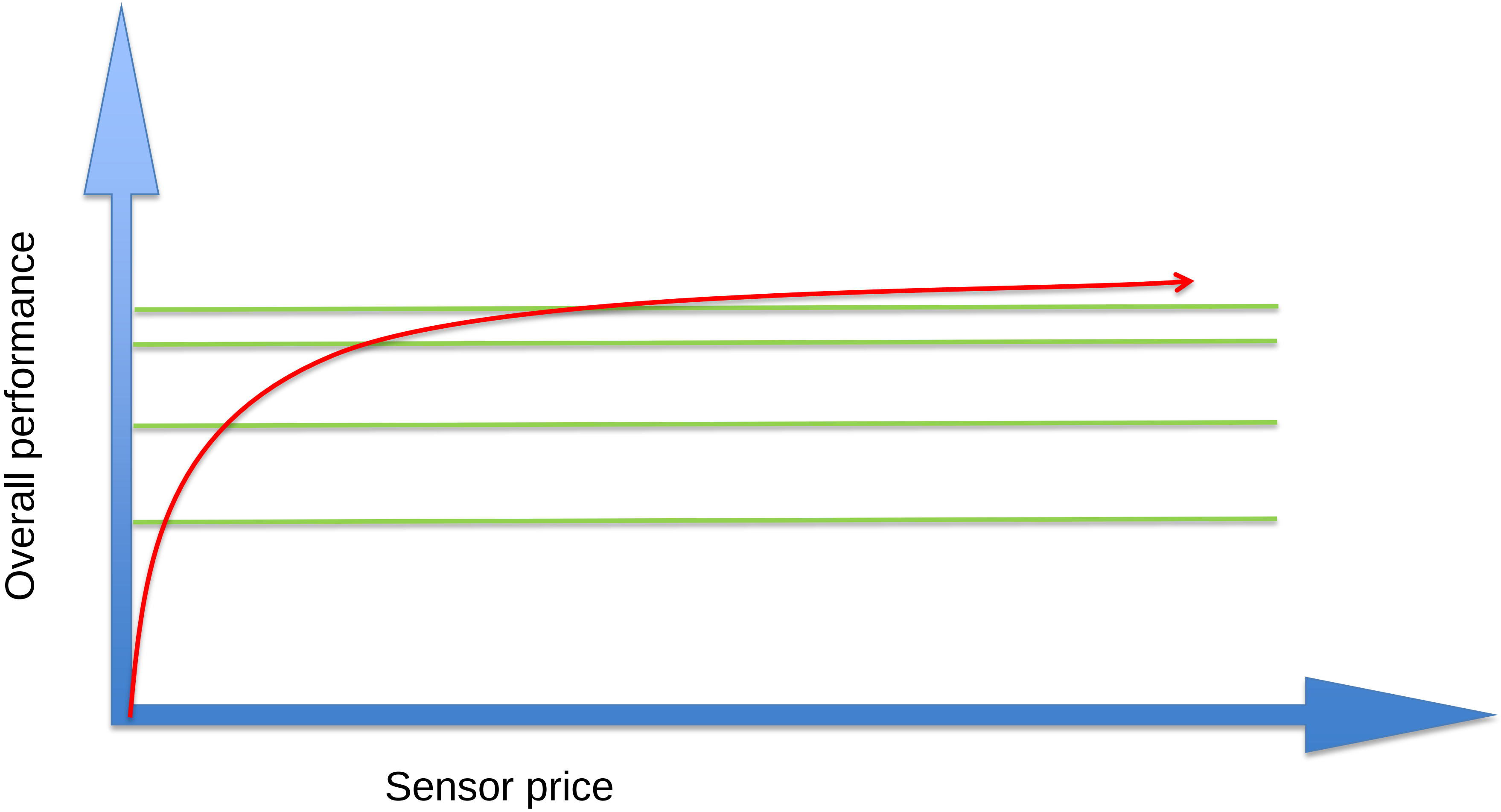
- Over 170 sorties were flown on the simulation
  - Different pilots (AH64, AH1, UH60, Ch53, Bell 206)
  - Different terrain shapes
  - Different maneuvering
  - Different scenes

LAB - Results

- **Validation of the concept**
- **Very specific requirements were concluded**



Simulations phases and lessons learned



Simulations phases and lessons learned

- Trade offs
  - range -> AC speed
  - FOR -> maneuvering
  - accuracy/latency -> general performance
- Installation issues (AC pitching)
- HMI issues (how to embed the signals on model)

Integration to the aircraft

- Proof of concept
  - Should be inexpensive
  - Should be valid
- Solution:
  - Integrating the app on an AH-64 (A)
  - No sensor at this time
  - Using Bag training methodology to validate

Integration to the aircraft

- Integration phase was surprisingly easy
  - Get NAV data from IMU
  - Get helmet attitude from helmet
  - Generate the visual in a rugged computer
  - Convert the visual to RS343 standard
  - Connect directly to the HMD:
    - using an a/b switch
    - The pilot can choose from cockpit PNVS or app

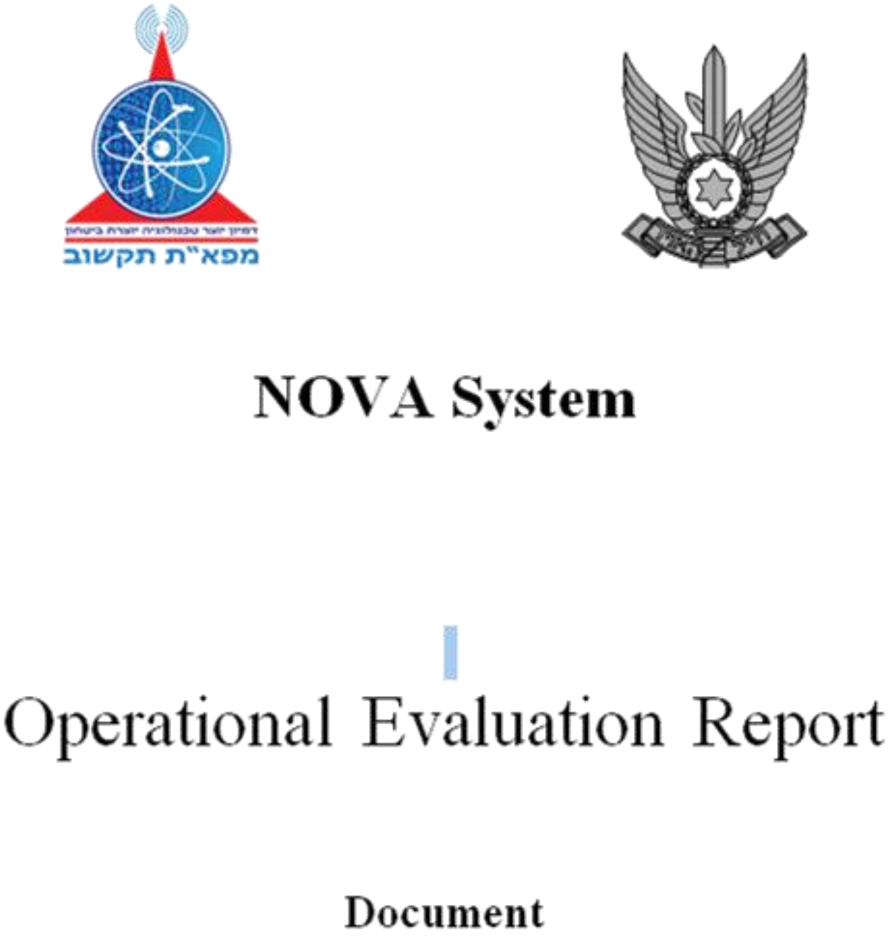
Integration to the aircraft

- One problem:
  - Could not synch with the SG
- Solution:
  - Bypass the SG, create our own symbols

Test flights – methodology and results

- The system flew several flights
    - IAF test center conducted the experiment
    - Cooper Harper for quality of handling
    - Bag flight, day time , front seat safety pilot
    - Build up level of maneuvering
    - Ending with 50’ AGL, 100 K free flight

Israel Air Force Conclusion From Real Test Flights



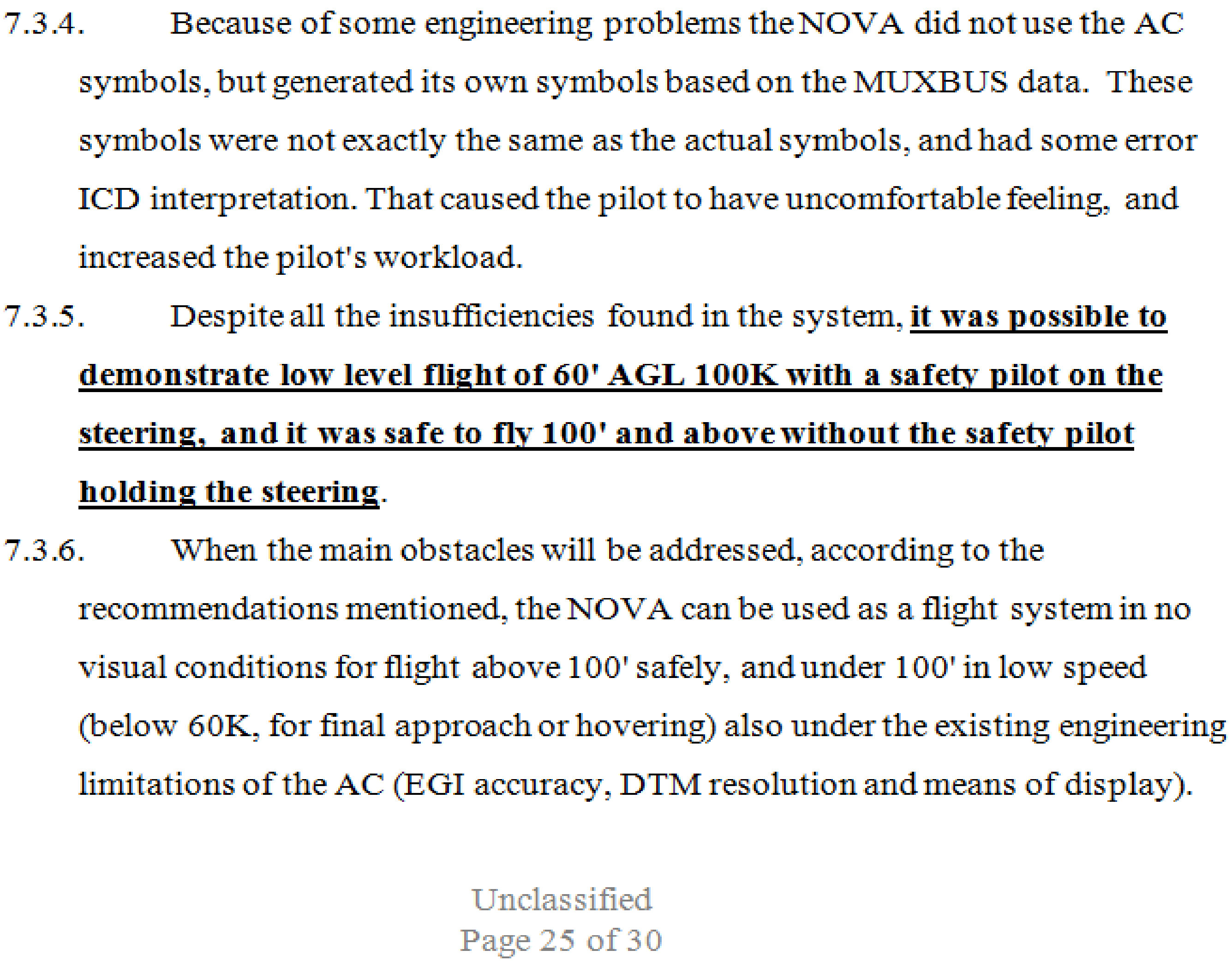
מפא"ת תקשוב

NOVA System

Operational Evaluation Report

Document

Israel Air Force Conclusion From Real Test Flights



7.3.4. Because of some engineering problems the NOVA did not use the AC symbols, but generated its own symbols based on the MUXBUS data. These symbols were not exactly the same as the actual symbols, and had some error ICD interpretation. That caused the pilot to have uncomfortable feeling, and increased the pilot's workload.

7.3.5. Despite all the insufficiencies found in the system, **it was possible to demonstrate low level flight of 60' AGL 100K with a safety pilot on the steering, and it was safe to fly 100' and above without the safety pilot holding the steering**.

7.3.6. When the main obstacles will be addressed, according to the recommendations mentioned, the NOVA can be used as a flight system in no visual conditions for flight above 100' safely, and under 100' in low speed (below 60K, for final approach or hovering) also under the existing engineering limitations of the AC (EGI accuracy, DTM resolution and means of display).

Unclassified
Page 25 of 30

Proprietary Information