Harvis

Human Aircraft Roadmap for Virtual Intelligent System

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

HARVIS
Cognitive assistant in the cockpit

Presenter: Antonio L. Rodriguez (SKYLIFE) and Stefano Bonelli (DEEP BLUE)

Date: 2nd September 2020

Place: Online - EASN Conference

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Project Overview

Context:

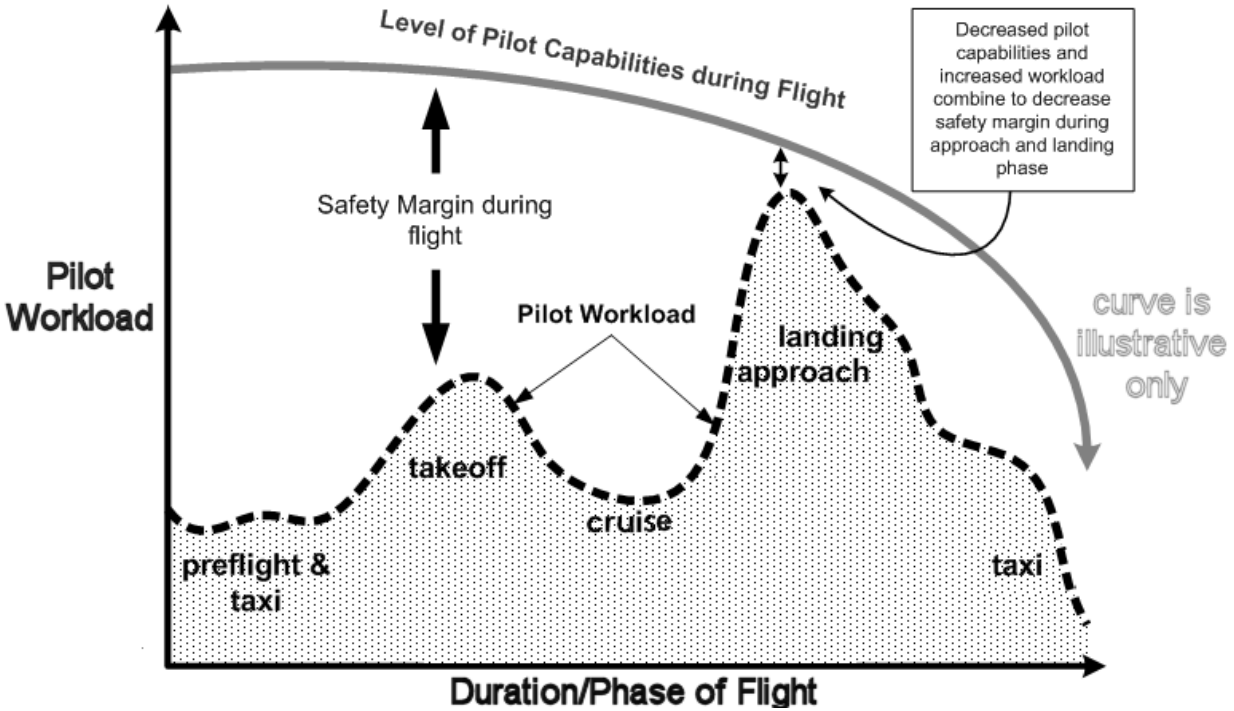
- The growth of air traffic
- Mobility Changes:
  - Integration of unmanned aircrafts into the European air space
  - Tasks' automation
  - Role of the humans in complex systems

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Project Overview

Context:

- Peak workload conditions:
  - Unpredictable situations
  - Difficult meteorological conditions
  - Multiple system failures or cockpit crew incapacitation, etc.
- Situation awareness
  - Pilot to have more and more information related to the flight conditions in lockstep with tighter restrictions to consider in their flight trajectories



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Project Overview

Harvis

Clean Sky 2 project ||| From June 2019 to December 2021

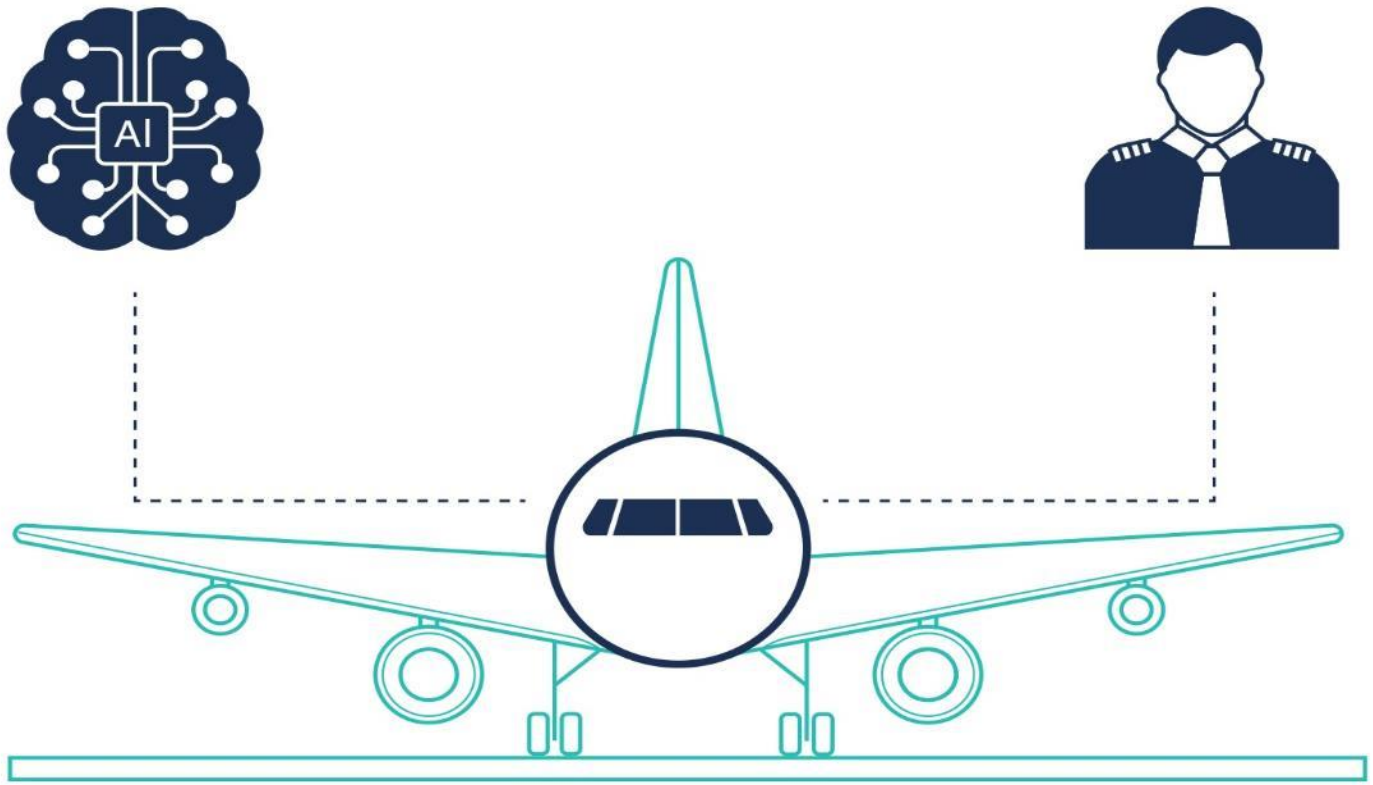
Harvis

Human Aircraft Roadmap for Virtual Intelligent System

Identify how cognitive computing algorithms implemented in a digital assistant could **support the decision making of a single pilot in complex situation**

HARVIS

Bringing Artificial Intelligence into the cockpit



outcomes

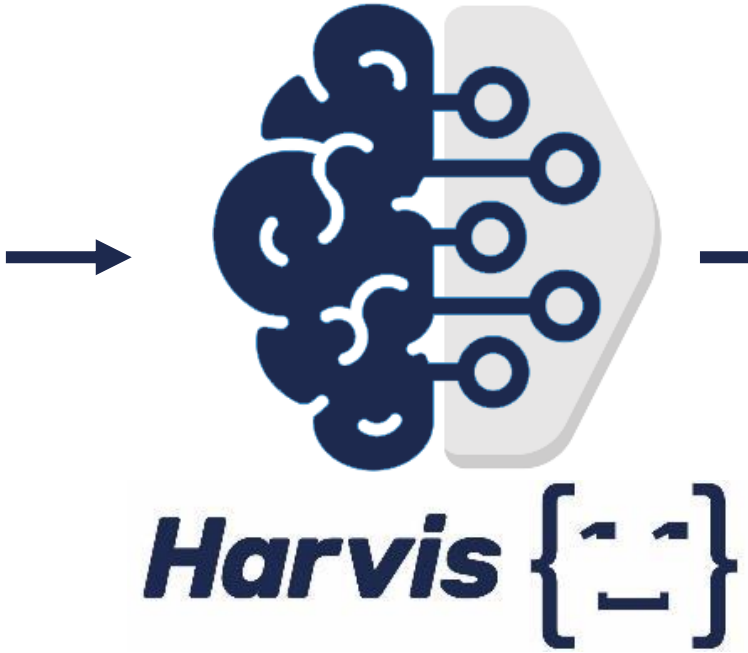
- Use cases
- Digital assistant concept
- Design guidelines
- Roadmap for AI deployment

Project Overview

Ambition

Inputs

- **Monitor Pilot's state and actions**
- **Pattern Recognition:**
  - ➢ **Flight data**
  - ➢ **Aircraft data**
  - ➢ **Environmental data**
- **Interaction between pilots and flight deck**
- **Pilot feedback through controls**



To provide

- **Information requested by the pilots**
- **Advisory alert if unsuitable decision are taken**
- **Automatic data interpretation**
- **Anticipate pilots' needs**
  - ➢ **Suggest new flight plans**
  - ➢ **Calculate optimal descent profiles**
- **Record the obtained data**

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Achievements

Preliminary results

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Use Case 1: Non-Stabilized Approach

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

UC 1: Non-Stabilized Approach support

Conceptual problem:

In single pilot operations, the Pilot Flying won't have the support and the monitoring of the second pilot to make the appropriate decisions

97% of non-stabilized approach are not followed by a go-around decision that is required by Standard Operating Procedures (SOP). As a consequence, an IA based on SOP only would go against pilot decision during most of non-stabilized approach

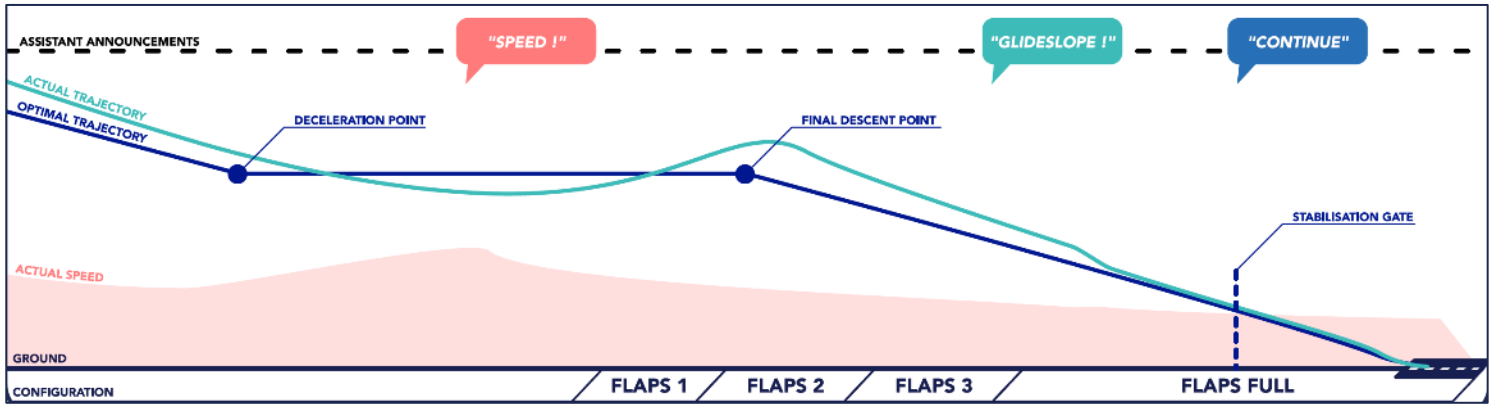
An AI based on the expertise of many pilots will **assist** the pilot during the approach by **alerting** about parameters deviations and **supporting** the go-around decision

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Objective of this support

Based on the expertise of many pilots:

1. To support pilot's decision making during the approach
2. To support pilot for approach stabilization



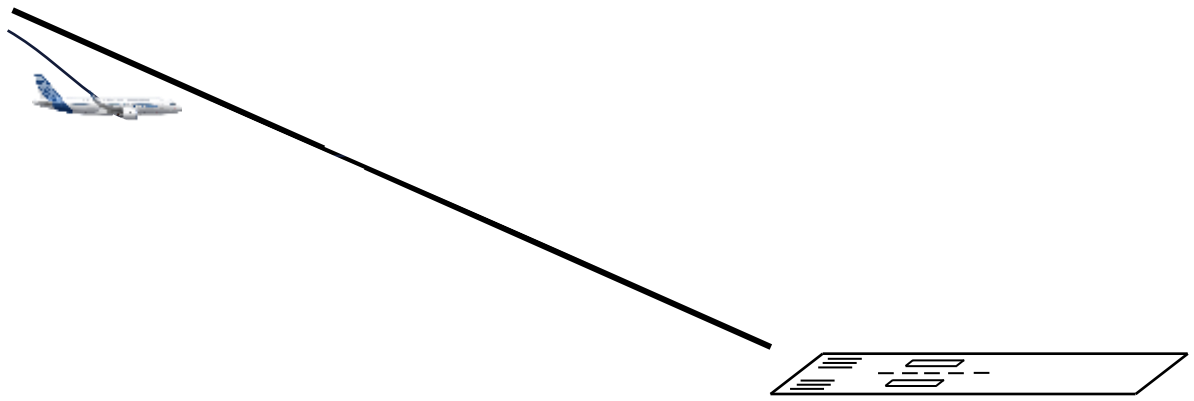
The assistant could:

- Provide support for go-around decision making
- Alert the pilot in case of parameter deviations
- Suggest corrective actions

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 1

Context : The AC has an unusual trajectory approaching stabilization point



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 1

Context : The Aircraft has an unusual trajectory approaching stabilization point

Specific pilot's behaviour: The pilot does not manage to stabilize the Aircraft for landing

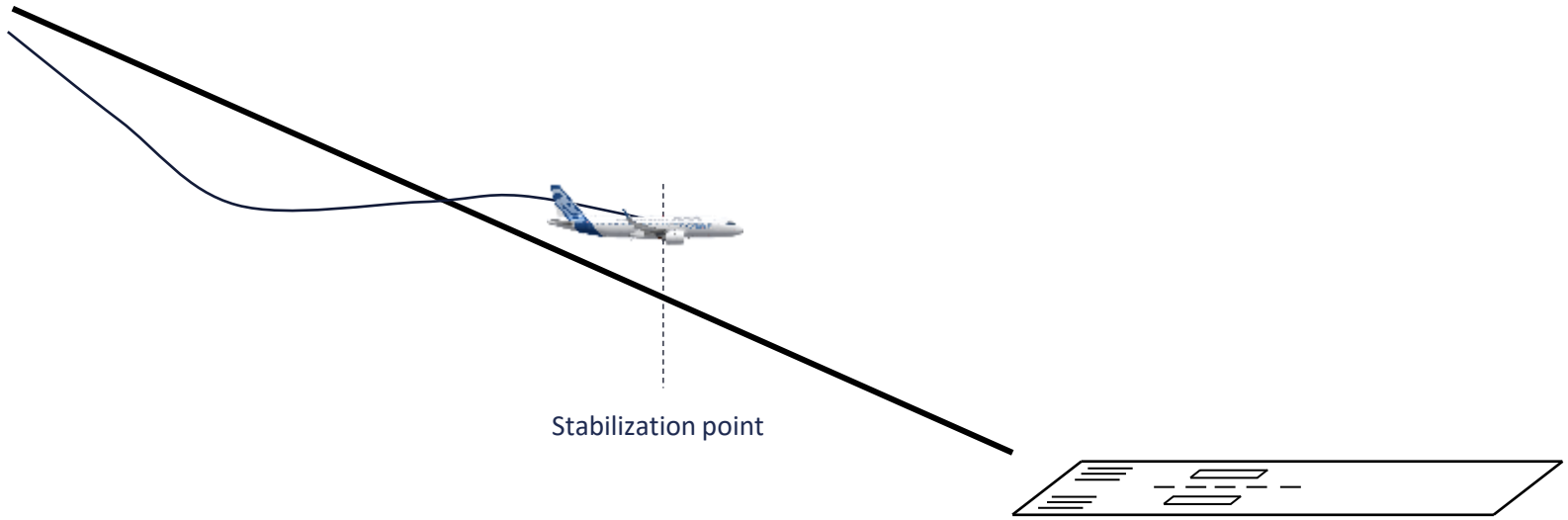
This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 1

Context : The Aircraft has an unusual trajectory approaching stabilization point

Specific pilot's behaviour: The pilot does not manage to stabilize the Aircraft for landing

Expert system: The AI detects based on many pilots expertise that the situation normally lead to a go-around



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

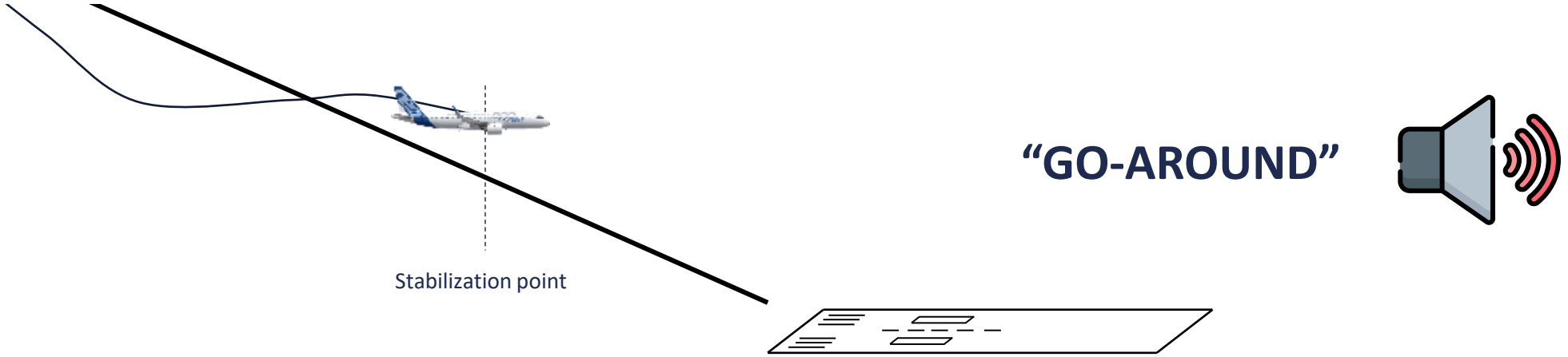
Non-Stabilized Approach support – Situation 1

Context : The Aircraft has an unusual trajectory approaching stabilization point

Specific pilot's behaviour: The pilot does not manage to stabilize the Aircraft for landing

Expert system: The AI detects based on many pilots expertise that the situation normally lead to a go-around

Digital assistant: During the final step of the approach, a voice advises the pilot to go-around



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 2

Context: The automatic system fails or is disconnected by the pilot. The pilot has to manually control the plane

AUTOMATIC SYSTEM

MANUAL SYSTEM

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 2

Context: The automatic system fails or is disconnected by the pilot. The pilot has to manually control the plane

Specific pilot's behaviour: Pilot is undecided or overwhelmed by the situation and doesn't check some important flight parameters in the control panel (e.g. altitude)

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Situation 2

Context: The automatic system fails or is disconnected by the pilot. The pilot has to manually control the plane

Specific pilot's behaviour: Pilot is undecided or overwhelmed by the situation and doesn't check some important flight parameters in the control panel (e.g. altitude)

Expert system: The developed eye-tracking algorithm detects that the pilot is not paying enough attention to the area corresponding to the altitude

ROI of the **altitude** variable

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

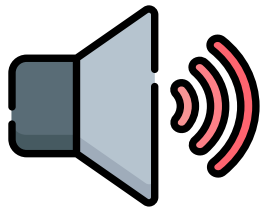
Non-Stabilized Approach support – Situation 2

Context: The automatic system fails or is disconnected by the pilot. The pilot has to manually control the plane

Specific pilot's behaviour: Pilot is undecided or overwhelmed by the situation and doesn't check some important flight parameters in the control panel (e.g. altitude)

Expert system: The developed eye-tracking algorithm detects that the pilot is not paying enough attention to the area corresponding to the altitude

Digital assistant: After pilot misbehavior identification, a voice system issues a specific indication

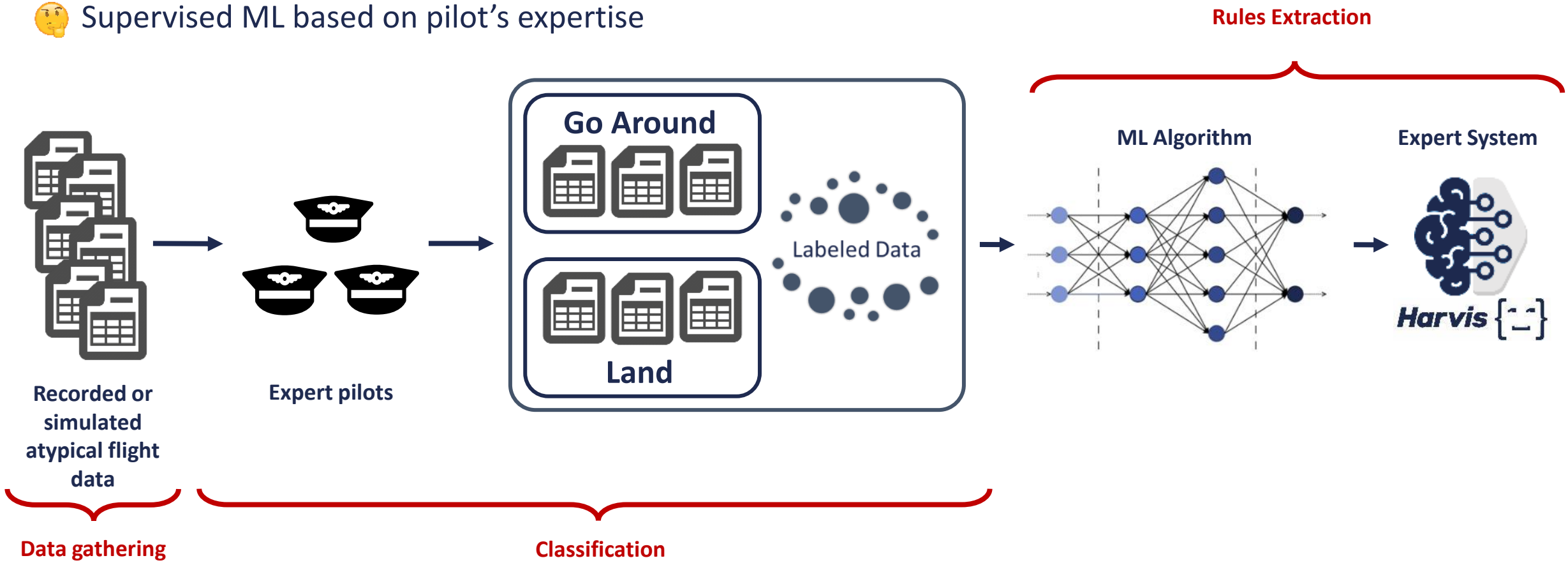


"CHECK ALTITUDE"

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – AI training (how the AI is developed)

🤔 Supervised ML based on pilot's expertise



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Non-Stabilized Approach support – Test with IA (how the IA is validated):

Generate different scenarios

Test on ENAC's Simulators

Validation

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Below glideslope scenario

Below glideslope scenario

Below glideslope scenario

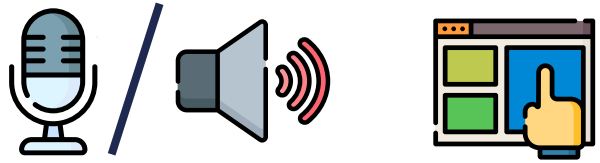
Use Case 2: Diversion assistance

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

UC 2: Description

In case of diversion or rerouting, assist the pilot and provide support in the decision-making process, suggesting a descent profile based on previous flights and innovative trajectory generation algorithms using AI reducing his/hers workload

Visual/aural HMI allowing verbal and tactile interaction



Situations considered:

Severe emergency: Provide the best options and feasible trajectories calculated, considering the aircraft restrictions

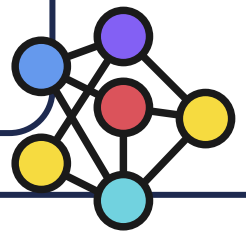
Light emergency: This situation is not time restricted, so the assistant will show further information so the pilot can ask for details and take a decision based on it

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

UC 2: AI algorithms description

The AI algorithm uses two different tools

A classification algorithm using neural network which will predict the landing runway using the available information



A regression algorithm which will evaluate the trajectory of the aircraft to the predicted runway and provide the pilot with a flight path based on previous flight experiences

The AI assistant is expected to

- Increase situational awareness
- Better support anticipation
- Simplify access to information
- Improve support in decision making process during emergency

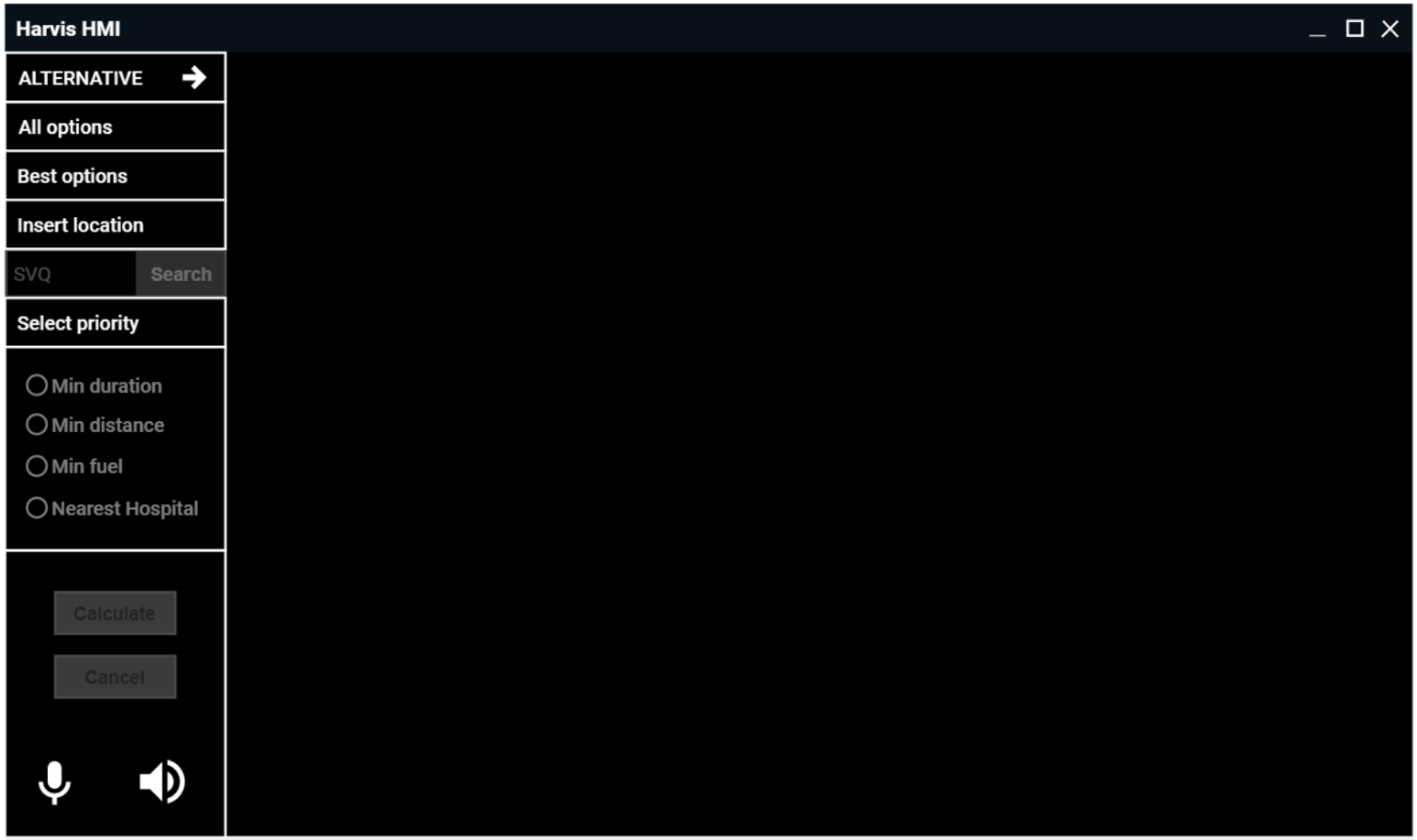
This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

UC 2: Assistant location in cockpit

The assistant will be running in a laptop/tablet on the left side of the cockpit

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

UC 2: Main Interface Overview



In normal conditions the screen will be kept black

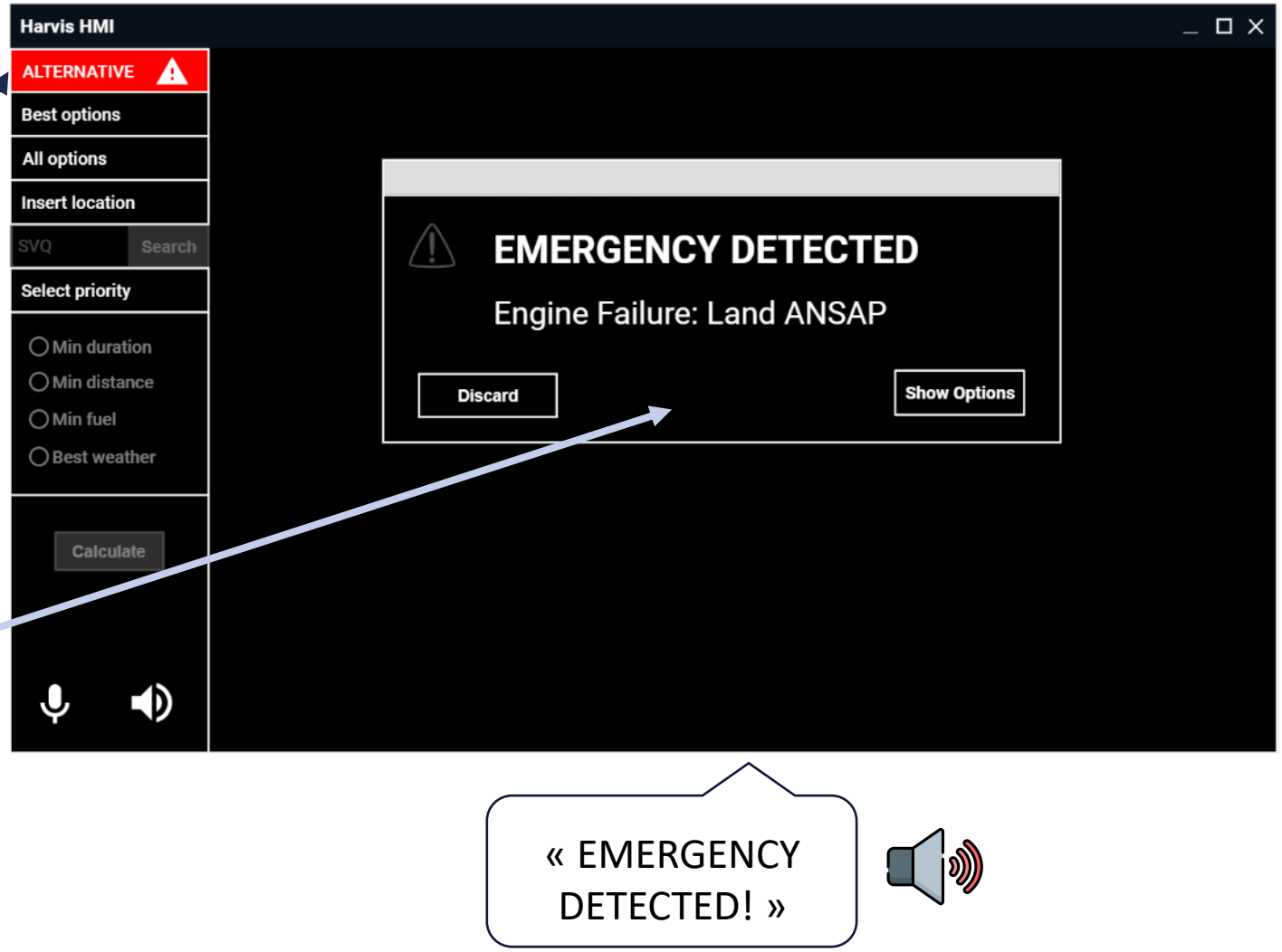
This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Option 1: Emergency detected automatically

If the assistant detects any kind of emergency which requires to land:

- The “ALTERNATIVE” icon will blink in red and visual and audio alerts messages will be announced

The alternatives will be shown In case the pilot considers that it is a false alarm, it can be discarded



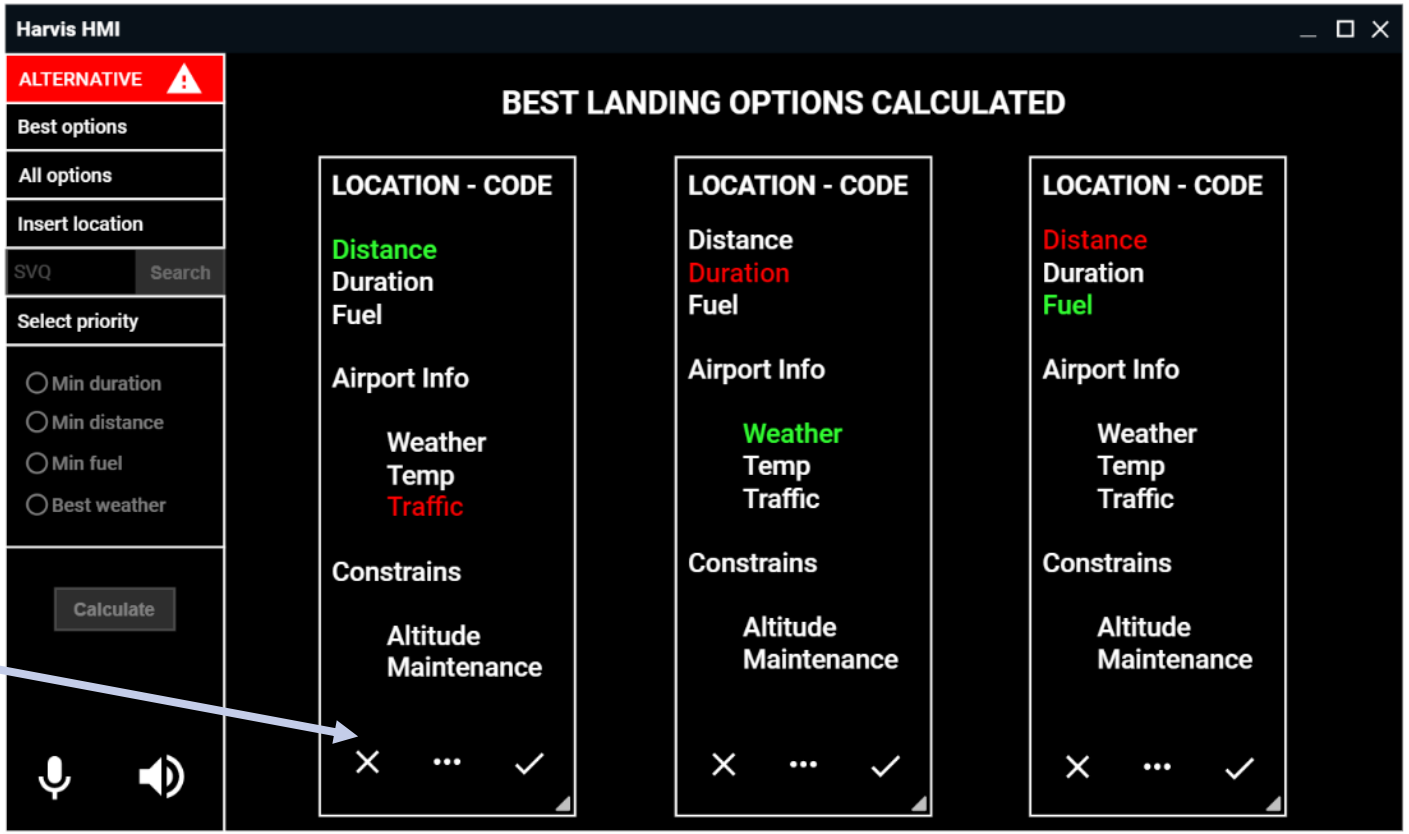
This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union’s Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Option 1: Emergency detected automatically

The most relevant information about each alternative will be summarized

The best and worst parameter of each one will be highlighted to help the decision making process

The pilot will be able to discard, get more information and select any option



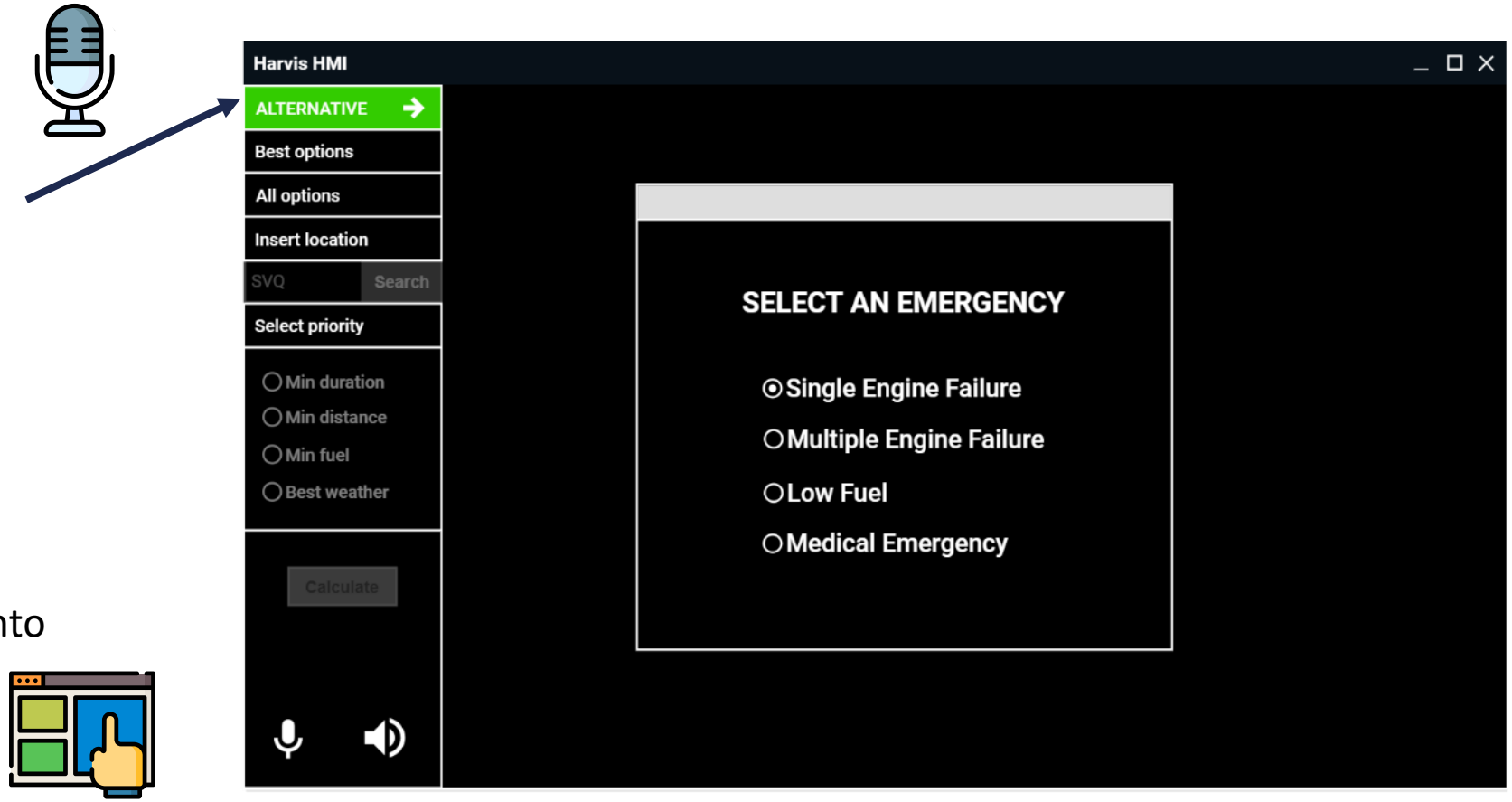
This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Option 2: Pilot needs an alternative

If the pilots requires alternatives for landing for any reason, he/she can ask the assistant to provide the options depending on the situation

The best options will be presented automatically

Depending on the reaction time available, the pilot will be able to dig into the assistant to get more alternatives



This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Additional functionalities

By selection the “all options” icon, a list of all the possible landing alternatives considered by the assistant will be presented (before applying the selection factors)

The data of these alternatives will be available by selecting each one of them

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union’s Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Additional functionalities

In case the pilot already knows the new location, he/she can ask the assistant to run the calculations for that particular airport

After pressing the calculate button the info will be automatically presented in the screen

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Additional functionalities

The pilot can also select which parameter is considered more important (which will modify the selection factors and might provide new possible options)

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Experiment planning

All the cases previously determined will be enriched with different flight and weather conditions so the result will be a set of about 20 different scenarios to randomly present in each round of tests

Individual tests will be carried out in the simulator with the help of pilots

4 types of emergencies presented:

- Single engine failure
- Multiple engine failure
- Fuel leak/low fuel condition
- Medical emergency on board

The results and insights will be discussed afterwards in a dedicated session

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Conclusions

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Conclusions

HARVIS will help in the cases of single-pilot operations (SPO)
Increasing situational awareness for the pilot
Better supporting and anticipation in stress situations
Simplify access to information in time constraint scenarios
Improve support in decision making process during emergency
Shape the knowledge of several pilots and bring it into the cockpit!

A roadmap will be produced and available at Cordis and project web page
✓ https://cordis.europa.eu/project/id/831884/es
✓ https://www.harvis-project.eu/

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Thank you very much for your attention

www.harvis-project.eu

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union