# “LEARNING ASSURANCE”
# FOR EMBEDDED SAFETY-CRITICAL APPLICATIONS

DSTI – [DS] PROJECT PROGRESS STATUS REPORT – APR 2021

Adeline VIEUSSE – 02-May-2021

# PROJECT OBJECTIVES

- **Project Objective** - To "mimic" the design, development and verification phases of a safety-critical embedded machine learning software based on the preliminary guidance material issued by EASA.

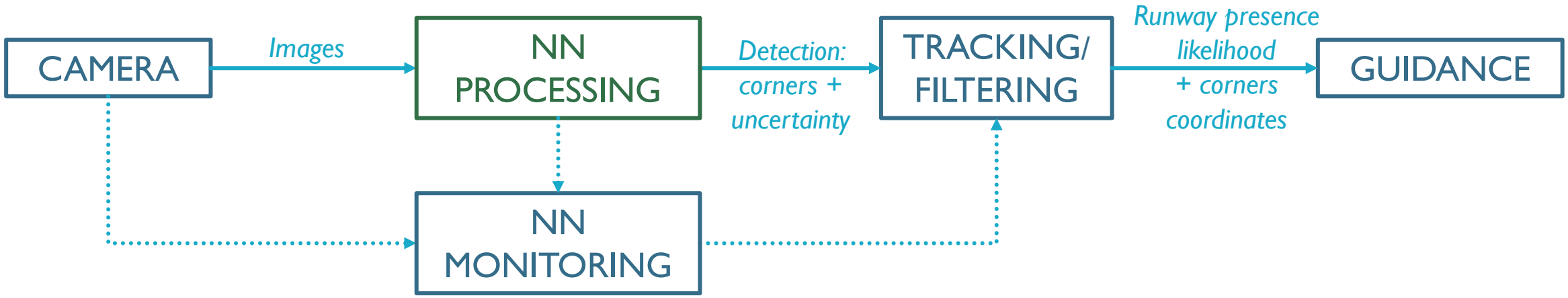
- "**Mission requirements**" - To detect a "runway" (presence and coordinates), define its centre line and align the vehicle on the runway axis.

- Based on the above, **3 main sub-objectives** can be defined:
  - Develop the ML model(s) for the runway detection (presence and coordinates)
  - Transfer the model onto an inference platform (taking into account specific hardware and software constraints)
  - Demonstrate compliance to "learning assurance" requirements

# PROJECT DETAILED SCOPE

- **In-scope**
  - Software development
  - Design assurance for Machine Learning Software
  - Machine Learning for runway presence prediction and location information
  - Non-adaptative deterministic system
- **Out-of-scope**
  - Hardware development
  - Design assurance for “Classical” Software
  - Machine Learning for end-to-end guidance
  - Adaptative non-deterministic system
  - Security concerns
  - Tools and development environment (hardware and software) qualification

# HIGH LEVEL ARCHITECTURE



# PROGRESS STATUS

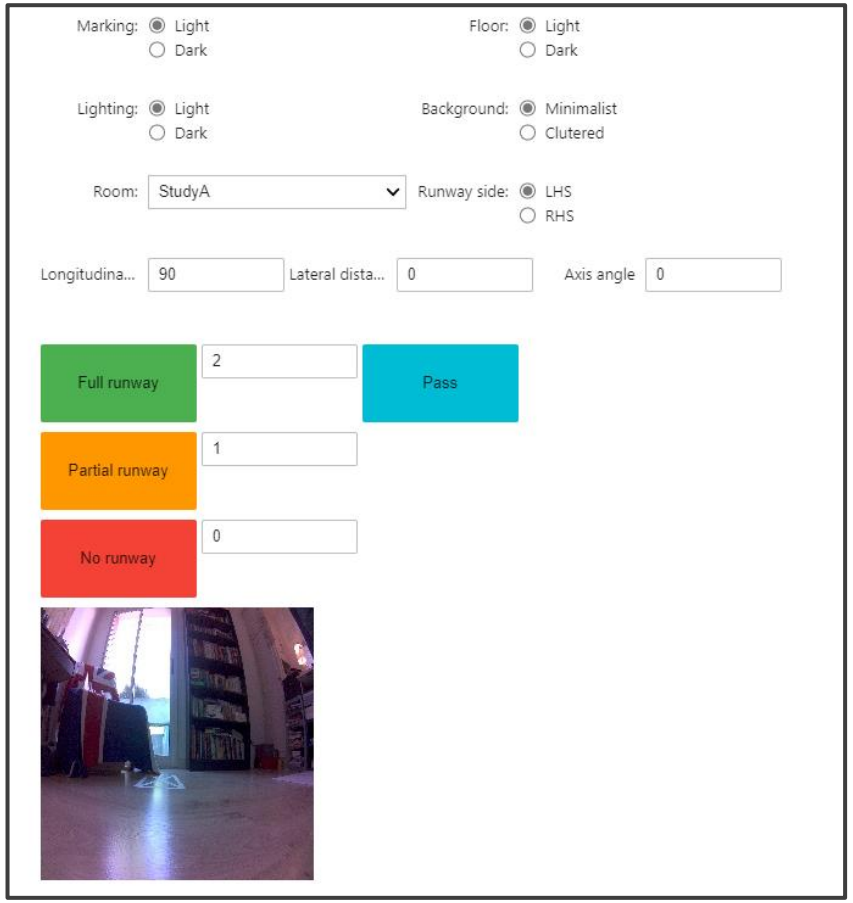
- Actions completed in December 2020-January 2021
  - Project scope and detailed outline finalised (see previous slides and link).
  - COTS Robot (Waveshare Jetbot) selected and preliminary testing performed.
  - "Learning Assurance" requirements identified (see link).
  - High-level architecture defined (see previous slide).
- Actions completed in February 2021
  - Data collection started
    - Annotation tool (LabelMe) selected and tested on dummy data
    - Dummy test dataset generated (COCO Dataset format)

# PROGRESS STATUS

- Actions completed in March 2021 (1/2)
  - Data collection criteria selected to (try to) ensure completeness of the dataset:
    - Runway Marking – Light or Dark
    - Flooring Colour – Light or Dark
    - Ambient Lighting – Light or Dark
    - Background – Minimalist or Clustered
    - Runway side wrt to Jetbot – RHS or LHS
    - Jetbot location wrt to Runway – On a grid pattern from 0 to 1200 mm (every 300 mm) laterally and longitudinally, i.e. 25 points
    - Jetbot axis angle wrt to Runway axis – 0°, 45° or 90° for each point on the grid pattern

# PROGRESS STATUS

- Actions completed in March 2021 (2/2)
  - Data collection interface developed and tested successfully
    - The interface aims at guiding the operator when collecting the data (see screenshot)
    - Output - .zip file containing
      - Pictures
      - .csv file capturing picture collection parameters (see list on previous slide) for traceability and completeness analysis
    - See Jupyter Notebook + Dummy dataset generated for test purposes in GitHub (https://github.com/AdelineVieusse/learning-assurance-project/tree/main/data-collection)



# PROGRESS STATUS

- Actions completed in April 2021
  - First attempt at data collection performed and issues found in data collection protocol and interface module:
    - Risk of **data corruption** during transfer and storage >> Data collection interface module modified to include hash computation for each file generated (.jpg, .csv and .zip).
    - The **grid pattern** originally chosen (from 0 mm to 1200 mm every 300 mm) was **too large**; on many of the pictures collected, the **runway was not clearly identifiable** >> Data collection interface module modified to reduce grid pattern spacing from 300 mm to 150 mm and overall range from 1200 mm to 600 mm (i.e. keep same number of points).
    - **Time consuming data collection process**: with initial design, the operator had to go through the grid pattern 3 times (one for each direction, 0, 45 and 90) >> Data collection interface module modified so that the operator only has to go through the grid pattern once and takes 3 pictures (one for each direction, 0, 45 and 90) at each point.
    - data_collection_1.2.ipynb available in GitHub (https://github.com/AdelineVieusse/learning-assurance-project/tree/main/data-collection)
  - Second attempt at data collection successful – Approx. 600 pictures collected
  - Preliminary model definition – Conducted extensive research into CNN.

# PROGRESS STATUS

- Upcoming steps (May 2021)
  - Discussion with Assan Sanogo scheduled on 04/05/2021 to discuss technical details and way forward (attached word document also sent via Teams)
  - Data collection finalisation:
    - Final COCO dataset format (annotations = "runway" corners coordinates + flag = runway presence/absence) still to be defined
    - More pictures to be taken and annotation to be completed
    - Analysis of collected data to ensure completeness of dataset
  - Preliminary model definition:
    - Key elements of the training algorithm selection
    - Verification metrics definition

# REFERENCES


- "Artificial Intelligence Roadmap – A human-centric approach to Ai in Aviation", EASA Report (link)
- "Concepts of Design Assurance for Neural Networks (CoDANN)", EASA AI Task Force and Daedalean AG (link)