“LEARNING ASSURANCE”
FOR EMBEDDED SAFETY-CRITICAL APPLICATIONS

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

Adeline VIEUSSE – 08-April-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.

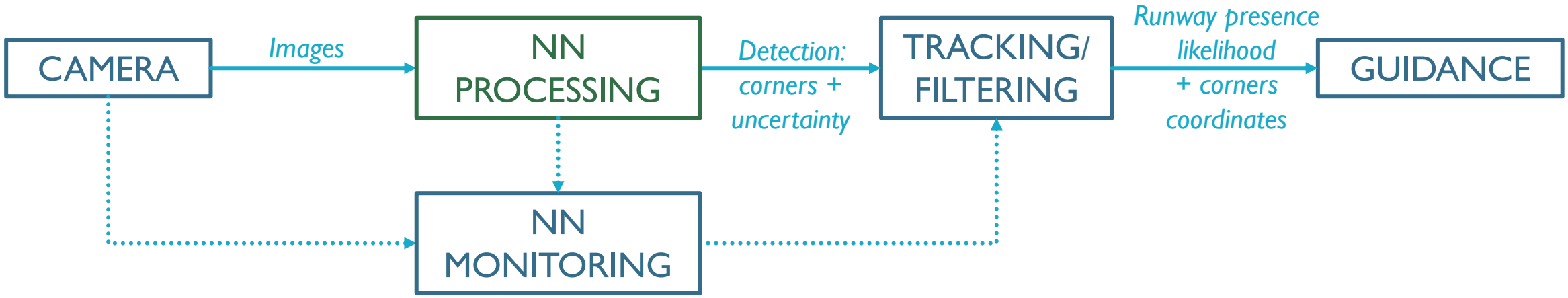
- "**Mission requirements**" - To detect a "runway" (presence and coordinates), define its centre line and align the vehicle on the runway axis.

- 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

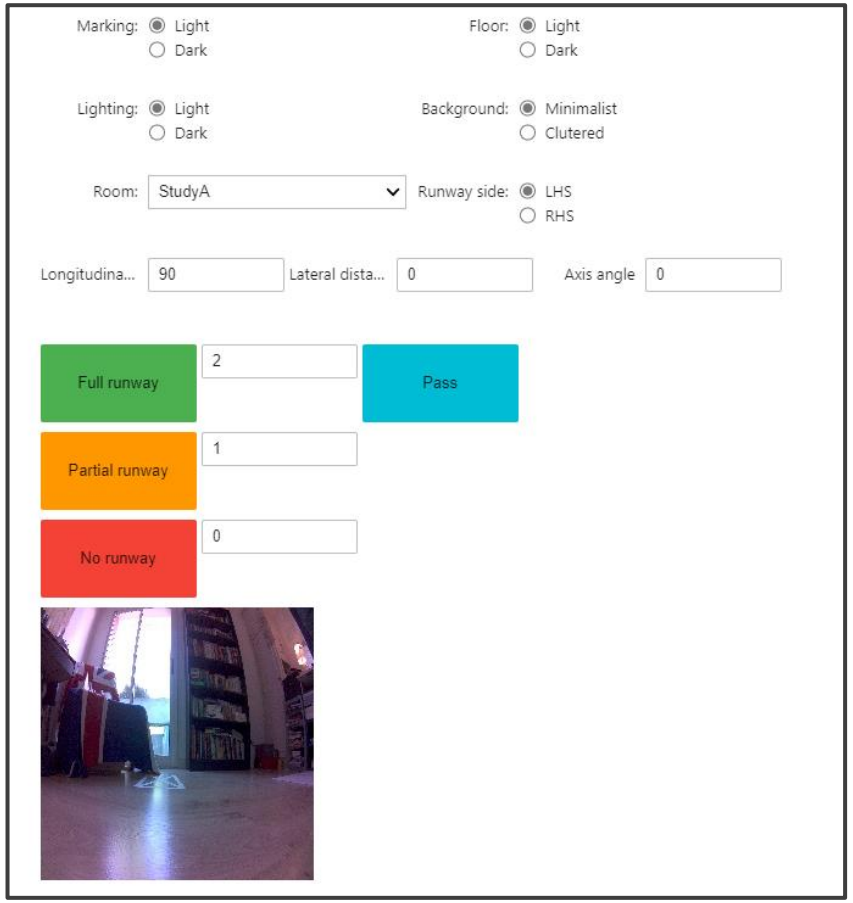
- Actions completed in December 2020-January 2021
  - Project scope and detailed outline finalised (see previous slides and link).
  - COTS Robot (Waveshare Jetbot) selected and preliminary testing performed.
  - "Learning Assurance" requirements identified (see link).
  - High-level architecture defined (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

- Upcoming steps (April 2021)
  - Data collection finalisation:
    - Final COCO dataset format (annotations = “runway” corners coordinates + flag = runway presence/absence) still to be defined
    - Pictures to be taken and annotation to be completed
  - 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)