Image Acquisition Protocol for Anomaly Detection in Panel

1 Objective

The goal of this protocol is to acquire high-quality images of a panel inside a controlled setup for anomaly detection. The dataset will be used to build a machine learning model to identify and classify defects in the panel.

2 Equipment & Setup

2.1 Camera System

- **Cameras**: Two high-resolution **Intel RealSense Depth Camera D435i**, equipped with stereo and depth sensors.

- **Resolution & Format**: Images captured at 1920×1080 **resolution** in **PNG** format to retain fine details.

2.2 Lighting Conditions

- Controlled artificial lighting setup to minimize shadows and reflections.

- No external light interference—setup is enclosed to prevent variation in ambient lighting.

- **Lighting Arrangement**:
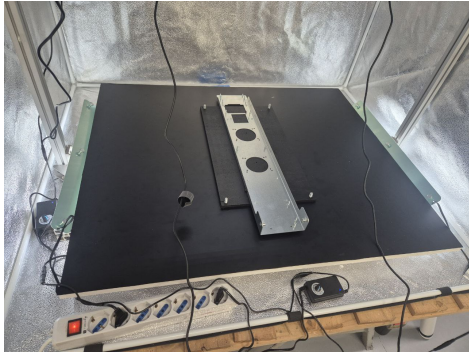
(a) Bottom lights (b) Top lights

Figure 1: Illumination setup

- **Four adjustable artificial lights** tested in different configurations.
  * **Bottom Lights**: Two lights placed on either side, inverted on a camera stand.
  * **Top Lights**: Two lights attached at the front and back, directed towards the panel.

Figure 2: Adjustable light meter

- **Light Meter Reading**: The lighting set up had adjustable meter. It was set between **two and three** to control exposure and prevent overexposure in reflective areas.

2.3 Environmental Setup

- **Enclosure**: Custom **closed-box setup** with a **reflective silver coating** for consistent illumination.

- **Base Surface**: **Black-colored base** to minimize reflections directly hitting the camera.

- The background blackboard should be as much **clean as possible (spotless)** especially close to the object as any kind of dirt or new item on the board influences the model's accuracy.
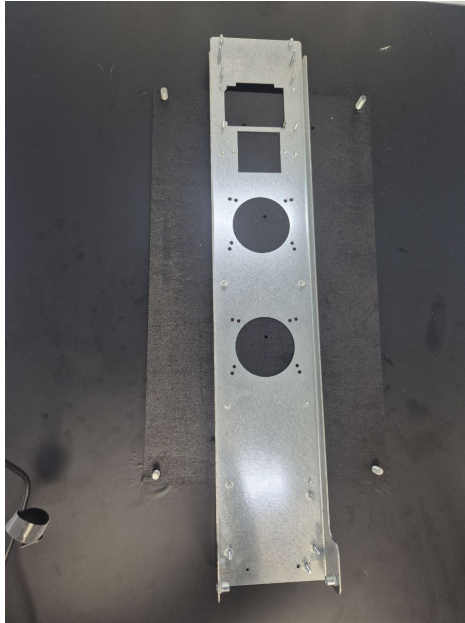
- **Panel Mounting**:

Figure 3: A sample panel on black base with pores and pins

- A **black board with pores** used to attach pins for secure and repeatable placement of the panel.
- Pins positioned to keep the object **stable and aligned** for all images.

2.4 Camera Mounting & Positioning

- **Custom-built adjustable camera stand** with both **horizontal and vertical adjustments**.

- Height of the stand: 55.7 cm
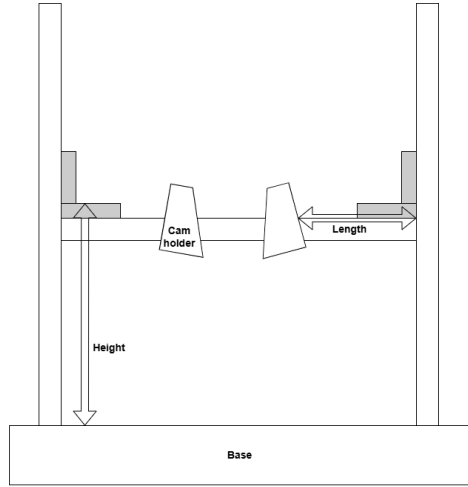
- Length from sides: 24.7 cm

Figure 4: Camera stand measurement references

- The camera is mounted at an angled perspective using a holder secured with two screws—one at the inner top and the other at the outer bottom for capturing **depth variations**(Figure 5). Both screws must be in contact with the horizontal bar to ensure a consistent and repeatable camera angle, thereby maintaining a reliable and accurate imaging perspective.
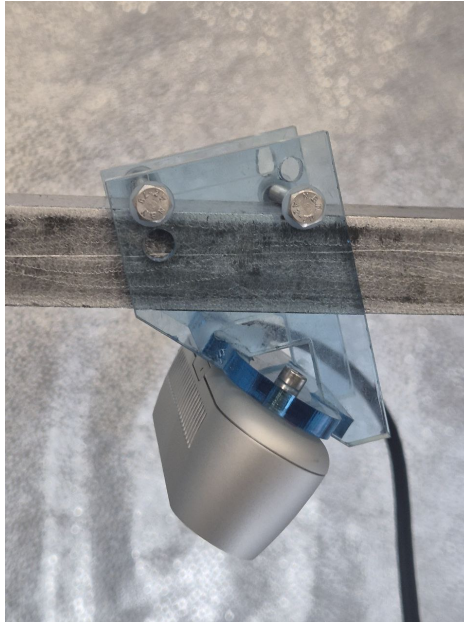

Figure 5: Camera holder

3   Image Capture & Software Configuration

3.1   Camera & Software Setup

- **Software Used**:

  - **Intel RealSense SDK**
  - **Python libraries** for image capture and processing

- **Custom Python Code**:

  - Implemented using **pyrealsense2** library.
  - Synchronized image capture from **both cameras simultaneously**.

- **Exposure & Processing Settings**:

  - **Auto-exposure disabled** to ensure consistency across images.
  - **Post-processing disabled** to avoid automatic filtering or enhancements.
  - **Configuration File**: Adjusted settings exported as `config_default.json` 4.2 , which is loaded in the Python script for consistent acquisition.

4   Dataset Collection & Distribution

4.1   Panel States

- **Normal Panel Samples**: Intact, defect-free panels captured under controlled conditions.

- **Anomalous Panel Samples**: Panels with defects introduced intentionally for anomaly detection. They would be used as part of validation dataset for the anomaly detection model.

- **Panel Placement**:

  - Panels secured using pins.
  - **Pin Positioning**: One pin at the **top-right** corner to secure alignment (holds left bottom corner of upper rectangle in the panel), another at the **bottom-left** to maintain stability.

4.2   Anomaly Types Considered

The defective panels were categorized based on the type of anomaly, as shown in Table 1. The keywords M3 and M4 refer to screw types, denoting their respective diameters.

Table 1: Types of Anomalies Considered

Anomaly Type	Description
Missing M4 Screw	M4 screw missing
Missing M3 Screw	M3 screw missing
Missing Low M3 Screw	Lower-positioned M3 screw missing
Cut M4 Screw	M4 screw with visible cut
Cut M3 Screw	M3 screw with partial cut
Damaged Circle	Circular cutout area deformed
Damaged Square	Square cutout area deformed
Damaged Gasket (Top)	Gasket at the top damaged
Damaged Gasket (Side)	Side section of gasket deformed
Damaged Gasket (Corner)	Gasket corner exhibiting damage

A   Configuration File

The configuration file can be accessed using the following link:
    config default.json