**1 Introduction**

Maintaining clean solar panels is essential for maximizing energy yield. This project investigates automated image-based detection of dusty versus clean surfaces using convolutional neural networks (CNNs). A dataset from Kaggle was augmented, two deep learning models were trained (SolNet architecture and MCD), and classical machine-learning baselines were explored using CNN feature embeddings.

**2 Dataset**

| **Class** | **Images** | **Resolution (typical)** |
| --- | --- | --- |
| Clean | 1 493 | ≈ 500 × 770 pixels |
| Dusty | 1 069 | ≈ 500 × 770 pixels |

* Split: 80 % training / 20 % validation-test.
* Total 2562 photos

**3 Methods**

**3.1 SolNet architecture**

* **Input** 227 × 227 × 3.
* 5 convolution blocks (96–384 filters; ReLU + BatchNorm + MaxPool).
* Flatten → 2 × 4096-unit dense with 50 % dropout → sigmoid output.
* Parameters: ~58.3m; Adam; binary-cross-entropy; early stopping (patience = 2). ​

**3.2 MCD**

* Pre-trained “imagenet” weights; top layers replaced with
* Input resized to 224 × 224.

**3.3 SVM on Deep Features**

* Features taken from penultimate dense layer of the custom CNN, scaled with StandardScaler, then classified by an RBF-kernel SVM with different C values. ​

**4 Results**

| **Model** | **Val/Test Accuracy** | **Precision (Dusty)** | **Recall (Dusty)** | **F1 (Dusty)** |
| --- | --- | --- | --- | --- |
| SolNet architecture | **71 %** | 0.81 | 0.39 | 0.53 |
| MCD | 71 %  test unstable (over-fitting after epoch 2) |  |  |  |
| SVM (C = 0.1) | 68 % | 0.69 | 0.44 | 0.54 |

Confusion matrix for the custom SolNet architecture high true-negative rate but a drop in dusty recall with only 39 %.

**5 Conclusion**

Overall, the SolNet architecture achieved the best headline accuracy (~71 %), but its low recall for dusty panels (39 %) means it would miss most problem cases. MCD peaked at similar accuracy yet over fit swiftly, while the SVM on deep CNN features reached 68 % accuracy with only marginally better balance.