

# config.py - Configuration Management

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## Overview

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This module centralizes all configuration settings for the solar panel detection system. It loads values from environment variables with sensible defaults, providing a single source of truth for system parameters.

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## Logic

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### Class: Config

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A static configuration class with class attributes and class methods - no instantiation required.

### Configuration Categories

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Category	Settings
API	GOOGLE_MAPS_API_KEY
Model	MODEL_PATH, CONFIDENCE_THRESHOLD
Directories	INPUT_FOLDER, OUTPUT_FOLDER, INPUT_FILENAME
Image	MAP_REQUEST_SIZE, MAP_SCALE, FINAL_IMAGE_SIZE, ZOOM_LEVEL
Detection	SLICE_HEIGHT, SLICE_WIDTH, OVERLAP_RATIO
Buffers	BUFFER_RADIUS_1_SQFT, BUFFER_RADIUS_2_SQFT
Quality Control	BRIGHTNESS_THRESHOLD_*, CLOUD_THRESHOLD, MIN_IMAGE_VARIANCE

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# How It Works

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## 1. Environment Variable Loading

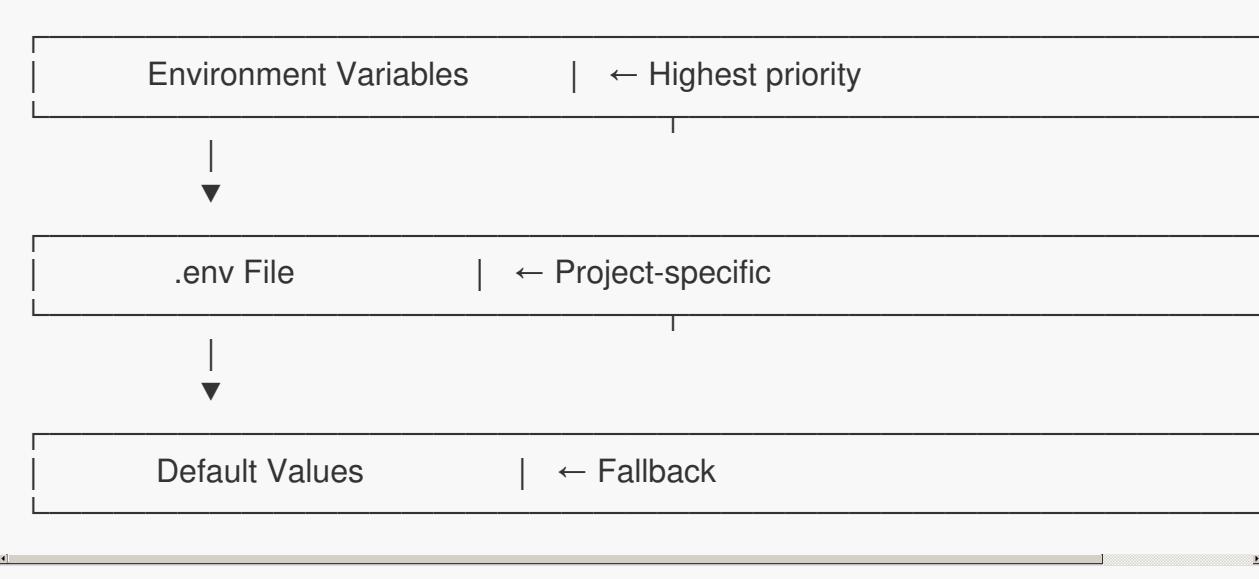
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```
from dotenv import load_dotenv  
load_dotenv() # Loads .env file at module import  
  
GOOGLE_MAPS_API_KEY = os.getenv('GOOGLE_MAPS_API_KEY', '')  
ZOOM_LEVEL = int(os.getenv('ZOOM_LEVEL', 20))
```

The `load_dotenv()` call reads the `.env` file and populates `os.environ`. Each setting uses `os.getenv()` with a fallback default value.

## 2. Configuration Hierarchy

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## 3. Key Methods

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`validate()`

Ensures critical settings are properly configured:

```
@classmethod
def validate(cls):
    if not cls.GOOGLE_MAPS_API_KEY:
        raise ValueError("Google Maps API Key not configured")

    if not Path(cls.MODEL_PATH).exists():
        raise FileNotFoundError(f"Model not found: {cls.MODEL_PATH}")
```

### setup\_directories()

Creates required folders if they don't exist:

```
@classmethod
def setup_directories(cls):
    cls.INPUT_FOLDER.mkdir(exist_ok=True)
    cls.OUTPUT_FOLDER.mkdir(exist_ok=True)
```

### get\_model\_path()

Handles model file fallback logic:

```
@classmethod
def get_model_path(cls):
    if Path(cls.MODEL_PATH).exists():
        return cls.MODEL_PATH

    fallback = cls.MODEL_PATH.replace("best.pt", "last.pt")
    if Path(fallback).exists():
        return fallback
```

## Why It Works

### Separation of Concerns

- **Code** contains logic, not configuration values
- **Environment** controls deployment-specific settings
- **Defaults** ensure the system works out of the box

### Type Conversion

Environment variables are always strings. The config handles conversion:

```
CONFIDENCE_THRESHOLD = float(os.getenv('CONFIDENCE_THRESHOLD', 0.25))
ZOOM_LEVEL = int(os.getenv('ZOOM_LEVEL', 20))
```

### Buffer Zone Design

Two buffer radii (1200 and 2400 sq.ft) create concentric zones:

- **Inner buffer** (1200 sq.ft) - High confidence match
- **Outer buffer** (2400 sq.ft) - Extended search area

## Quality Control Thresholds

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```
BRIGHTNESS_THRESHOLD_LOW = 30    # Reject dark/shadowed images
BRIGHTNESS_THRESHOLD_HIGH = 225   # Detect overexposed/cloudy areas
CLOUD_THRESHOLD = 0.7            # Max 70% bright pixels allowed
MIN_IMAGE_VARIANCE = 100         # Reject blank/uniform images
```

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## Usage in Main Pipeline

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### Initialization

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```
# In pipeline.py
from .config import Config

class SolarDetectionPipeline:
    def __init__(self):
        self.config = Config

        self.maps_client = GoogleMapsClient(
            api_key=Config.GOOGLE_MAPS_API_KEY,
            zoom_level=Config.ZOOM_LEVEL,
            ...
        )
```

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### Pipeline Startup

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```
def run(self):
    Config.validate()      # Fail fast on misconfig
    Config.setup_directories() # Ensure folders exist

    input_path = Config.INPUT_FOLDER / Config.INPUT_FILENAME
    ...
```

## Configuration Flow

```
main.py
  |
  ▼ imports
pipeline.py
  |
  ▼ uses
Config (config.py)
  |
  ▼ reads
.env file
```

All pipeline components access Config directly, ensuring consistent settings across:

- API client
- Quality checker
- Detector
- Geometry calculations
- Visualizer