T E N S O R C R E T E

AUTONOMOUS STRUCTURAL INTELLIGENCE ENGINE

Technical Manual & User Guide *Version 1.0 Enterprise Edition*

NEURAL ENGINE | **TENSORFLOW KERAS** | CLEARANCE | **CIVIL ENGINEERING**

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1. Executive Summary

TensorCrete is a next-generation computer vision software designed to automate the inspection of civil infrastructure. By integrating **Convolutional Neural Networks (CNN)** with **OpenCV-based thermal mapping**, it provides structural engineers with a non-destructive testing (NDT) tool capable of detecting concrete fissures with >90% confidence.

The system features a **"Drone Swarm"** batch processor, allowing for the rapid analysis of thousands of aerial survey images, reducing inspection time by approximately 70% compared to manual visual methods.

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2. System Architecture

TensorCrete operates on a localized, GPU-accelerated pipeline that prioritizes data privacy and speed.

2.1 The Neural Core

- **Model Architecture:** Custom CNN trained on the *Concrete Crack Images for Classification* dataset.
- **Input Resolution:** 224x224 (LANCZOS Resampling).
- **Inference Engine:** TensorFlow Keras.

2.2 Visual Signal Processing (VSP)

The "X-Ray Vision" feature utilizes a multi-stage post-processing algorithm: 1. **Gaussian Blur:** Noise reduction to isolate structural anomalies. 2. **Canny Edge Detection:** Gradient-based contour finding. 3. **Dilation:** Enhancing hairline fractures for visibility. 4. **Heatmap Overlay:** Applying **`cv2.COLORMAP_JET`** to visualize severity intensity.

2.3 Data Persistence

- **Settings Storage:** JSON serialization in **`%APPDATA%/RatulApps/TensorCrete`**.
- **History Log:** Immutable local JSON ledger tracking every scan performed.

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3. Installation & Setup

3.1 Prerequisites

- **OS:** Windows 10 or Windows 11 (64-bit).
- **Processor:** Intel Core i5 / AMD Ryzen 5 (AVX2 Support required for AI operations).
- **RAM:** 4 GB Minimum (8 GB Recommended for Batch Mode).
- **Disk:** 500 MB SSD space.

3.2 Deployment

1. Download **`TensorCrete_Setup_v1.0.exe`** from the official repository.
2. Execute the installer with Administrative Privileges.
3. Follow the **Inno Setup** wizard to deploy to **`Program Files`**.
4. Launch via the Desktop Shortcut.

> **Note:** On first launch, the application will initialize the Neural Engine. This may take up to 30 seconds.

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4. User Guide: Inspection Modes

4.1 Mode A: Single Scope Inspection

Designed for detailed, granular analysis of specific structural photos.

1. **Toggle Mode:** Ensure the top switch is set to **"Single Scope"**.

2. **Load Data:** Click **`Load Photo`** and select a **`.JPG`**, **`.PNG`**, or **`.WEBP`** file.
3. **Analyze:** Click **`Analyze Crack`**. The system will:
   - Compute a Confidence Score (0-100%).
   - Classify as **SAFE** or **CRACK**.
   - Estimate Pixel Width & Severity (Hairline/Moderate/Severe).
   - Extract GPS Coordinates (if EXIF data exists).
4. **X-Ray Vision:** Check the **`Enable X-Ray`** box to overlay the thermal damage map.
5. **Report:** Click **`Download Report`** to generate a signed PDF.

4.2 Mode B: Drone Swarm (Batch)

Designed for bulk processing of aerial survey data.

1. **Toggle Mode:** Switch to **"Drone Swarm"**.
2. **Select Source:** Click **`Select Folder`** and choose a directory containing survey images.
3. **Initiate:** Click **`Initiate Swarm`**. The AI will process the queue in the background.
4. **Live Feed:** Watch the **Mission Status** ring and the live feed monitor.
5. **Review:** Click any file in the log to inspect it in the main view.
6. **Mission Report:** Click **`Download Mission Report`** for a summary table PDF.

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5. Interface Customization

TensorCrete utilizes the Windows DWM API to render a **Glass/Acrylic** UI.

- **Themes:** Switch between "Ambient" (Dark Blue/Grey) and "Dark" (True Black).
- **Accents:** Customize UI highlights (Civil Red, Structure Blue, Safety Green).
- **Glass Effect:** Toggle transparency in Settings if performance is low.
- **Opacity:** Adjust window transparency slider (50% - 100%).

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6. Troubleshooting

Error Code	Symptom	Solution
ERR_MODEL	"Model file not found"	Reinstall the app. The internal

		`.h5` file is corrupted.
ERR_GPU	Slow Batch Processing	Ensure your CPU supports AVX2. The app falls back to CPU if no CUDA GPU is found.
ERR_PDF	Report Generation Fail	Ensure you have write permissions in the save folder. Do not open the PDF while saving.

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7. Legal & Compliance

7.1 License

This software is proprietary. Unauthorized redistribution, reverse engineering, or commercial leasing is strictly prohibited under the **End User License Agreement (EULA)** included in the installer.

7.2 Safety Disclaimer

TensorCrete is an assistive diagnostic tool. It does not replace the professional judgment of a certified structural engineer. The developer assumes no liability for missed detections or structural failures.

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