Modexion

# USER MANUAL

## MX-100 Manhole Inspection Instruction

**HARDWARE**




Please read the instruction manual carefully before using the product and keep it properly.

# 01

## Preface

Thank you for selecting the intelligent manhole detector developed by our company.

This device is a professional detection system designed for urban underground pipe networks, manhole facilities and confined space operation scenarios. It integrates multiple functions such as high-definition imaging, gas detection, attitude measurement, auxiliary lighting, wireless transmission and data recording. It is widely applicable to municipal drainage, power and communication, gas pipelines, underground utility tunnels, emergency inspection and other fields.

The manhole detector adopts a modular hardware architecture. With the advantages of compact structure, strong environmental adaptability, convenient operation, stability and reliability, it can effectively improve on-site inspection efficiency and reduce risks of manual inspection, and provide reliable data support for the safe operation and maintenance of underground facilities.

To ensure safe, stable and efficient operation of the device, please carefully read this manual before installation, commissioning, operation and maintenance, and operate the device in strict accordance with relevant requirements. This manual covers device composition, interface definitions, performance parameters, installation procedures, operation processes, maintenance, precautions and other contents, serving as an important reference for device operation and maintenance.

Should you encounter any problems during operation, please contact our technical support personnel for assistance in a timely manner.

# 02

## Equipment Layout

- **Equipment Placement Layout**



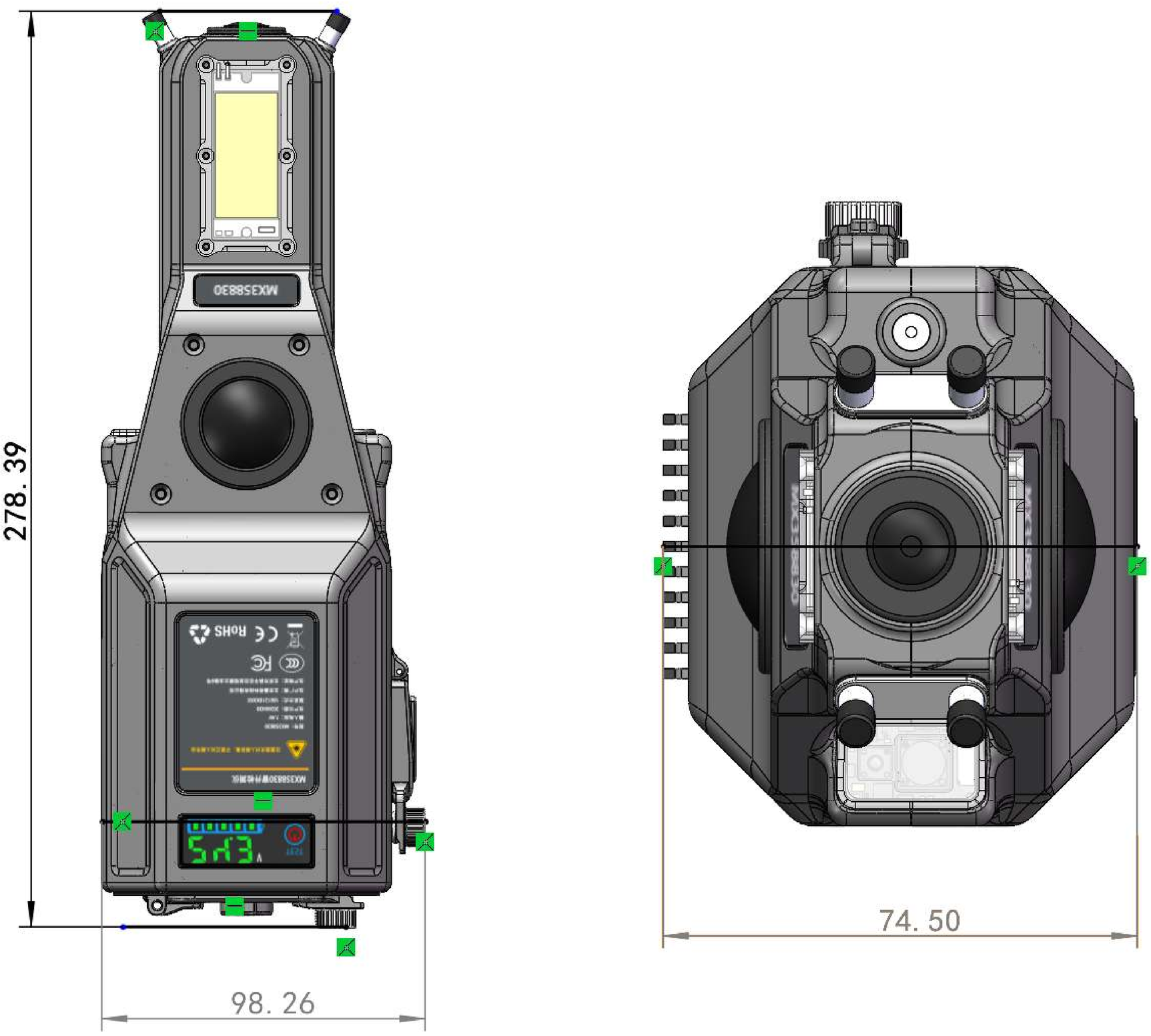
If you encounter operational problems during field work or you are a new user, please refer to the Quick User Manaul to quickly learn and operate the equipment.



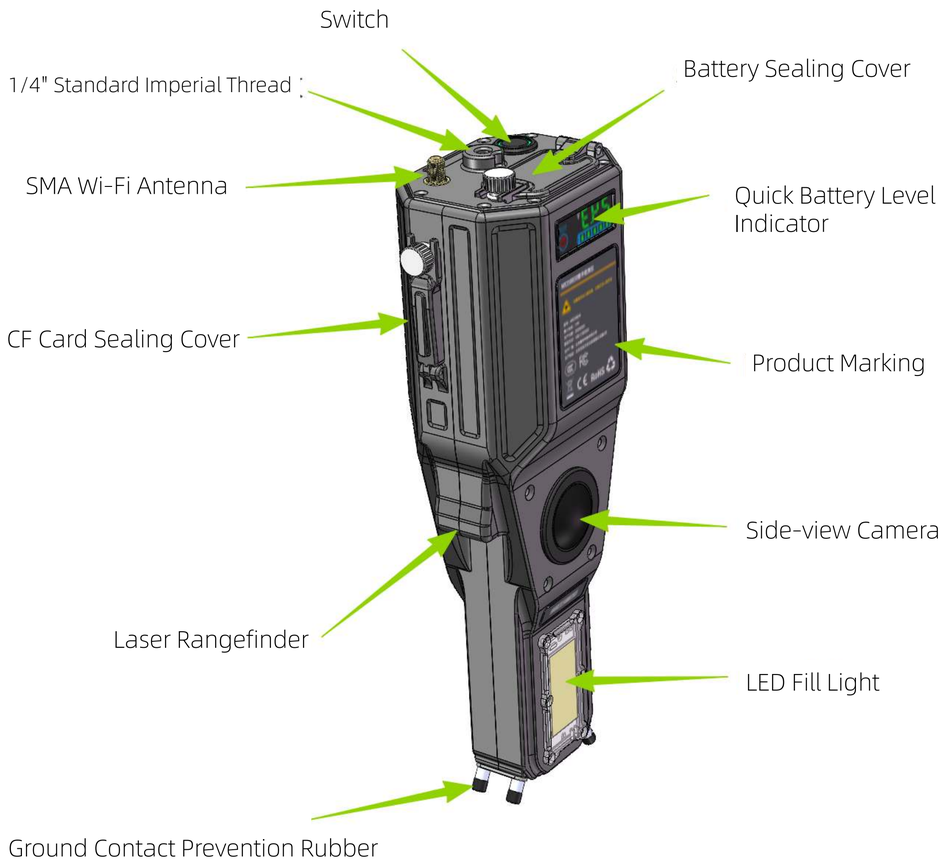
# 03

## Manhole Inspection Instrument

- **Overall Dimensions**

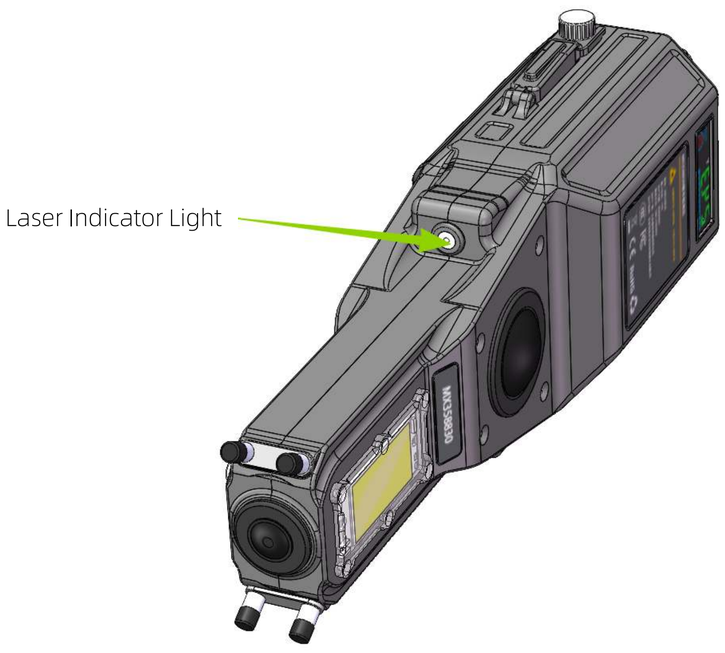


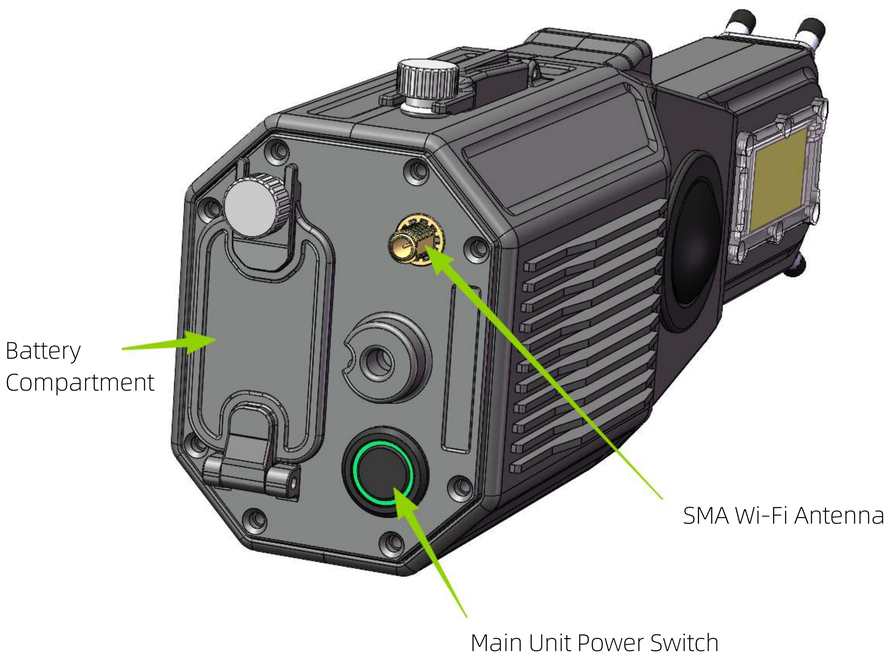
# Equipment External Function Layout









# 04

## Specific Function Introduction



Battery Compartment




The battery compartment cover can be opened by unscrewing the hand-tightened screw. Insert the battery smoothly. If resistance is encountered, the battery may be inserted in the wrong orientation. Please reverse the battery and reinsert it. After installation, close the battery cover and tighten the screw by hand to achieve sealing.



CF Card




The CF Card compartment can also be opened by loosening the hand-tightened screw. Insert the CF Card smoothly. Close the CF Card Sealing Cover and tighten the screw securely after insertion.

This CF Card adopts the NVMe protocol. Hot swapping is not supported for the time being. Please ensure the memory card is installed before powering on the device.

Press and hold for 3 seconds to power on the device; press and hold for another 3 seconds to power off. A single short press turns on the LED Fill Light. Repeated short presses cycle the LED Fill Light through On, Off, Low Brightness, Medium Brightness and High Brightness modes. It is recommended to turn off the device if it will not be operated for an extended period. This reduces battery consumption to extend working duration.



Main Unit Power Switch




LED Fill Light

Short press the power button to switch the LED Fill Light between on/off states and brightness levels. Users may adjust the LED Fill Light according to actual acquisition conditions. It is recommended to turn off the power when not working to reduce battery consumption.

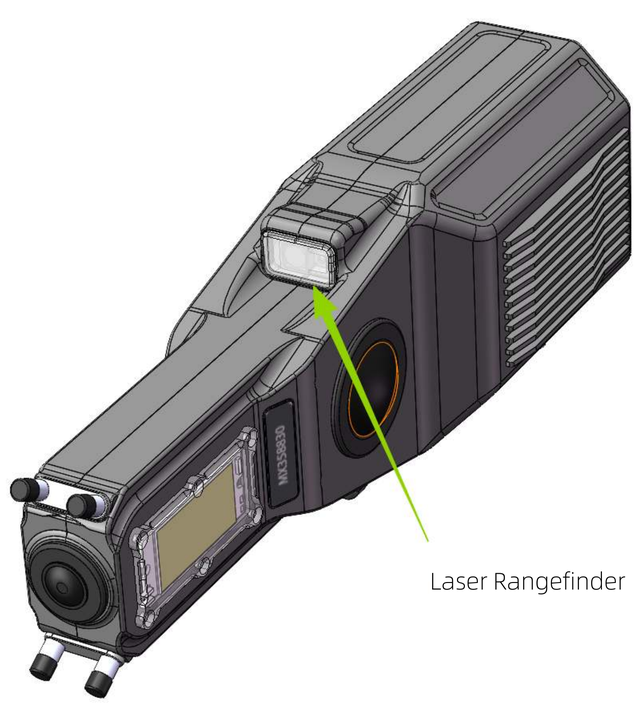



Side-view Camera

Front-view Camera

Before field data collection, wipe and clean the camera lenses with a lens cloth, and inspect for damage or impact marks. If lens replacement is required, please contact the manufacturer to arrange return and replacement.

The Laser Rangefinder Window also needs to be inspected to ensure there is no dirt or abrasion. This rangefinder has a maximum measuring range of 18 meters.







The Laser Indicator is designed to assist field operators. The device can be positioned in the center of the manhole, and the laser serves as an aiming reference.




External SMA antenna connector. In most cases, the standard small antenna meets the requirements for routine operations. If you need to extend the antenna with an RF cable, please contact the manufacturer for customization.

# 05

## Equipment parameter introduction

- **Camera Parameters**

| Side-view Camera | |
|---|---|
| Sensor Size | 1/1.8" |
| Effective Pixels | Approx. 8.4 MP |
| Resolution | 3856 × 2180 / 3840 × 2160 |
| Pixel Size | 2.0 μm × 2.0 μm |
| Shutter Type | Rolling Shutter |
| Technology | STARVIS 2 Back-Illuminated |
| Output Bit Depth | RAW10 / RAW12 |
| Maximum Frame Rate | 72 fps (10 bit) / 60 fps (12 bit) |
| High Dynamic Range | DOL HDR Supported |
| Spectrum | Color RGB |
| **Front-view Camera** | |
| Sensor Size | 1/2.8 inch |
| Effective Pixels | Approx. 8.4 MP |
| Resolution | 3864 × 2192 |
| Standard 4K | 3840 × 2160 |
| Pixel Size | 1.45 μm × 1.45 μm |
| Shutter Type | Rolling Shutter |
| Technology | STARVIS |
| Output Bit Depth | RAW10 / RAW12 |
| Maximum Frame Rate | 90 fps (10 bit) |
| HDR | DOL HDR Supported |
| Spectral Response | Visible Light |

## Core Board Parameters

| Core Board | |
|---|---|
| CPU | 8-core ARM |
| Architecture | 4× Cortex-A76 + 4× Cortex-A55 |
| Clock Frequency | A76 up to 2.4 GHz |
| Process Technology | 8 nm |
| GPU | Mali-G610 MP4 |
| NPU | 6 TOPS |
| Memory | 8 GB |
| Storage | 32 GB |
| Video Encoding | 8K H.264 / H.265 |
| Video Decoding | 8K@60fps |
| PCIe | PCIe 3.0 |
| USB | USB 3.1 |
| Ethernet | 2.5G |
| Operating System | Linux |
| CF Card | Write: 480 MB/s; Read: 1200 MB/s |

## Battery Parameters

| Battery Parameters | |
|---|---|
| Rated Voltage | 7.2V |
| Rated Capacity | 3300mah |
| Maximum Charging Current | 2.41A |
| Maximum Charging Voltage | 8.4V |
| Maximum Discharge Current | 4A |
| Dimensions | 85X42X22.4(mm) |
| Weight | 130g |

## ● Main Unit Parameters

| Main Unit | |
|---|---|
| Dimensions | 278.39 × 98.26 × 74.5 mm |
| Weight | 848 g (excluding battery) |
| Maximum LED Power Consumption | 3 W |
| LED Color | 6500K (White Light) |
| Measuring Range of Laser Rangefinder | 8 m |
| Laser Indicator | 1 mW |
| Laser Color | Red |
| Material | Aluminum Alloy, Rubber, Nylon |

This manual is intended to help users operate the manhole inspection device correctly, safely and efficiently. As product functions are continuously optimized and upgraded, some hard-ware configurations, software interfaces and technical parameters are subject to change without prior notice. Please refer to the actual product.

To ensure long-term stable operation of the equipment, users are recommended to conduct regular inspection, cleaning and maintenance, and operate the device in strict accordance with specifications. The company shall not be liable for any equipment damage caused by improper operation, unauthorized disassembly or abnormal usage.

Thank you for your trust and support in our product. We will continue to commit ourselves to delivering more stable, intelligent and efficient underground inspection solutions for users.

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# USER MANUAL

## MXview User Guide

**Manhole Inspection Post-processing Software**
**| Operation Workflow & Button Function Description**

**Applicable Software:**
MXview / Manhole Inspection Post-processing Software

**Version Info:**
Version 2.4.4 20260622

**Production Date:**
2026-07-23

Please read this user manual carefully before using the product and keep it properly.

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# 01

# Software Overview

MXview is a desktop manhole inspection post-processing software. It extracts images from data captured inside manholes and performs photo alignment, 3D reconstruction, manhole wall unfolding, result review, manhole information editing and inspection report export.

## Recommended Main Workflow

- Select project directory → Select data file → Data extraction → Photo alignment → 3D reconstruction →
- Manhole wall unfolding → View results and markings → Export report.

  Select project directory → Select data file → One-click reconstruction → View results and markings → Export report.

## 1.1 Operation Mode

**Software Startup: Click MXview.exe or the application icon.**
The target computer does not require Python or Conda, but needs a compatible 64-bit Windows operating system and GPU drivers required for reconstruction computation.

## 1.2 Inputs and Outputs

| Categories | Contents | Description |
|---|---|---|
| Input | Project Directory | Root directory for saving images, reconstruction results, unfolded views, markings and reports. |
| Input | Data File | Raw captured data; used to generate front/left/right images during data extraction. |
| Input | XML Configuration (Optional) | Select manually only when algorithm parameters need to be modified. Users are not recommended to adjust parameters on their own. |
| Output | 3D Model and Point Cloud | Prioritize cropped OBJ/PLY results for visualization, unfolding and report screenshots. |
| Output | Manhole Wall Unfolded View and Markings | Generates unwrapped_well.jpg, metadata, annotated images and JSON files. |
| Output | Inspection Report | A report.docx file is generated under Chinese interface; report_en.docx under English interface. |

# 02

## Main Window Layout

The main window adopts a three-column layout. The left panel is for project preparation and workflow control, the middle panel for result preview, and the right panel for manhole information management.

| Location | Panel | Main Contents | Operation Purpose |
|---|---|---|---|
| Left Panel | Project Configuration | Select project directory, select XML configuration (optional) | Determine input and output root directories and parameter configuration |
| Left Panel | Data Selection | Select Data File | Select original acquisition files |
| Left Panel | Automation、Workflow Stop | One-Click Reconstruction、Four Independent Steps、Stop Button | Execute complete workflow or step-by-step troubleshooting |
| Left Panel | Run Log | Log Output and Clear Logs | View progress, warnings, errors and stage markers |
| Middle Panel | Result Display | OBJ/PLY/Open3D Results Unfolded View Viewer | Fixed panel preview and result review |
| Middle Panel | Result Buttons | 3D Model Display, Point Cloud Display View Unfolded Views, Export Report | Open results or generate report |
| Right Panel | Manhole Information | Manhole Name, ID, Area, Type, Cover Spec, Acquisition Date | Edit basic information for reports and project records |
| Right Panel | Save / Restore | Save, Restore | Modify manhole information or restore original manhole information |

### Progress Window:

Workflow, One-Click Reconstruction and Export Report will display a "Processing" progress window.

Progress is estimated based on logs of major stages and reaches 100% upon successful task completion.

# 03

# Main Window Buttons and Fields Guide

## 3.1 Top and Left Control Buttons

| Icon | Buttons / Fields | Area | Purpose | Prerequisites / Outputs |
|---|---|---|---|---|
|  | Language Switch | Top Title Bar | Switch between Chinese and English interfaces. | Project data will not be modified; opened unfolded viewers will synchronize the language. |
|  | Select Project Directory | Project Configuration | Select current project directory. All subsequent outputs will be saved to this directory. | After selection, automatically load Info.json and refresh well information fields. |
| | Select XML Configuration (Optional) | Project Configuration | Select to load the default configuration file. | Use default config if unselected; for tuning and debugging only |
|  | Select Data Files | Data Selection | Select Original Acquisition Data | Enable Data Decompression and One-Click Reconstruction after selection |
|  | One-Click Reconstruction | Automation | Automatically execute the reconstruction process in sequence. | If data files exist: decompress data, align photos, reconstruct 3D model and unfold manhole wall. Otherwise check existing left/front/right images and start from photo alignment. |
|  | Stop | Stop | Cancel the currently running task. | Available only when a task is running; the entire task process tree will also be terminated when the main program closes. |
| | Clear Logs | Run Logs | Clear the log display on the current interface. | Project output files will not be deleted. |

## 3.2 Workflow Step Buttons

| Icon | Buttons / Fields | Area | Purpose | Prerequisites / Outputs |
|---|---|---|---|---|
|  | Extraction | Workflow | Parse and filter borehole images from data files to generate project image data. | A project directory and data file must be selected first; outputs include front/left/right images, pic_distance.txt, Info.json and other files. |
|  | Alignment | Workflow | Execute the photo alignment process to establish camera poses and sparse model. | Project images are required; outputs include reconstruction/undistorted/images and photo alignment model. |
|  | Reconstruction | Workflow | Perform reconstruction based o n photo alignment results. | Photo alignment must be completed first; outputs OBJ/PLY files under reconstruction /dense. |
|  | Unwrap | Workflow | Unfold the 3D manhole wall model into a 2D image and write measurement metadata. | Valid OBJ file and required textures must be available. |

## 3.3 Result Display & Report Buttons

| Buttons / Fields | Area | Purpose | Prerequisites / Outputs |
|---|---|---|---|
| 3D Model Display | Result | Open result OBJ in the intermediate result display panel. | The automatic reconstruction process or 3D reconstruction process must be completed first. If materials/textures are missing, a prompt will indicate that the model may have no color. |
| Point Cloud Display | Result | Open cropped PLY point cloud in the intermediate result display panel. | The automatic reconstruction process or 3D reconstruction process must be completed first. A prompt will notify missing results if unavailable. |
| View Unfolded Image | Result | Open unwrapped_well.jpg and launch the unfolded image viewer. | Well wall unwrapping must be completed first. Dynamic physical scale and metric distance measurement are enabled when metadata exists. |
| Export Report | Result | Save well information, export annotations on the current unfolded image, render six-view images and generate inspection report. | Unfolded image, metadata, OBJ and photo alignment model are required. Report.docx will be exported under Chinese interface. |
| Full Screen | Result Display Title Bar | Switch the current result display panel to full screen view. | Suitable for reviewing model details or annotations on unfolded images; restorable. |
| Close Result | Result Display Title Bar | Close the content displayed in the current intermediate result panel. | Result files on disk will not be deleted. |

## 3.4 Well Information Fields and Buttons

| Icon | Buttons / Fields | Area | Purpose | Prerequisites / Outputs |
|---|---|---|---|---|
| | Manhole Name | Manhole Information | Fill in or display manhole name | Saved data for report form |
| | Manhole ID | Manhole Information | Fill in or display manhole name | Saved data for report form |
| | Location Area | Manhole Information | Enter manhole area or address | Saved data for report form |
| | Type | Manhole Information | Enter manhole type | Saved data for report form |
| | Manhole Cover Specification | Manhole Information | Enter manhole cover spec | Saved data for report form |
| | Acquisition Date | Manhole Information | Enter data acquisition date | Saved data for report form |
| | Save | Manhole Information Button Area | Save six right-side fields to project directory | Select project directory first |
| | Restore | Manhole Information Button Area | Restore original info | Info.original.json required in project directory |

# 04

# Standard Operating Procedure

## 4.1 New Project: Data Parsing to Report

1.Launch the software by running MXview.exe or clicking the application icon.

2.Click Select Project Directory, then select or create a project folder to store all outputs.

3.Click Select XML Configuration (Optional) if you need to customize algorithm parameters; default settings are acceptable for regular operations.

4.Click Select Data File and choose the captured data file.

5.Choose execution mode: Click One-Click Reconstruction to run all stages automatically, or sequentially run Data Extraction, Photo Alignment, 3D Reconstruction, Manhole Wall Unfolding.

6.Monitor the Processing window and Run Log during each stage. If errors occur, check the log to locate missing inputs or failed outputs from previous steps.

7.After manhole wall unfolding completes, click 3D Model View, Point Cloud View, View Unfolded Image to verify results.

8.Add defect annotations and required distance measurements in the unfolded image viewer; confirm annotation name, type and description.

9.Return to the main window, edit the manhole information on the right panel and click Save. Click Export Report to generate report.docx (Chinese interface) or report_en.docx (English interface) in the project directory.

## 4.2 Existing Image Project: Skip Data Extraction

Existing left/front/right folders detected. Skip data file selection and start reconstruction from photo alignment.

## 4.3 Suggestions for Step-by-Step Execution

| Scene | Recommended Operations | Reason |
| --- | --- | --- |
| First processing of complete captured data | Prioritize One-Click Reconstruction | Reduce risk of missing steps and automatically connect the four processing stages |
| Troubleshooting after stage failure | Rerun failed stage and subsequent stages only after correcting inputs or configurations | Save time and facilitate log checking |
| Modify Unfolding Parameters Only | Restart from Manhole Wall Unfolding | No need to repeat data extraction, photo alignment and 3D reconstruction |
| Only Edit Manhole Information or Annotations | Save Manhole Information or Re-Export Report | No Need to Rerun Reconstruction Process |

# 05

# Operations of Unfolded Drawing Viewer

After clicking View Unfolded Image on the main window, the software opens the unfolded 、image viewer in the intermediate result panel. The viewer is used to verify the manhole wall unfolded image, add rectangular defect annotations, draw measurement lines and export annotation results.

## 5.1 Toolbar Button

| Button | Purpose | Output / Notes |
| --- | --- | --- |
| Open Image | Manually open images such as PNG/JPG/BMP/TIF | If the .metadata.json file with the same nameexists, the program will attempt to read dynamic scale data |
| Load XML | Load previously saved annotation XML | Restore image path, rotation angle, rectangular annotations and measurement lines |
| Save XML | Save current annotations and measurement lines as XML | The default filename is .annotations.xml corresponding to the current image |
| Export | Export unfolded image with annotations and JSON | unwrapped_well_annotated.jpg and matching JSON will be generated by default |
| Fit | Automatically fit the image to the window size | Auto fit when window size changes |
| Zoom In / Zoom Out | Adjust the zoom ratio of current view | Scroll wheel can also zoom; zooming will not modify the original image |
| Rotate Left / Rotate Right | Rotate the view by 90 degrees | Rotation state is saved in XML; exported image adopts current rotation setting |

## 5.2 Distance measurement operation

- Click to set the start point on the image. A preview line, movable endpoints and real-time distance will be displayed as you move the mouse.
- Click again to confirm the measurement line; the measurement result will be added to the Measurement Records (m) list on the right.
- Distance conversion relies on the metadata file in the project directory. If the metadata file is missing, distances are calculated in pixel length and shall not be regarded as official metric distances.
- After selecting a measurement record, click Edit to modify its name and type, or click Delete to remove the corresponding measurement line.
- Click Clear All to delete all measurement lines.

## 5.3 Defect Annotation Operations

- Hold Ctrl + Left Mouse Button and drag to create a rectangular defect annotation on the unfolded image.
- Auto-generated IDs and names will be shown in the annotation list. Selected annotations will be highlighted and centered in the image.
- Click Edit to update the annotation name, type and description; click Delete to remove the current annotation; click Clear All to delete all annotations.
- Before report export, the main window will attempt to export annotations of the current unfolded image. Please verify that annotation types and descriptions are complete prior to exporting the report.

# 06

## Description of Project Output Files

| Path or File | Generation Stage | Purpose |
|---|---|---|
| Info.json | Data Extraction / Saving | Save Shaft Information Fields for Reading on Report Export |
| Info.original.json | Data Extraction | Backup original shaft information. The Restore button on the right overwrites data using this backup. |
| front/ left/ right/ | Data Extraction | Camera-split images extracted and filtered from the data file |
| pic_distance.txt | Data Extraction | Distance records corresponding to front images |
| reconstruction/undistorted/ images/ | Photo Alignment | 3D Reconstruction Input Images |
| reconstruction/undistorted/ sparse/ | Photo Alignment | Camera poses and photo alignment model will be used for shaft wall unfolding and report screenshots. |
| reconstruction/dense/scene _dense_crop.ply | 3D Reconstruction | Cropped point cloud, to be opened preferentially by Point Cloud Display. |
| reconstruction/dense/scene_ dense_mesh_refine_texture_ crop.obj | 3D Reconstruction | Cropped textured mesh, preferentially used for Model Display, shaft wall unfolding and report generation. |
| unwrapped_well.jpg | Shaft Wall Unfolding | 2D Shaft Wall Unfolded Image |
| unwrapped_well.metadata.json | Shaft Wall Unfolding | Measurement metadata including unfolded image dimensions, physical scale, local radius, etc. |
| unwrapped_well_annotated.jpg | Unfolded Image Export / Report Export | Annotated unfolded images to be written into the defect section of the report. |
| unwrapped_well_annotated.json | Unfolded Image Export / Report Export | Annotation name, type, description and position data, to be read by the defect table in the report. |
| scene_views/front.png | Export Report | Six-direction screenshots of the 3D model in the report |
| report.docx / report_en.docx | Export Report | Chinese or English Inspection Report |
| runtime.txt | After Task Completion | Record runtime duration of each stage |

# 07

## Frequently Asked Questions & Precautions

| Phenomenon | Cause | Suggestions |
| --- | --- | --- |
| Data Extraction button is unavailable. | Both the project directory and data file are not selected. | Select the project directory first, then select the data file. |
| Photo alignment or subsequent steps failed. | Project directory, XML configuration or output from the previous step is incomplete. | Check prompts such as Cannot prepare, Missing, Invalid i n running logs, complete inputs and rerun. |
| 3D reconstruction prompts that sparse output is missing. | Photo alignment is incomplete, or undistorted/images does not exist. | Run Photo Alignment first and confirm reconstruction/ undistorted/images exists. |
| Shaft wall unfolding reports missing mesh or texture. | 3D reconstruction output does not exist, or MTL/texture files required by OBJ are missing. | Rerun 3D Reconstruction; do not move OBJ files separately. |
| OBJ displays without color. | OBJ material or texture files are missing. | Rerun 3D Reconstruction and ensure related material and texture files remain in the same directory. |
| Report export failed | Unfolded image, metadata, OBJ or photo alignment model is missing. | Complete well wall unwrapping and 3D reconstruction first, and confirm project results can be opened. |
| Abnormality occurs when running dense reconstruction again after stopping. | Interrupted outputs may remain from the last 3D reconstruction. | The program will attempt to clean up 3D reconstruction outputs. If it still fails, check logs and rerun 3D Reconstruction. |
| Tasks continue running upon closing the software. | Background tasks are unfinished. | Confirm exit to terminate the full task process tree and prevent background processes from continuing. |
| Report information is incorrect. | Right manhole information is not saved. | Click Save after modifying fields, then export the report again. |
| Distance measurement unit is abnormal. | unwrapped_well.metadata.json is missing or unreadable. | Open the auto-generated unfolded image via View Unfolded Image on the main window first, and confirm the metadata file exists. |

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# USER MANUAL

## MX-100

For technical support, product upgrade or
after-sales service, please contact

**Technical Support Department: _____**

**Contact Phone: _____**

**E-mail Address: _____**

**Company Address: _____**

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