DEMO-02 LASER SCAN AND CAMERA SENSE DEMONSTRATOR KIT USER GUIDE
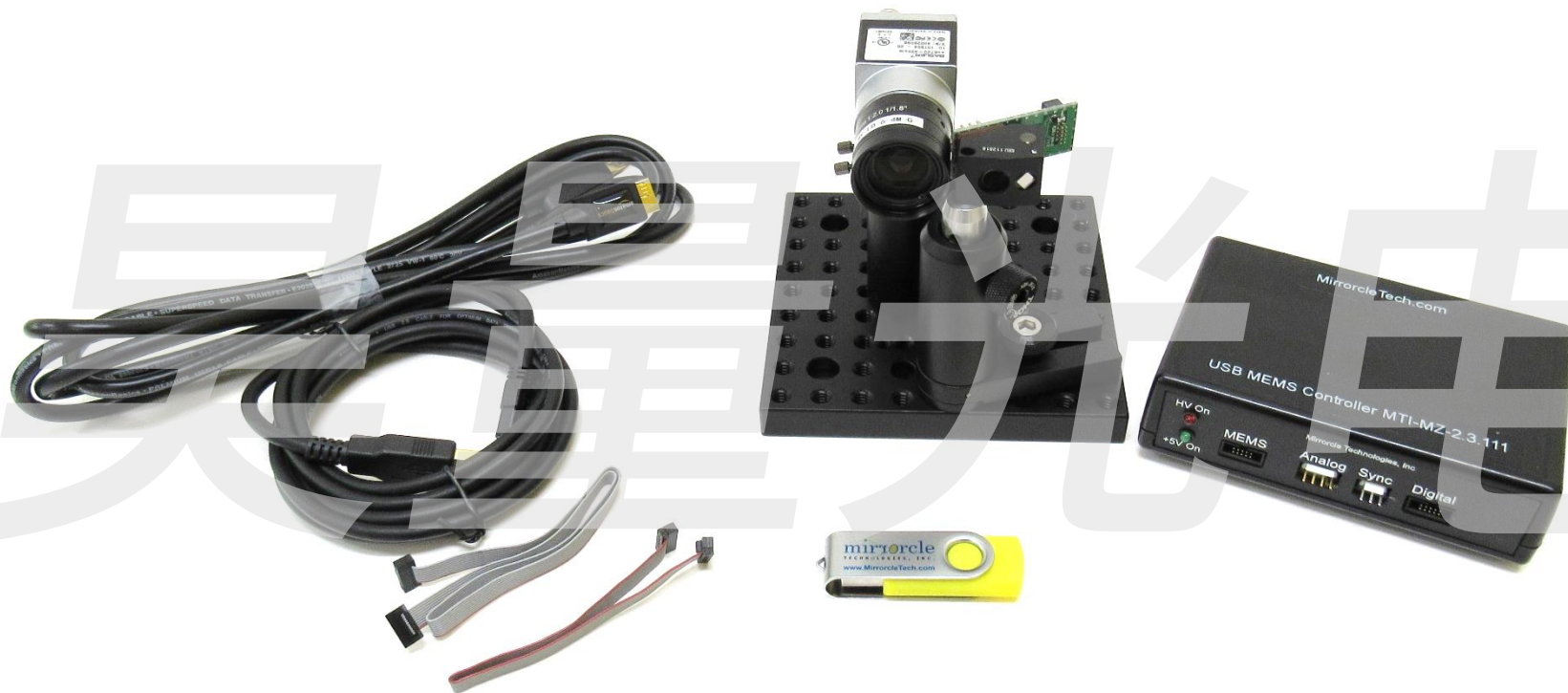
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Important Operating Guidelines

- Never exceed the maximum voltage level and angles specified for each mirror on the individual datasheet enclosed with your development kit.

- Always perform tests that include any new settings such as new drawings, new refresh rates, new filter settings etc., at low voltage settings until you can verify that those settings are working properly and not exciting the device beyond its mechanical limits.

- The devices are sensitive to electrostatic discharge. Always ensure adequate grounding when handling the packages. A wrist grounding strap with a 10MΩ series resistance is recommended.

Table of Contents

Laser Scan and Camera Sense Demonstrator Kit

*not all cables and connections shown

Kit Contents Overview

- EaZy 2.0 **Scan Module** - optomechanical cell with mirror, laser and optics
  - MEMS Mirror: A3I12.2-1200AL-T0822/H1280-NOCAP
  - Green Laser module (3-10mW CW Power) with TTL modulation
  - Wide Angle Lens and optics with 40° optical FoV
  - Cable for laser and MEMS mirror attached
- **USB 3.0 Camera** with 6mm lens (~45°x 34.5° FoV)
  - 720x540 pixels, capable of >500 fps
- Mechanical mounting for Camera and Scan Module
- USB-SL MZ **MEMS Controller** with Embedded MEMS ˙˙
- Mirrorcle **Software Suite** + Camera Sense API
  - With comprehensive documentation
- Software examples specific to DEMO-02

Connectorized PCB for Laser and MEMS

MEMS Mirror

Laser Module

0   1cm   2cm

40° Field of View

5
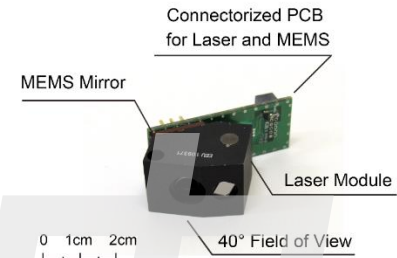
Getting Started

Getting Started – Terms & Definitions

- **Camera FoV** is the full Field-of-View of the camera frame. Note that the angles of Camera FoV may be a function of chosen camera settings (in mticamera.ini file). (DEMO-02 ships with 45.0° x 34.5°)

- **MEMS FoR** – MEMS Mirror based Scan Module has a Field-of-Regard – range (pyramidal cone) of angles where it can point the laser beam (typically up to 40° x 40°, depending on voltage settings etc.)

- **Calibrated FoR** (**CFOR**) is defined as a square within the Camera FoV which is addressable by the Scan Module (FoR) and which is calibrated with respect to the Scan Module commands (see iLUT below).

- **iLUT**: "inverse" Look up Table – stored table of normalized mirror position commands (x,y) corresponding to a uniform table of optical angle points (θ_x, θ_y)
  - Used to request driving commands that will point the laser beam to a specified angle in the CFOR. iLUT is obtained during Camera 1 iLUT calibration step and changes only when mounting/camera settings are changed.

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Getting Started – Terms & Definitions

Camera FoV vs MEMS FoR vs Calibrated FOR (CFOR)

Camera FoV
(720x540 pixels)

Calibrated FOR (CFOR)
(in degrees)

MEMS FoR
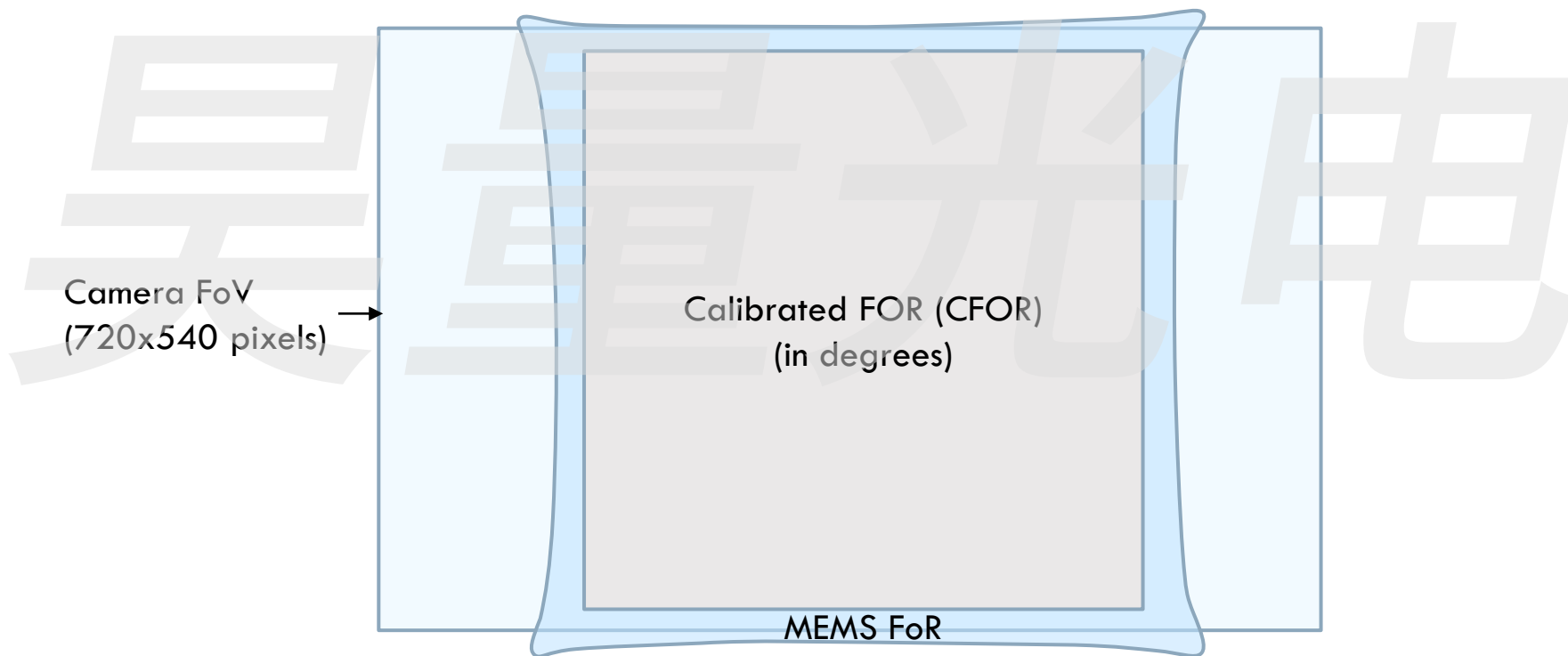
Getting Started – Hardware/Environment Setup

- **DEMO-02 comes calibrated and ready to run directly out of the box**

- For the best initial results, the user should prepare an environment analogous to the one where the kit was originally calibrated:
  - Indoors
  - Low to medium ambient lighting
  - White or low-contrast background (e.g. a projector screen)

- **DEMO-02 is calibrated for a 1m distance**, but users may recalibrate as needed (more info on calibration later)

- **The low-contrast background should ideally fill the Camera FoV, the MEMS FoR, or at the minimum – the CFOR**

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# Getting Started – Hardware/Environment Setup
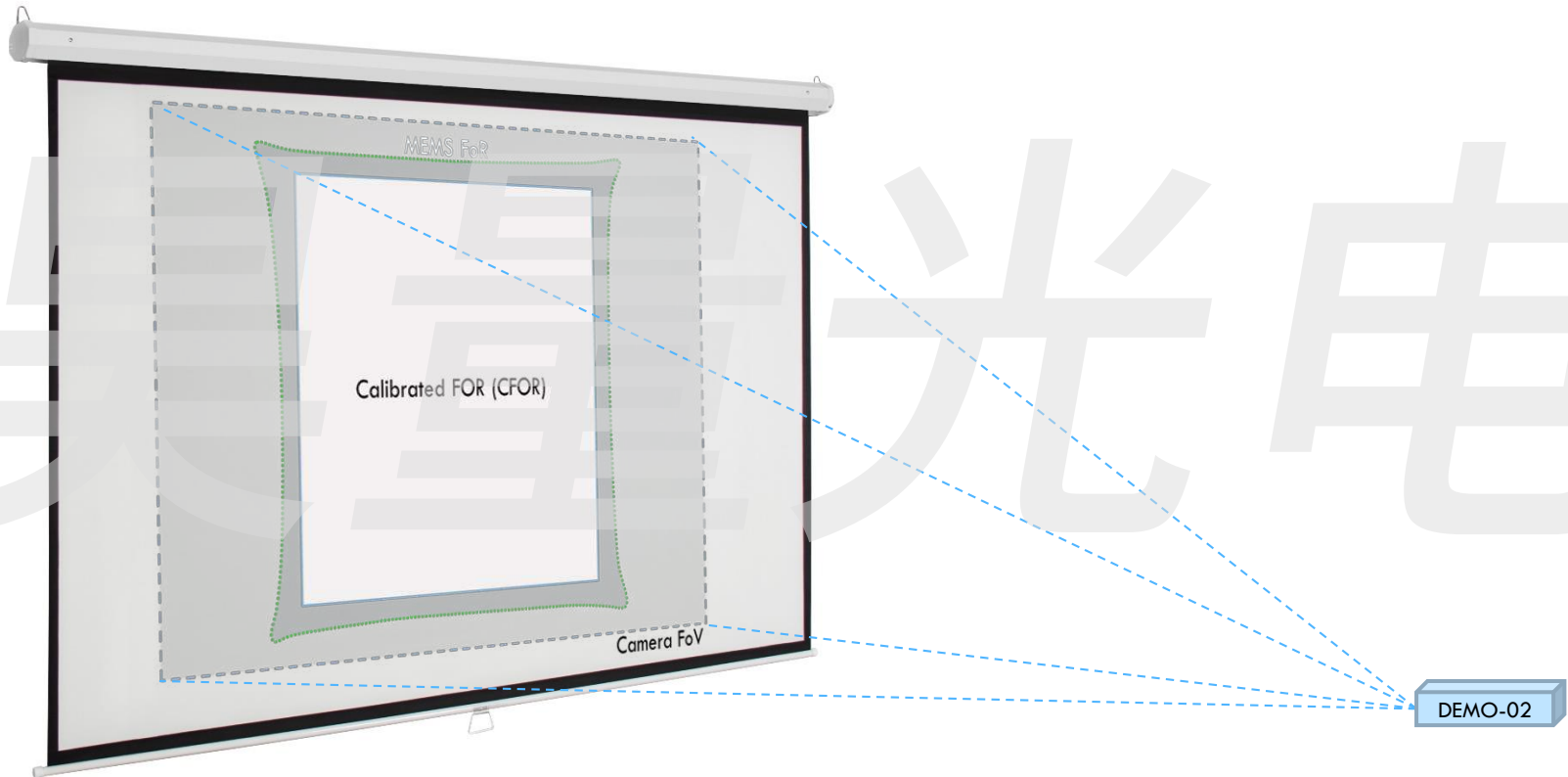
Getting Started – Connections and Drivers

☐ Connections

  ▫ Connect the **10-pin MEMS header** from the **Scan Module** to the "MEMS" port of the **USB-SL MZ Controller**

  ▫ Connect the **USB Mini cable** into the "USB" port of the **USB-SL MZ Controller** and then into your **PC**

  ▫ Connect the **USB 3.0 Micro-B** end into the **USB Camera** and the other end into a **USB 3.0 port on your PC**

☐ Drivers

  ▫ Mirrorcle's USB-SL MZ MEMS Controller drivers will auto-install upon connection to the PC

    ■ Successful driver installation can be verified by checking Device Manager for the USB Serial Port under **Ports (COM & LPT)**

    ■ If the drivers did not successfully install, an installation package is provided in **\Drivers\CDM20830_Setup.exe**

  ▫ The USB 3.0 Camera (Basler ace) has drivers and software that must be installed before using DEMO-02

    ■ More information on "Getting Started – Drivers (Basler Pylon)"
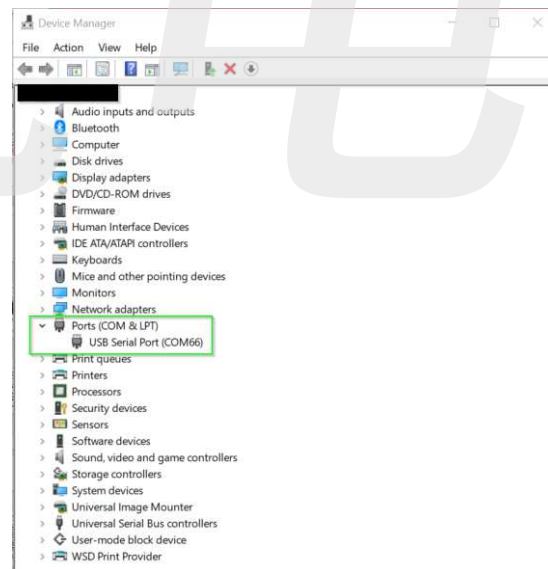
Getting Started – Drivers (Basler Pylon)

- The USB 3.0 Camera (Basler ace) has drivers and software (Basler pylon) that must be installed before using DEMO-02

- The installation package is found at **\Drivers\Basler_pylon_5.2.0.13457.exe**
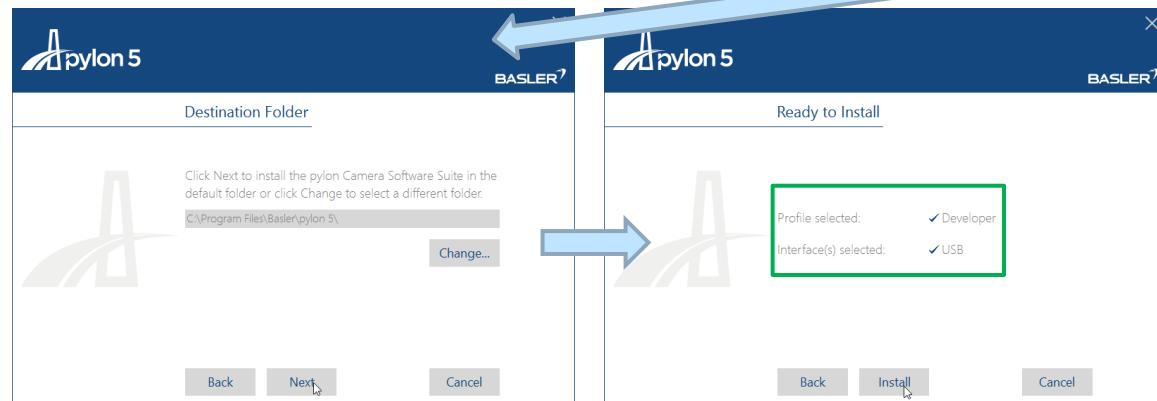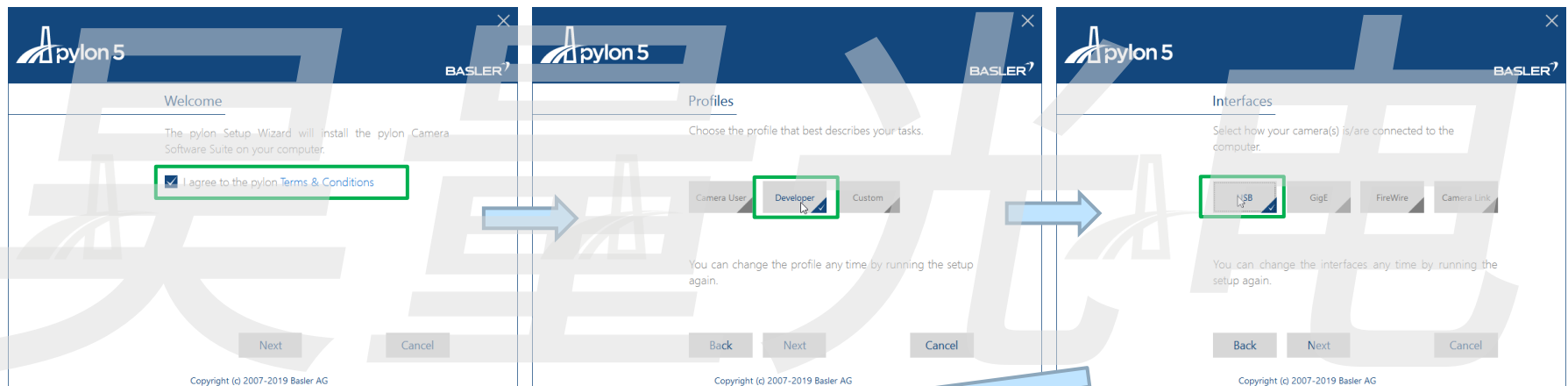
DEMO-02 Software

MTICamera-Demo – Overview

- **MTICamera-Demo** executable and source code are provided on the included USB stick with a DEMO-02 delivery

- MTICamera-Demo demonstrates system calibration as well as application examples for DEMO-02

- **Executable:** *C:\MirrorcleTech\exe\MTICamera-Demo.exe*

- **Source:** *C:\MirrorcleTech\SDK-Cpp\camera_demo*

```
************** MTICamera-Demo 1.1 - Camera/Scan Module Interaction Examples **************

Camera/Scan Module Interaction Demos:
        1: Send Laser to Camera Pixel/Angle
        2: Track Laser Pointer
        3: Track and Illuminate Objects

Setup:
        5: Set Laser Detect Threshold and Camera Alignment
        6: View and Setup Field of Regard
        7: Calibrate Inverse Lookup Table

(Q/q)uit
```

# MTICamera-Demo – Laser to Camera Pixel/Angle

□ Laser to Camera Pixel/Angle demonstrates DEMO-02's ability to address any position in the CFOR

□ To send the laser to a position:

- ▫ Users may click anywhere in the camera view (send to pixel)
- ▫ Type an angle in the terminal (send to angle)
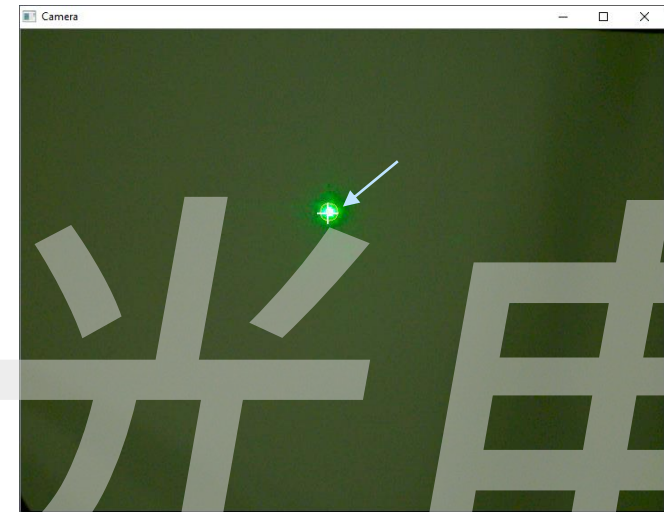

Users may click anywhere in the camera view


```
C:\Projects\Repositories\mss-cpp\Debug\MTICamera-Demo.exe
Click window or enter an angle "x,y" to send laser to that position
Enter non-number to quit

-1,5.5
```

Users may type an angle in the terminal

5.5°
-1°

15
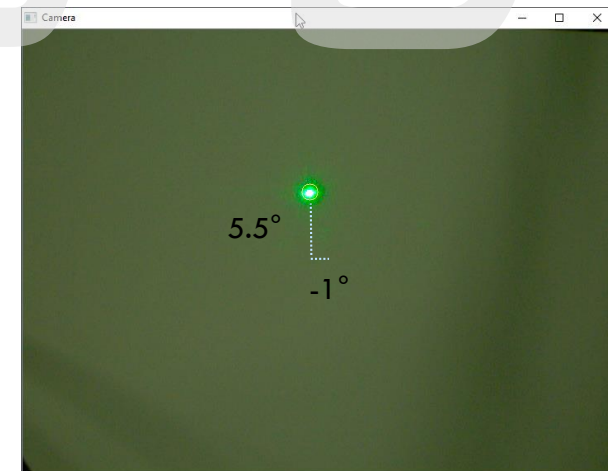
MTICamera-Demo – Laser Pointer Tracking

- In Track Laser Pointer, DEMO-02 tracks a red laser pointer with the green text, "MEMS".

- DEMO-02 will follow the laser pointer as long as it remains within the CFOR

- The provided Hue/Saturation/Value (HSV) settings show the settings used to ensure only the red laser pointer meets the threshold for tracking

- *This demo can be sped up by toggling the GUI windows off [W/w]*
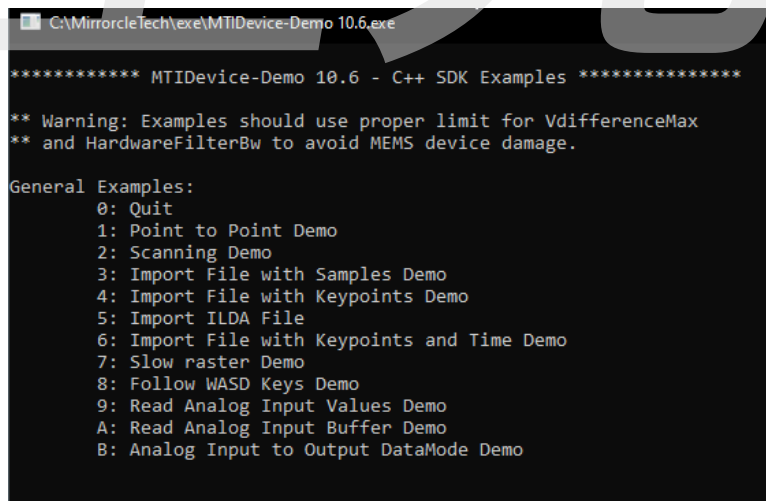

Camera 1 view

Threshold filtered image
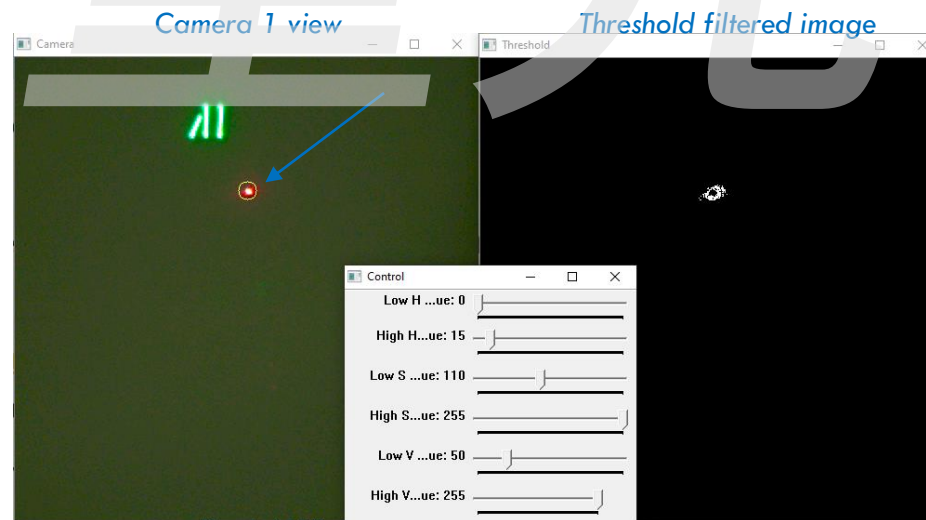
HSV threshold settings control

MTICamera-Demo – Track and Illuminate Objects

Camera 1 view   *HSV filtered image*

Threshold settings control
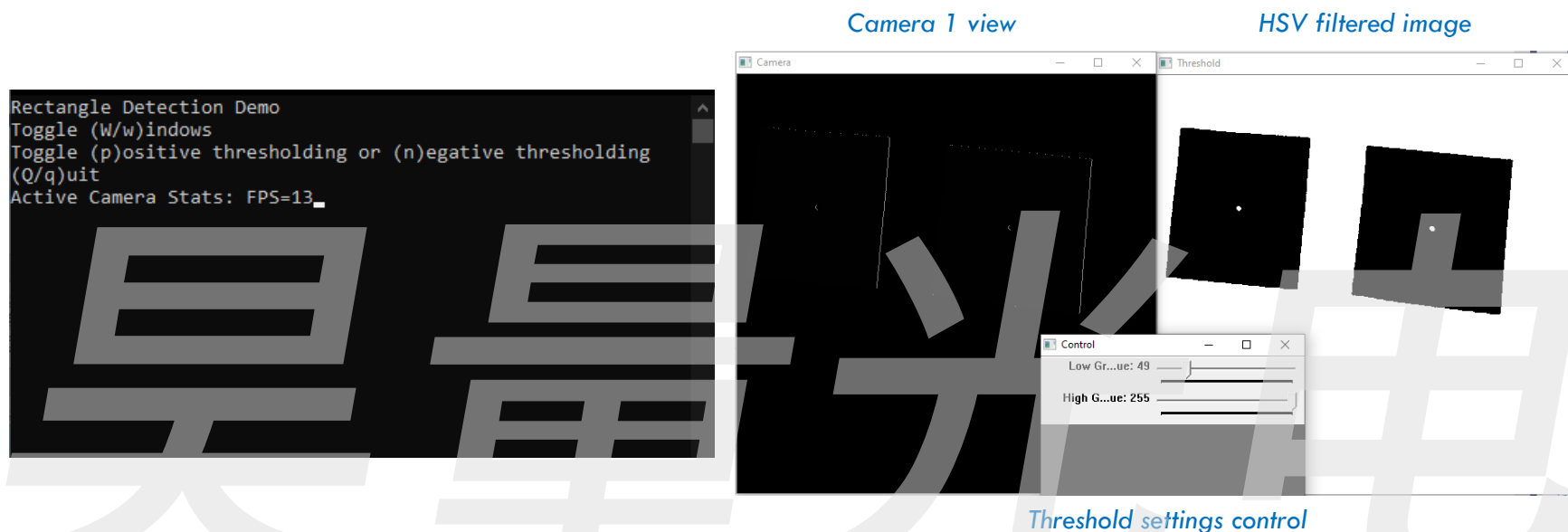
- ☐ In Track Objects demo, DEMO-02 recognizes regions of high contrast within the CFOR and paints the centroid of each detected region with a green dot.

- ☐ DEMO-02 can track and address multiple high-contrast regions simultaneously.

- ☐ Use **[P/p]** to set thresholding to positive and **[N/n]** to set thresholding to negative

- ☐ *This demo can be sped up by toggling the GUI windows off **[W/w]***

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MTIDevice-Demo

- **MTIDevice-Demo** provides 10 different ways of actuating Mirrorcle MEMS mirrors.

- As an SDK example, the C++ source code comes with detailed comments to facilitate customers' own software development.

- The program starts with a prompt for the user to select the USB-SL MEMS Controller.

- After the controller is selected, the following UI is presented:


```
C:\MirrorcleTech\exe\MTIDevice-Demo 10.6.exe

************* MTIDevice-Demo 10.6 - C++ SDK Examples **************

** Warning: Examples should use proper limit for VdifferenceMax
** and HardwareFilterBw to avoid MEMS device damage.

General Examples:
        0: Quit
        1: Point to Point Demo
        2: Scanning Demo
        3: Import File with Samples Demo
        4: Import File with Keypoints Demo
        5: Import ILDA File
        6: Import File with Keypoints and Time Demo
        7: Slow raster Demo
        8: Follow WASD Keys Demo
        9: Read Analog Input Values Demo
        A: Read Analog Input Buffer Demo
        B: Analog Input to Output DataMode Demo
```

SDK-Cpp

- The provided **SDK-Cpp** folder contains both the source for MTICamera-Demo and MTIDevice-Demo

- The source files for MTICamera-Demo are intended to provide examples for user implementation of Mirrorcle's **MTICamera API**.

- The source files for MTIDevice-Demo are the ideal starting point for users to familiarize themselves with the **MTIDevice API**

- MTICamera-Demo (source): C:\MirrorcleTech\SDK-Cpp\camera_demo

- MTIDevice-Demo (source): C:\MirrorcleTech\SDK-Cpp\

Calibrating DEMO-02

Calibrating DEMO-02 - Overview

```
************* MTICamera-Demo 1.1 - Camera/Scan Module Interaction Examples ***************

Camera/Scan Module Interaction Demos:
        1: Send Laser to Camera Pixel/Angle
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Setup:
        5: Set Laser Detect Threshold and Camera Alignment
        6: View and Setup Field of Regard
        7: Calibrate Inverse Lookup Table

(Q/q)uit
```
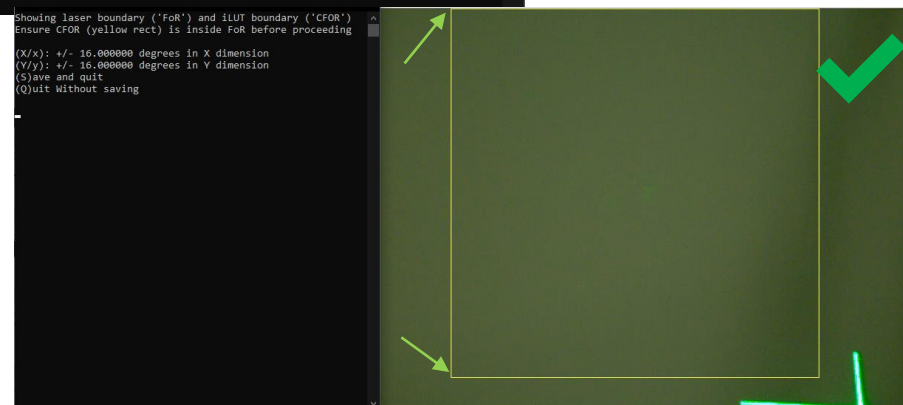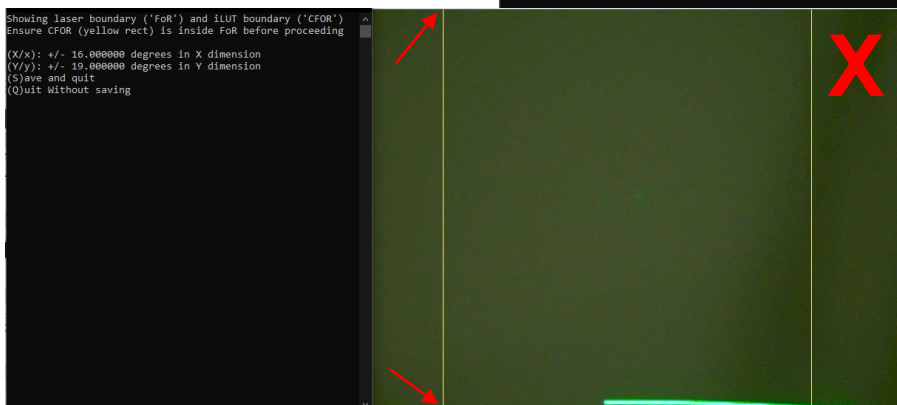
- Calibrating DEMO-02 is a 3 step process.

  - The steps are ordered in the MTICamera-Demo UI according to the order in which they should be executed. Options **5**, **6**, and **7**

- 1. Set Laser Detect Threshold and Camera Alignment

  - Here users will set the lower and upper grayscale acceptance values (normalized 0-255) for the detection algorithm to detect the laser spot. Additionally, users will use this demo to mechanically align the USB camera and Scan Module so that the laser spot is centered in the camera's FoV

- 2. View and Setup Field of Regard

  - Based on the result found in the previous step, the UI will draw a rectangle corresponding to the CFOR. Users will need to adjust the size of the target CFOR so that it fits within the limits of the camera's FoV and the MEMS FoR.

- 3. Calibrate Inverse Lookup Table

  - Using the results from the last two steps, the application will calibrate an inverse lookup table by steering the MEMS to a target camera pixel using the camera as a feedback tool. The corresponding MEMS voltage required to reach that pixel is recorded

Calibrating DEMO-02 - Laser Threshold/Alignment

1. Device Laser Threshold and Camera Alignment

   □ Send Laser to (0, 0), find pixel, and that becomes the Calibrated Field of Regard (CFOR) center (user must assist by adjusting the threshold slider values if lighting in the room or target surface is very different than factory)
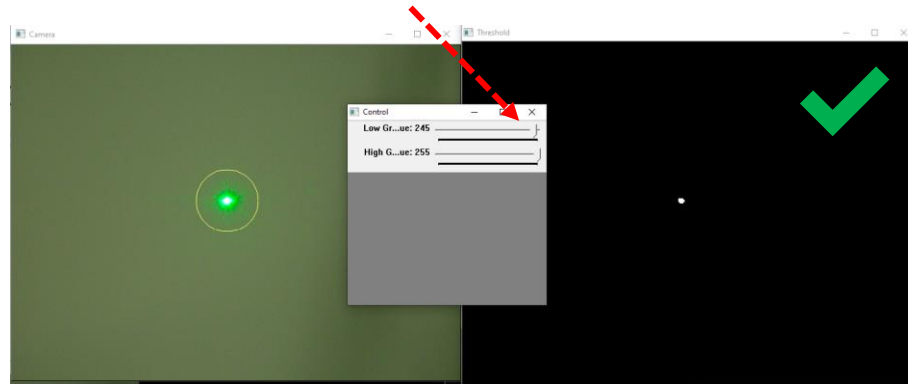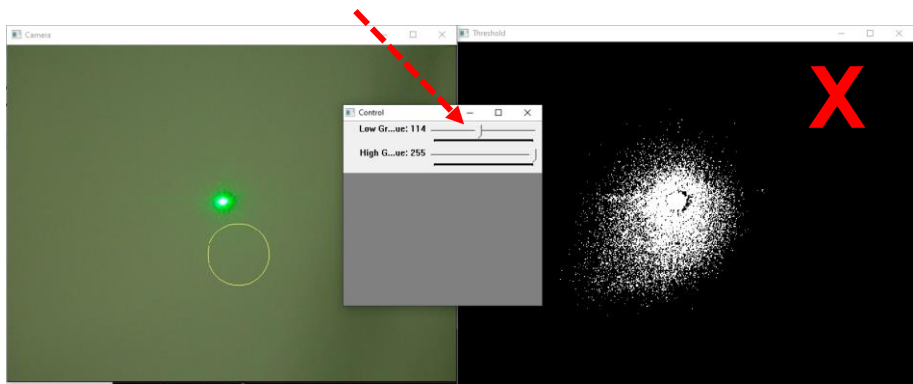
Calibrating DEMO-02 - Field of Regard

2. View and setup Calibrated Field of Regard boundaries

- View max angles that will fit within the MEMS FoR (integer x integer optical angle rectangle), e.g. +/-16° x +/-16°

- Use the [X/x] and [Y/y] keys to adjust the CFOR (yellow rect) such that it fits inside the Camera FoV

Calibrating DEMO-02 - Inverse Lookup Table

3. Calibrate Inverse Lookup Table –

- Resolves the relationship between applied drive voltages to MEMS and the resulting Optical Scan Angles

- Once the calibration is complete, press [S/s] to save the calibration file or press

- If the calibration fails, the user should adjust the laser threshold settings in Setup **5: Device Laser Threshold and Camera Alignment** or ensure that the CFOR fits inside the MEMS FoR and Camera FoV as defined in

Calibrating DEMO-02 – 5x5 Inverse Look Up Table

□ Example of the ILUT as it is stored in a file. The Lookup table consist out of two linear arrays with length **LUT_ROWS * LUT_COLS**. The **values** on the lookup table are **float**.

□ In **black: Row, Col numbers** of ILUT file.

□ In **green:** the **overlaying coordinate system** in the **CFOR**.

0,0 -1,1	0,1	0,2 0,1	0,3	0,4 1,1
1,0	1,1	1,2	1,3	1,4
2,0 -1,0	2,1	2,2 0,0	2,3	2,4 1,0
3,0	3,1	3,2	3,3	3,4
4,0 -1,-1	4,1	4,2 0,-1	4,3	4,4 1,-1
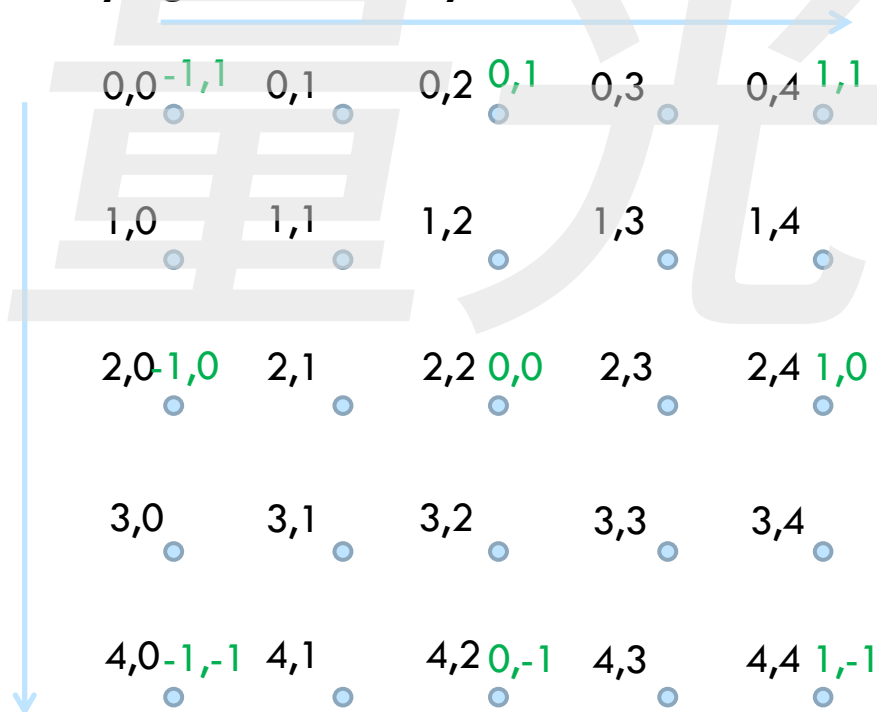
Calibrating DEMO-02 - Conclusion

- This completes the DEMO-02 calibration process

- If a user wants to address a pixel of the CFOR with the laser beam, all of the necessary information is stored in the "ini" file

- **Any changes to the .ini file or to the mechanical mounting should be followed with a re-calibration of the system.**

Additional Resources

- Manuals for Software and hardware are in the USB Thumb Drive's "Documentation" folder, and after software installation are also placed in the C:\MirrorcleTech\Documentation\ folder

  - **Mirrorcle Software Suite - Application Guide** - Software Applications Manual
  - **Mirrorcle Technologies MEMS Mirrors - Technical Overview** – Overview document about Mirrorcle's MEMS Devices
  - **USB-SL MZ MEMS Controller - User Guide** – USB MEMS Controller Manual
  - **Mirrorcle Products List**

- Supporting documents, publications and sample device datasheets are available online:
  http://www.mirrorcletech.com/support.html

- If you have any further questions please contact support@mirrorcletech.com

That's it! Thank you for reading through this guide.

If you have any further questions or suggestions please email us:
support@mirrorcletech.com