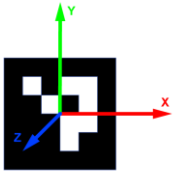
3D Displacement Measurement using ARUCO Marker

User Guide



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Overview

This is the user manual for the 3D displacement measurement toolkit utilizing GigE cameras and aruco marker.

Requirements

The following are the system's specifications:

1. Desktop Computer System (Intel Core i5, 8GB, 256GB)
2. Gigabit Ethernet GigE Machine Vision Industrial Camera (MS-GE40GC-T 0.4MP 298fps)
3. Quad Network Interface Card (I340-T4 Network Card Intel 1000Mbps) – (for multiple cameras)
4. Ubuntu 20.04 LTE with ROS Noetic

Working Instructions

The following describe the working of the system:

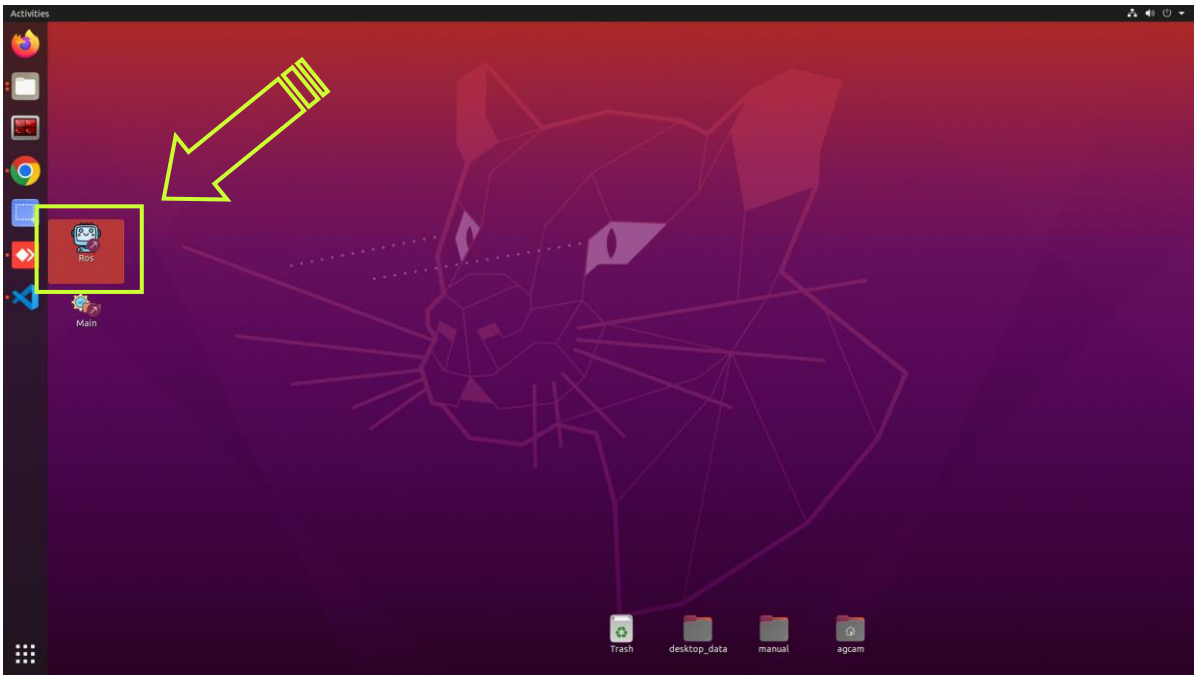
1. Ros Initialization
2. Store camera video stream for post processing
3. Displacement calculation using post processing of stored video stream data.

Following is a comprehensive description of the preceding steps:

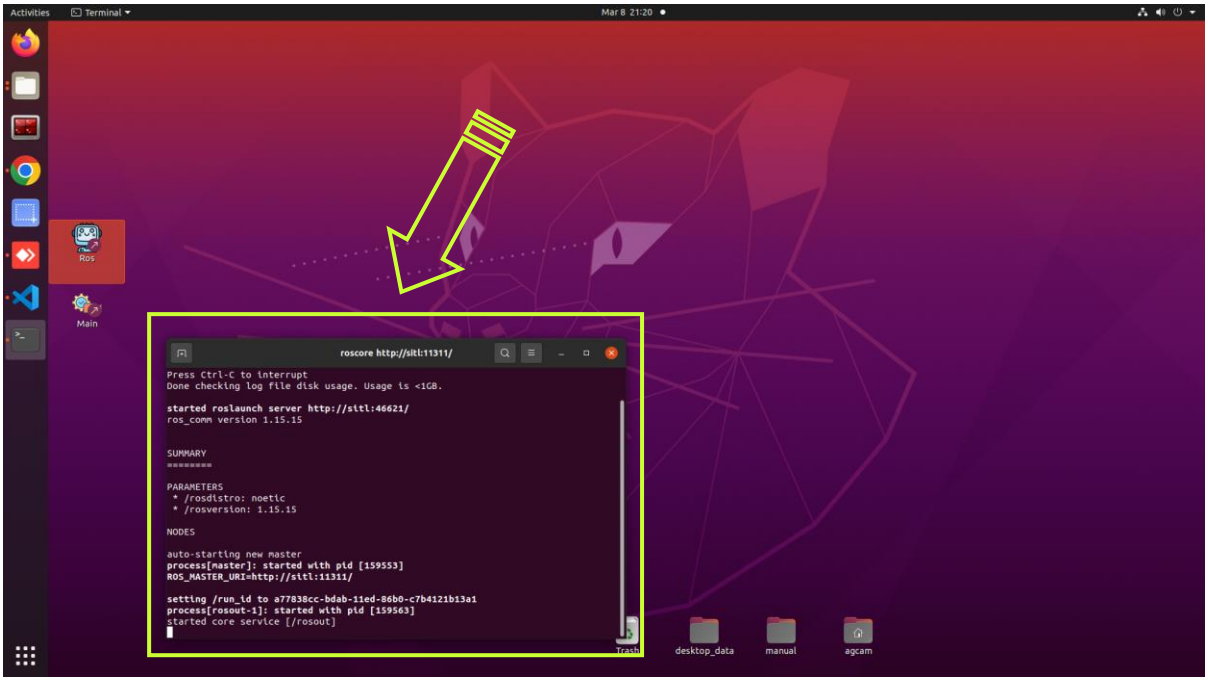
Step No. 01: ROS Initialization

The following steps are required for every ROS-compatible program:

1. Initialize the **ROS node** by pressing the **Ros** desktop icon ( ) as shown in the following figure:



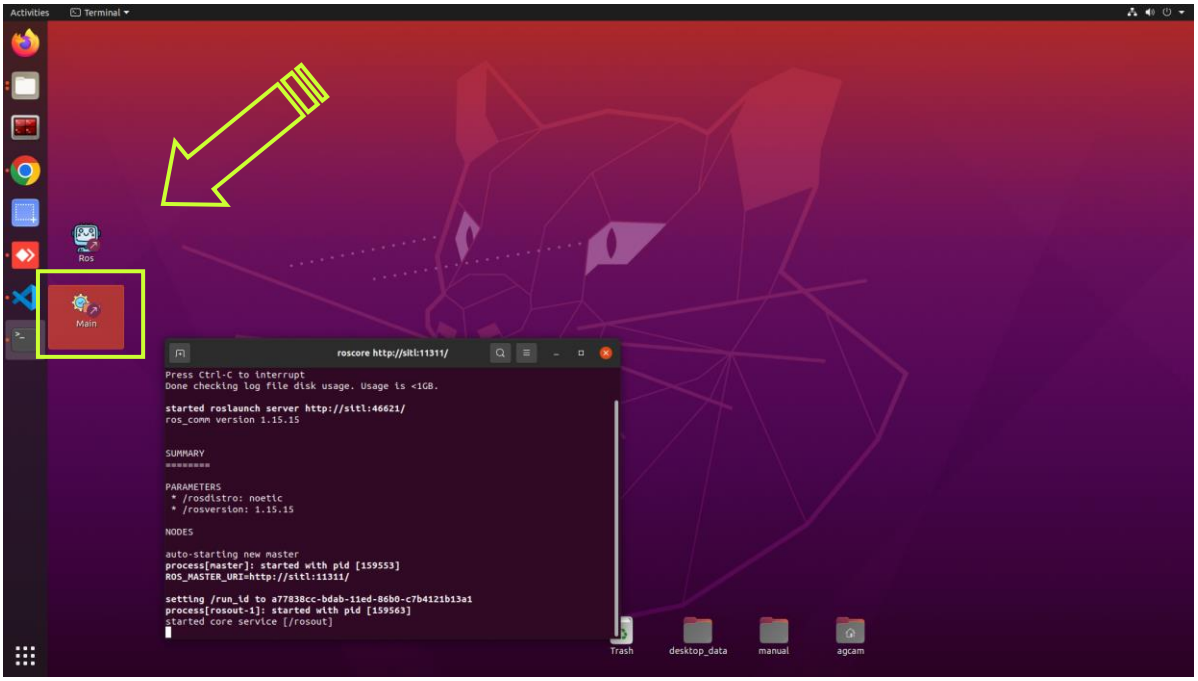
2. The **ROS node** is now operational, as illustrated in the following figure:



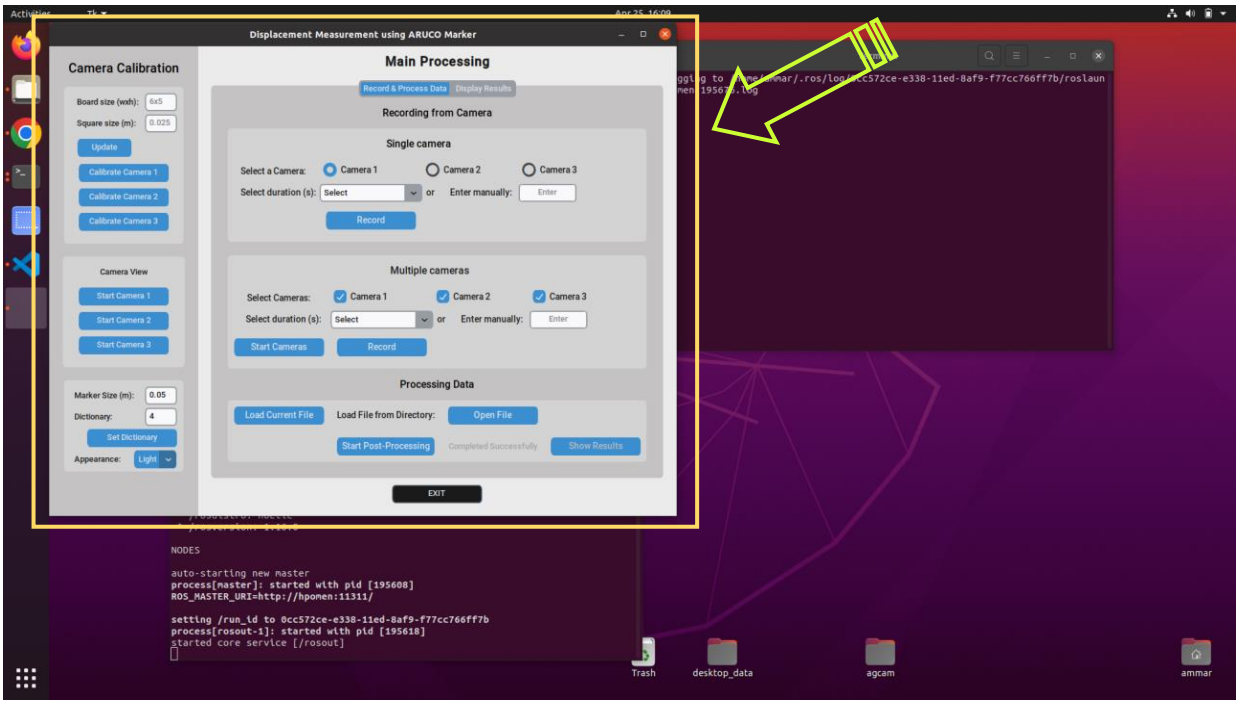
3. Next, we will launch our main program.

Step No. 02: Main Program Initialization

1. Initialize the **Main Graphical User Interface (GUI)** program by pressing the **Main** desktop icon () as shown in the following figure:



2. Now the ***Main program*** node is running, as showing in the following figure:

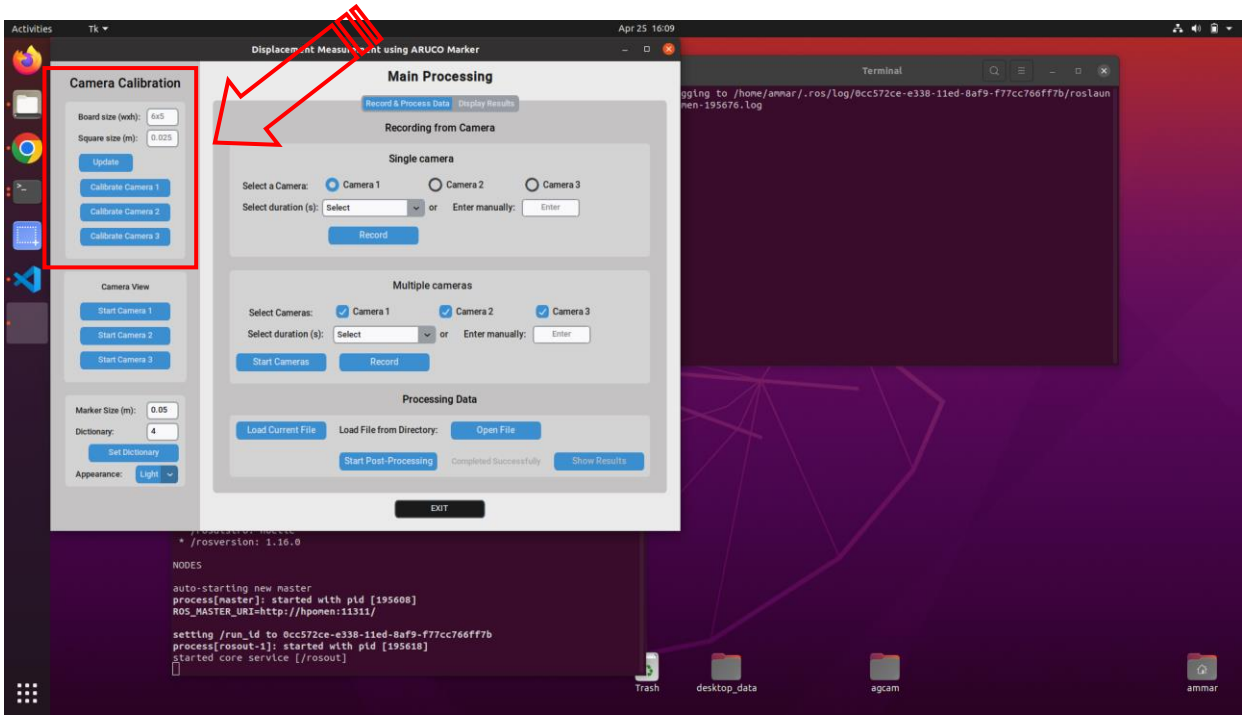


3. Now we may proceed to the next steps.

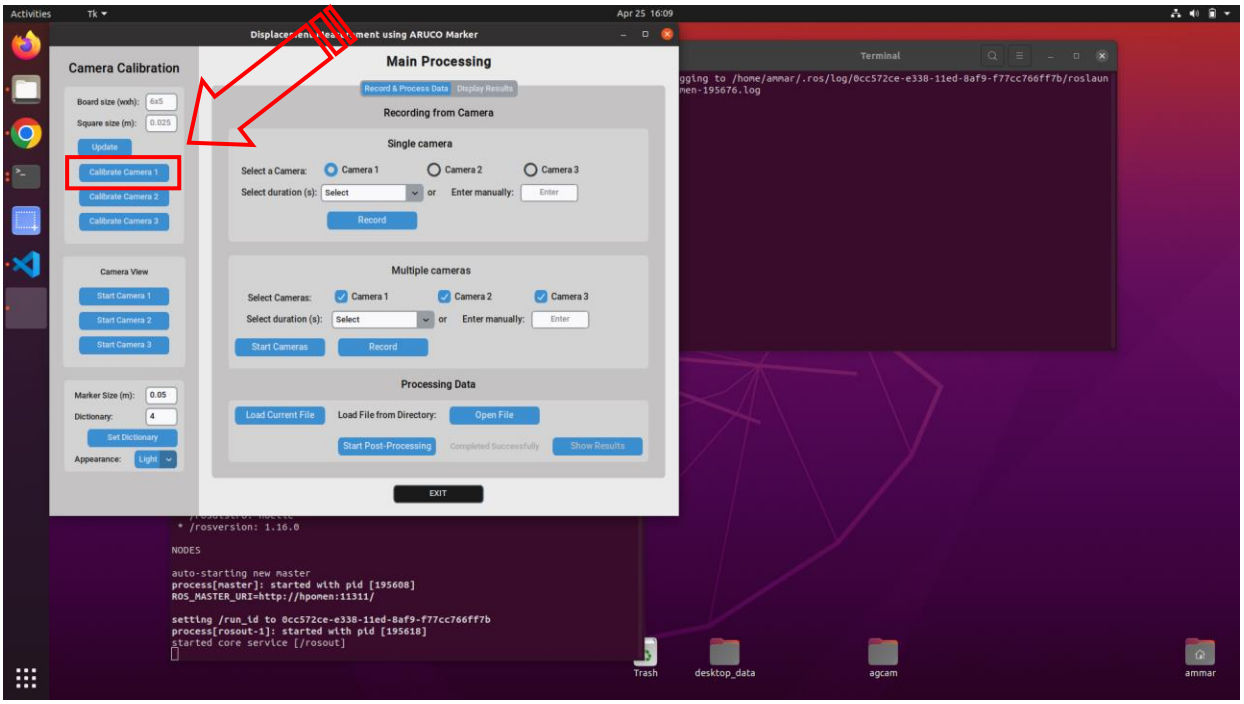
Step No. 03: Camera Calibration

The next step is to calibrate the cameras as described in the subsequent steps:

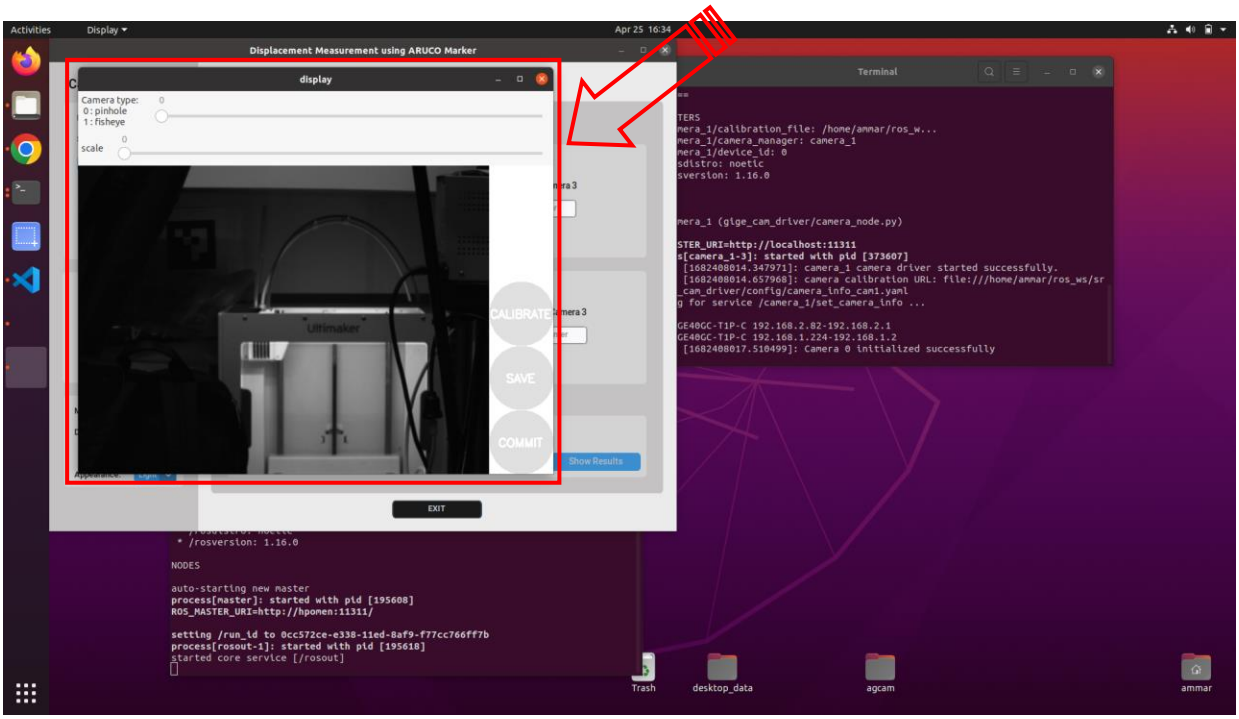
1. The first step is to set the **Camera Calibration** parameters, as depicted in the figure below:
    a. Enter the **Board size** of the checkerboard in the given format (e.g., 6x5).
    b. Enter the Checkerboard **Square size** in meters (e.g., 0.020).
    c. Press the **Update** button to set the Camera Calibration parameters.



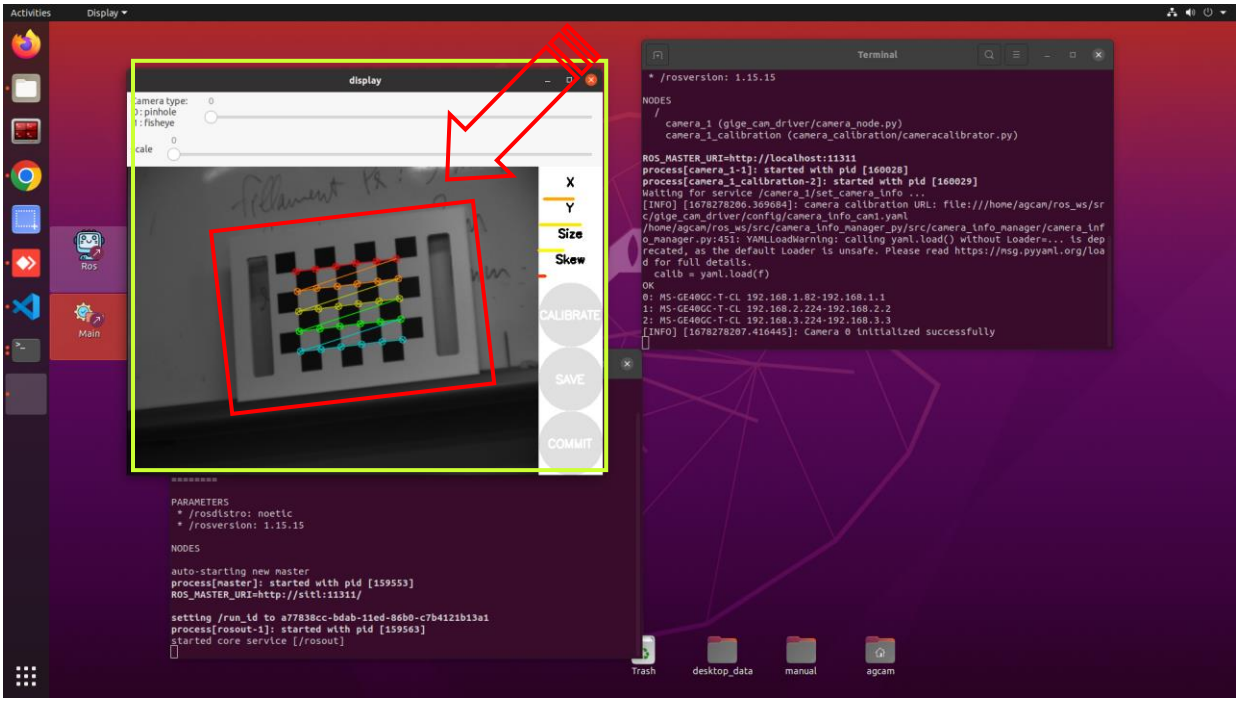
2. To calibrate Camera 1 press, **Calibrate Camera 1** button, as shown below:



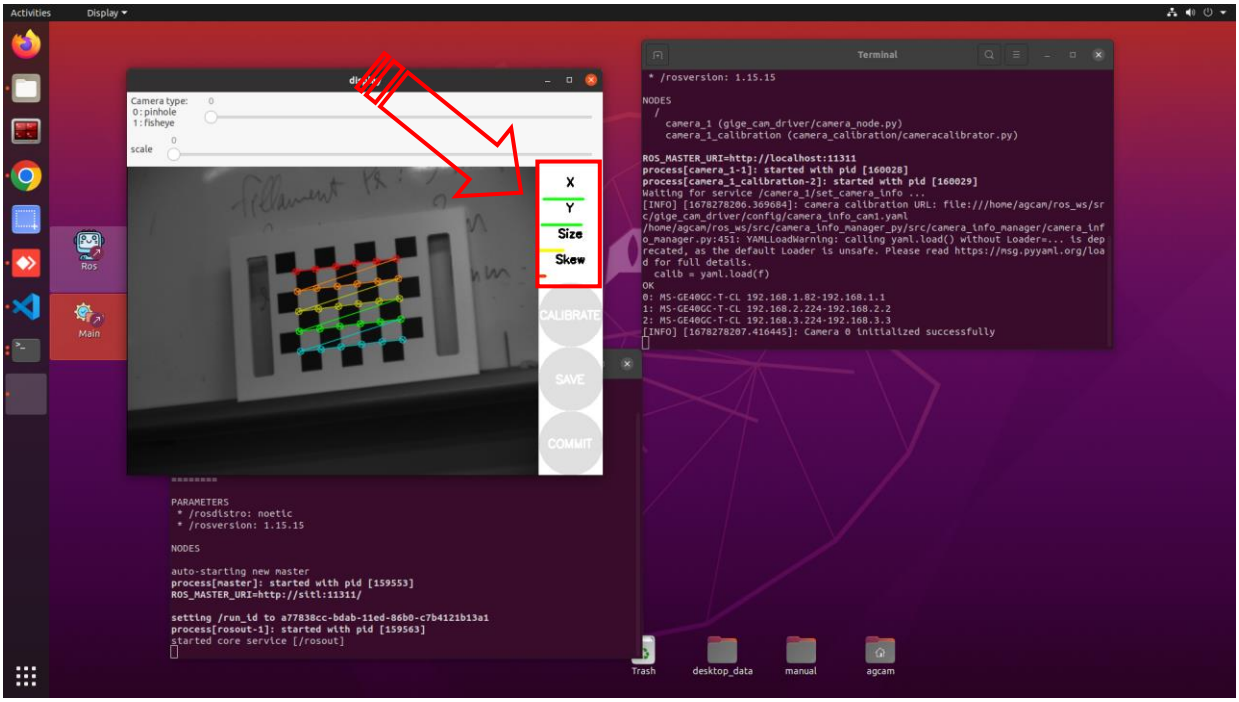
3. The camera calibration window will launch as shown below:



4. Place a **6x4 Checkerboard** in front of the **Camera 1** to initiate the **Calibration** process. As depicted in the figure below, if the checkerboard is identified, a **colorful pattern** will appear:

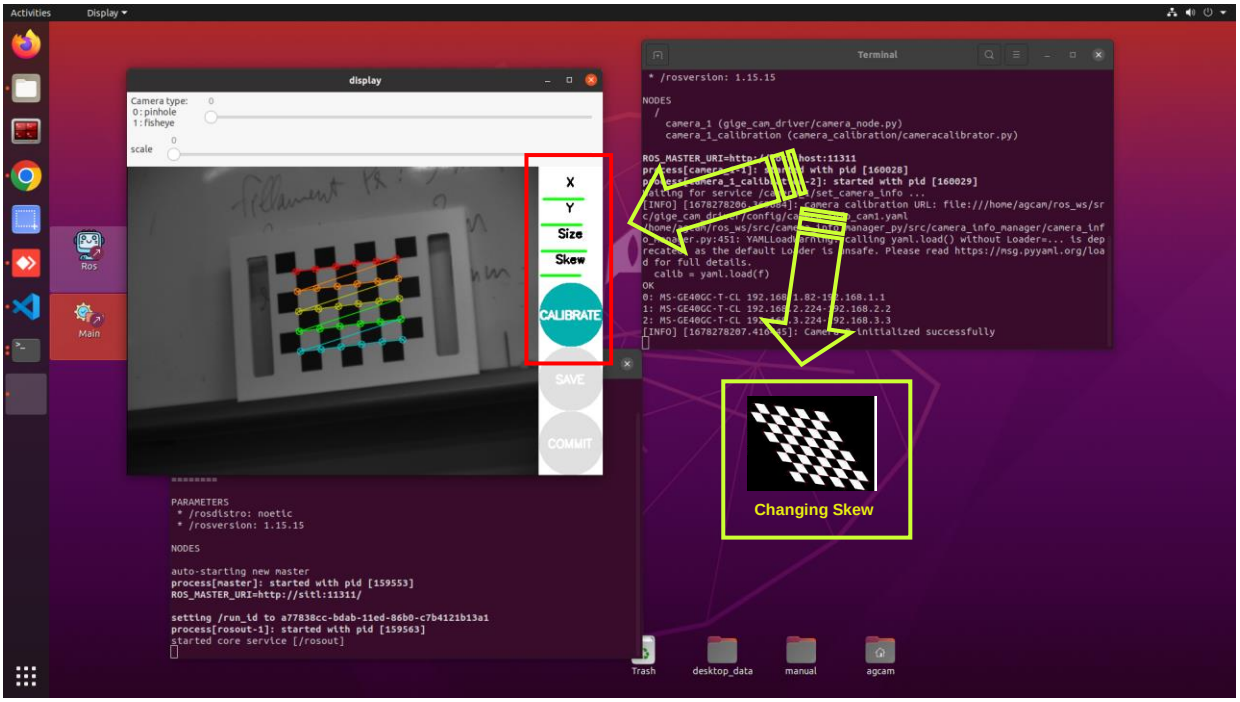


5. Move the **Checkerboard** in horizontal and vertical directions until the bars below **X** and **Y** turn **Green**, as depicted in the figure below:

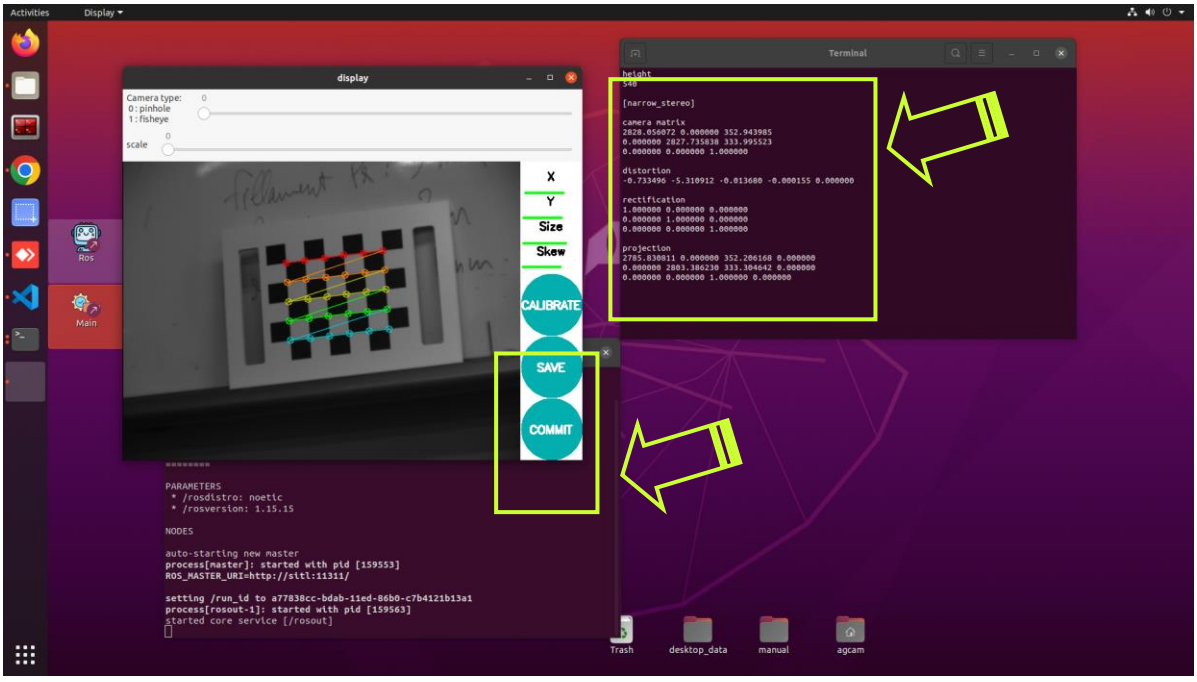


6. Move the **Checkerboard** towards and away from the camera for **Size** adjustment, and turn diagonally (changing roll, pitch, and yaw axis) for **Skew** adjustment, until the bars below **Size**

and **Skew** turn **Green** and the **CALIBRATE** button also turns **Green**, as shown in the figure below:



7. Press the **SAVE** button to save the camera parameters and calibration images, then press the **COMMIT** button to conclude the **Camera Calibrating** procedure. The terminal screen will display the camera's parameters as shown below:

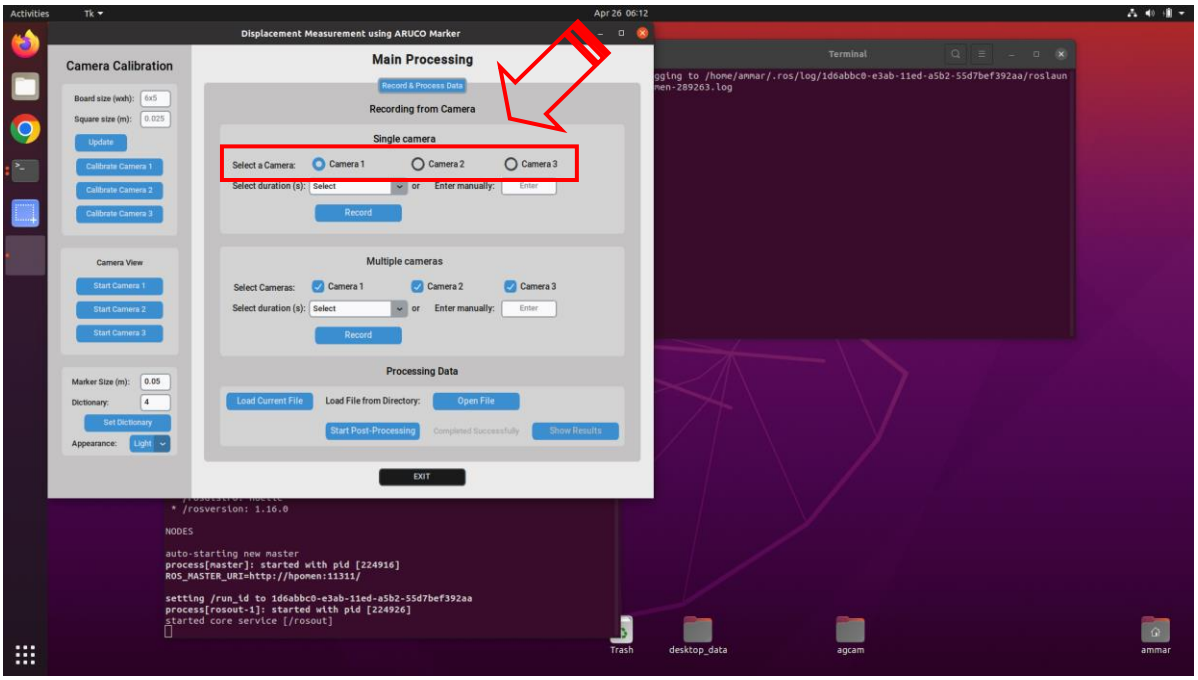


8. Camera Calibration has been completed successfully, close the terminal window and now we may proceed to the next steps.

9. Repeat the same steps to calibrate Camera 2 and Camera 3.

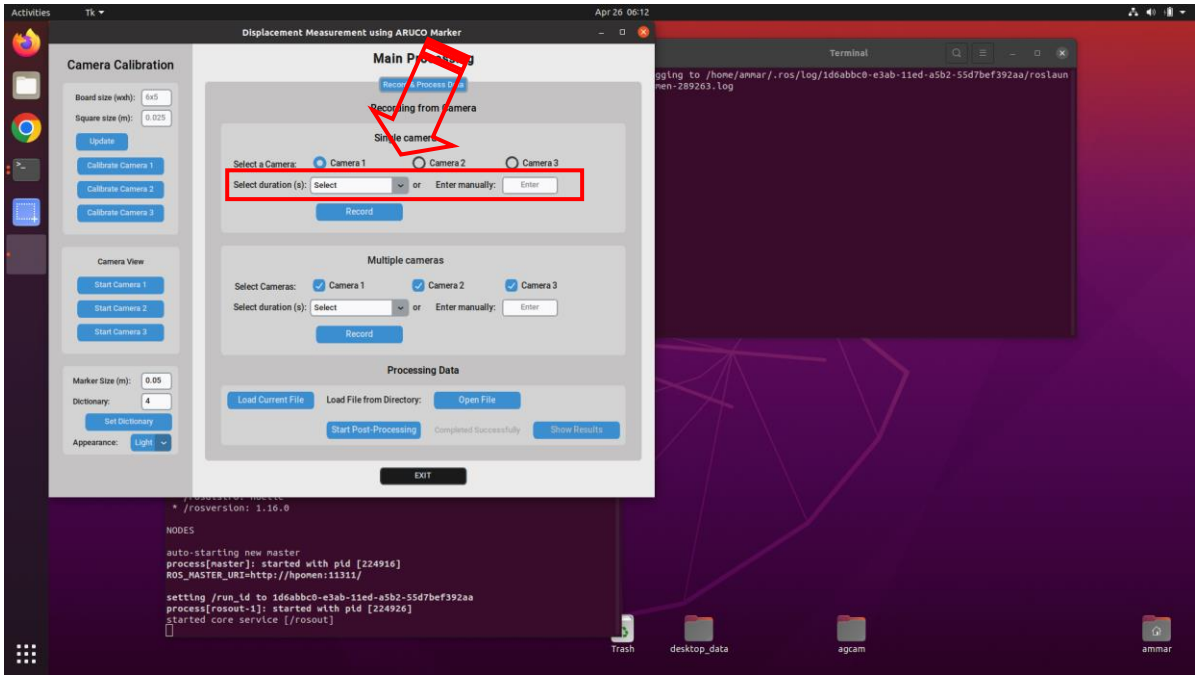
Step No. 04: Recording Camera Data for Post Processing

1. The first step in recording camera data for post processing is Camera Selection. **Select Camera** among the given options: (**Camera 1** or **Camera 2** or **Camera 3**) as shown below:

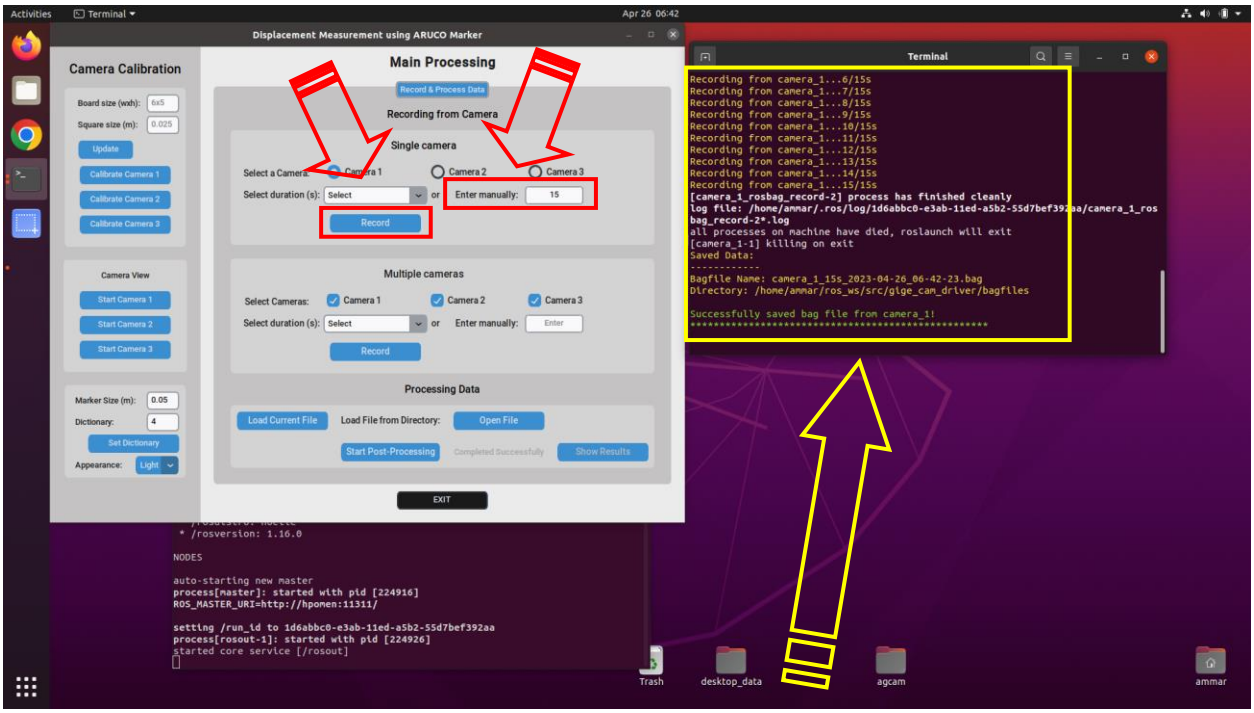


2. Now Select duration in seconds for camera recording

   a. Either choose from the **drop-down menu** (among **10s, 20s, 30s, 40s, 50s** or **60s**)
   b. Or you may enter the time duration **manually.**
   c. **Note:** If both drop-down and manual entry are present, the **manual entry will be considered** for camera recording.



3. Now press the **Record** button, to store the camera data for the desired time duration, as shown below:

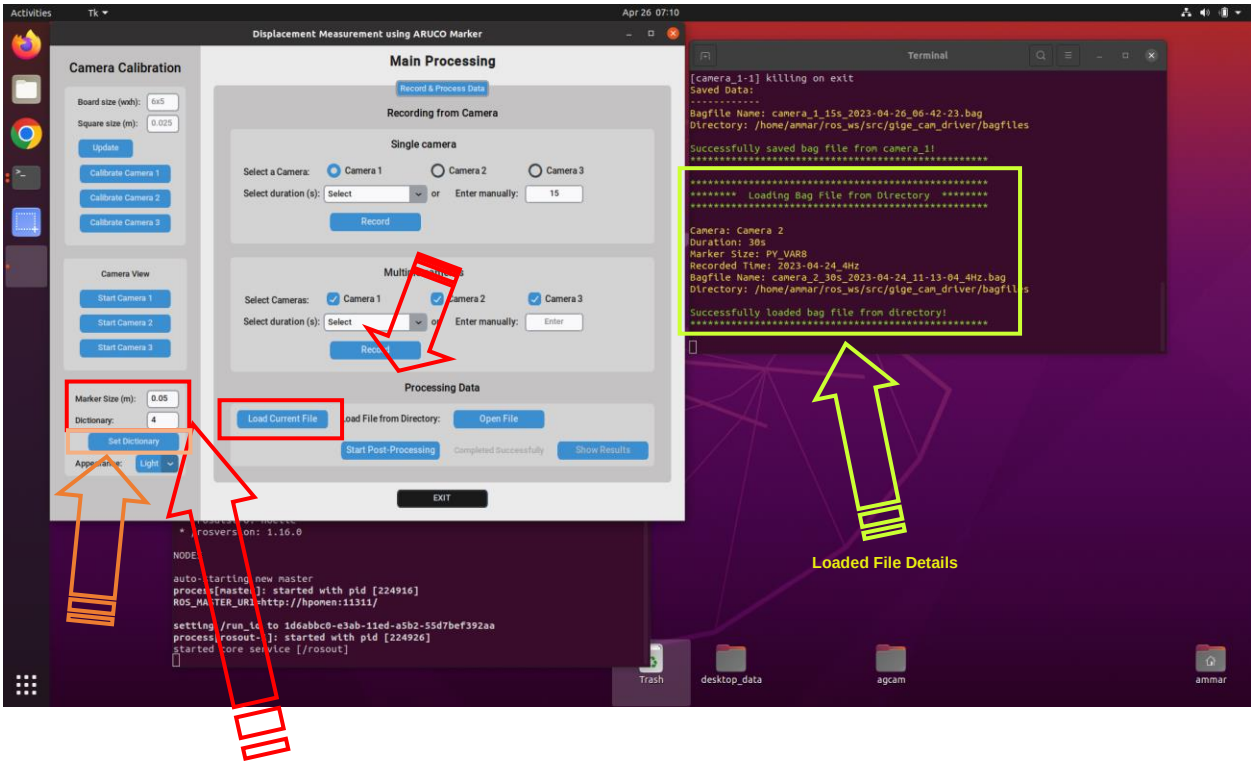


4. A message will be displayed after successful recording or camera data as shown in the figure above:

   Now you may proceed to the next step.

Step No. 05: Post Processing from Saved Camera Data

1. The first step in post processing is to load the recorded camera file:
    a. Either press the **Load Current File** button to load the last saved file.
    b. Or press **Open File** button to open a window and select the recorded camera file for post processing.
    c. The loaded file details are displayed in the Terminal window.
    d. The process is depicted in the following figure:

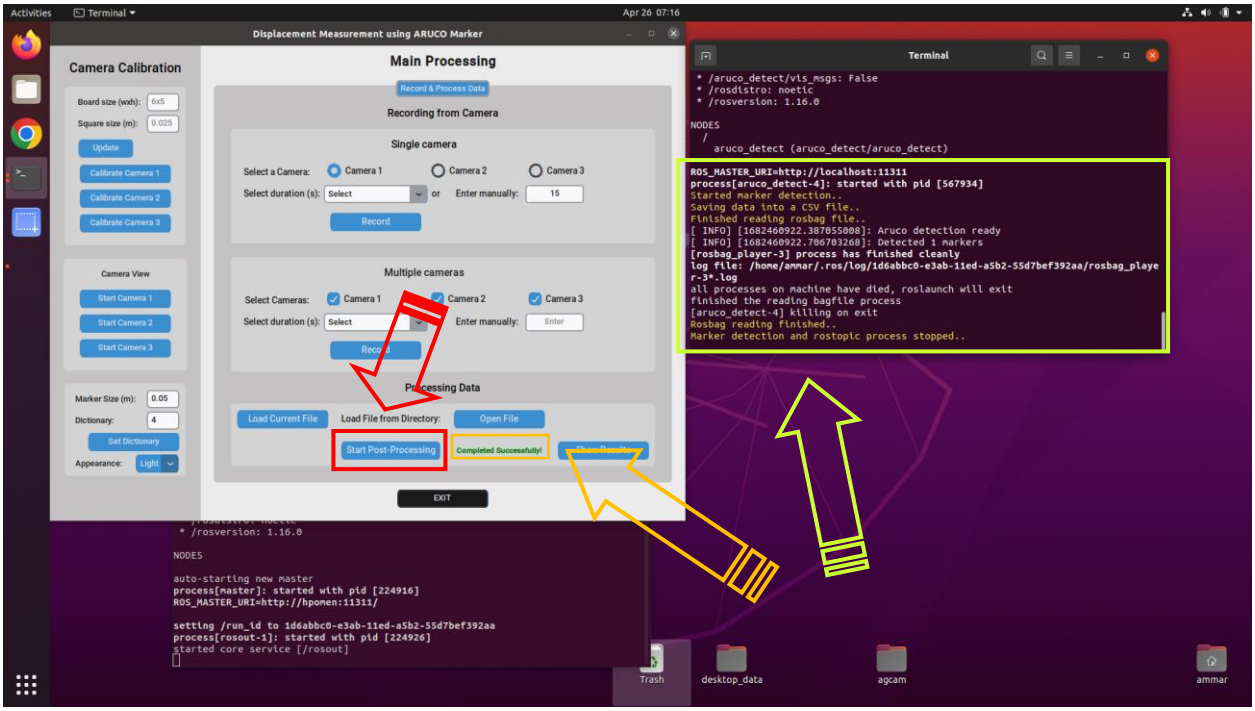


2. The next step in post processing is to set the ARUCO Marker parameters as shown in the above figure:
    a. Enter the ARUCO **Marker Size** in meters.
    b. Enter the Dictionary value as per given values:

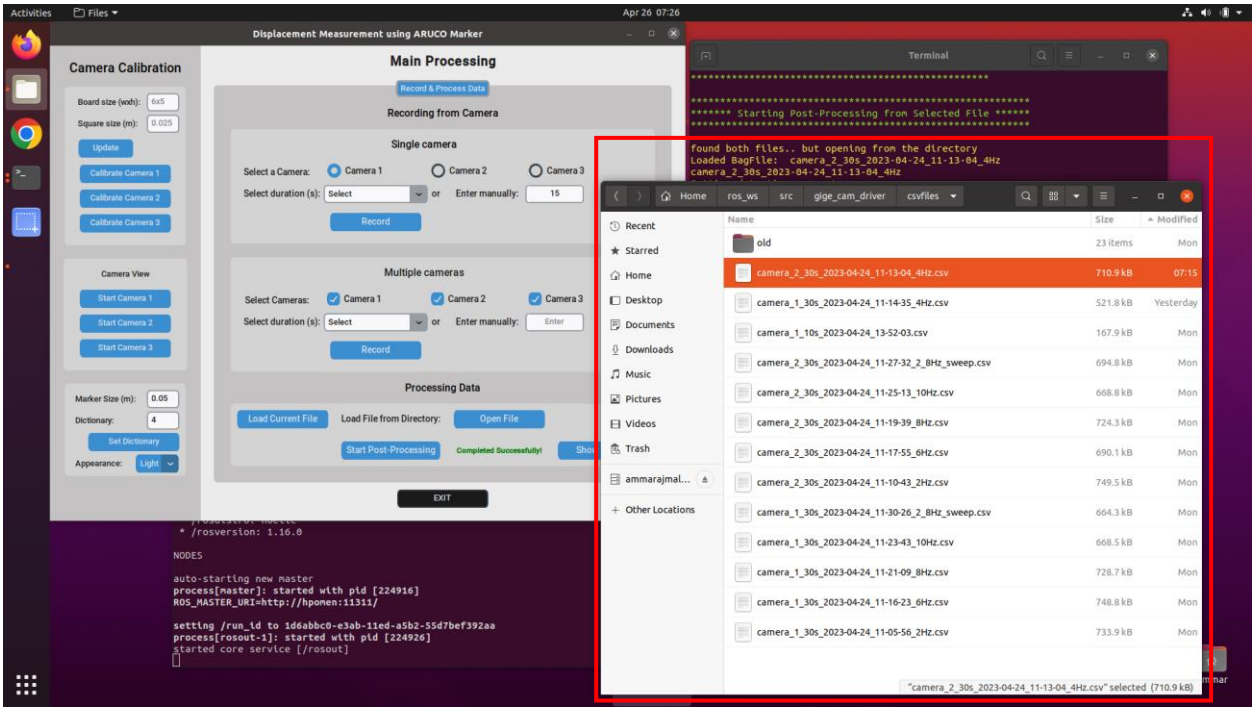
    `Dictionary` (`i.e.`, **default: 4**)

    c. The ARUCO dictionary to use. Possible values: 0 (DICT_4X4_50), 1 (DICT_4X4_100), 2 (DICT_4X4_250), 3 (DICT_4X4_1000), 4 (DICT_5X5_50), 5 (DICT_5X5_100), 6 (DICT_5X5_250), 7 (DICT_5X5_1000), 8 (DICT_6X6_50), 9 (DICT_6X6_100), 10 (DICT_6X6_250), 11 (DICT_6X6_1000), 12 (DICT_7X7_50), 13 (DICT_7X7_100), 14 (DICT_7X7_250), 15 (DICT_7X7_1000), 16 (DICT_ARUCO_ORIGINAL)
    d. Once the ARUCO Marker Size and Dictionary values are set, press **Set Dictionary** button as shown in the above figure:
        i.

3. Now press **Start Post Processing** button to start **Displacement Calculation** from camera data, as depicted in the figure below:



4. The three-dimensional displacement data stored as the **.csv file** is stored under the directory **/home/agcam/ros_ws/src/gige_cam_driver/csvfiles/**, as shown below:

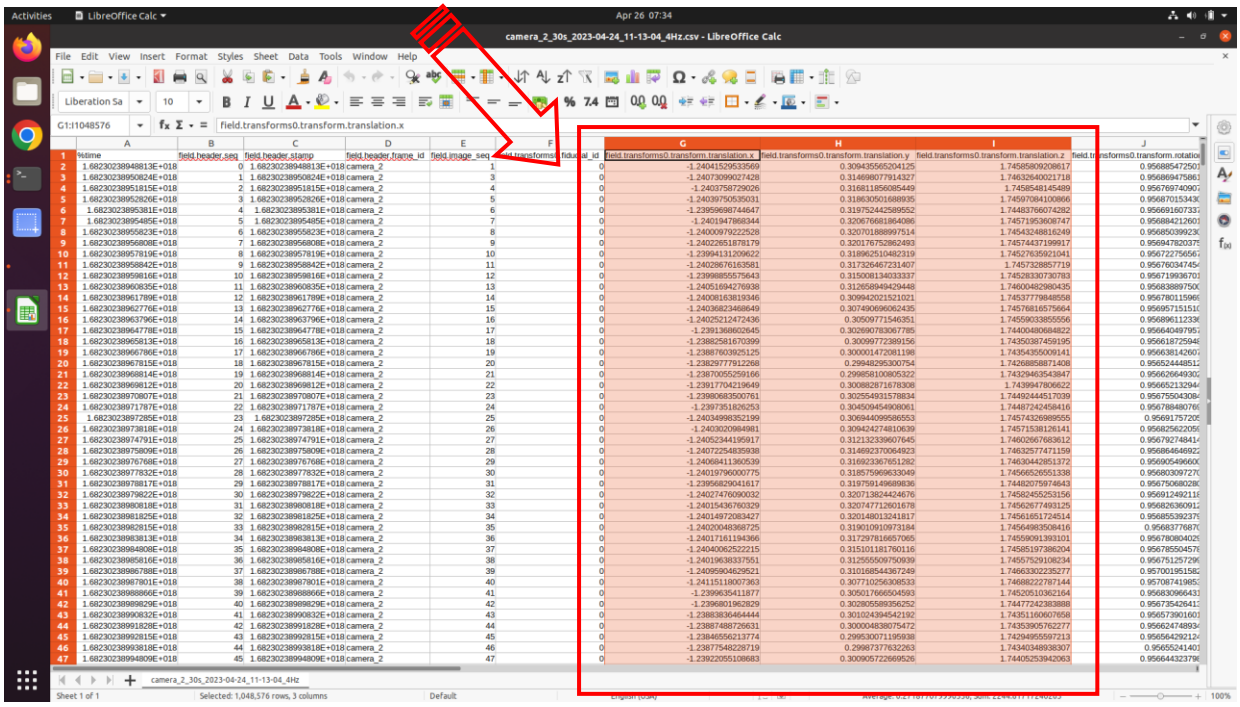


5. The following illustration depicts the contents of a CSV file featuring three-dimensional displacement data as variables:

    a. field.transforms0.transform.translation.x

    b. field.transforms0.transform.translation.y

    c. field.transforms0.transform.translation.z



6. The post-processing **has** completed effectively.