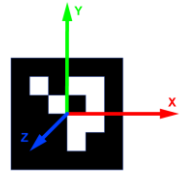


3D Displacement Measurement using ARUCO Marker

User Guide

ROS



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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 LTS with ROS Noetic

Working Instructions

The following describe the working of the system:

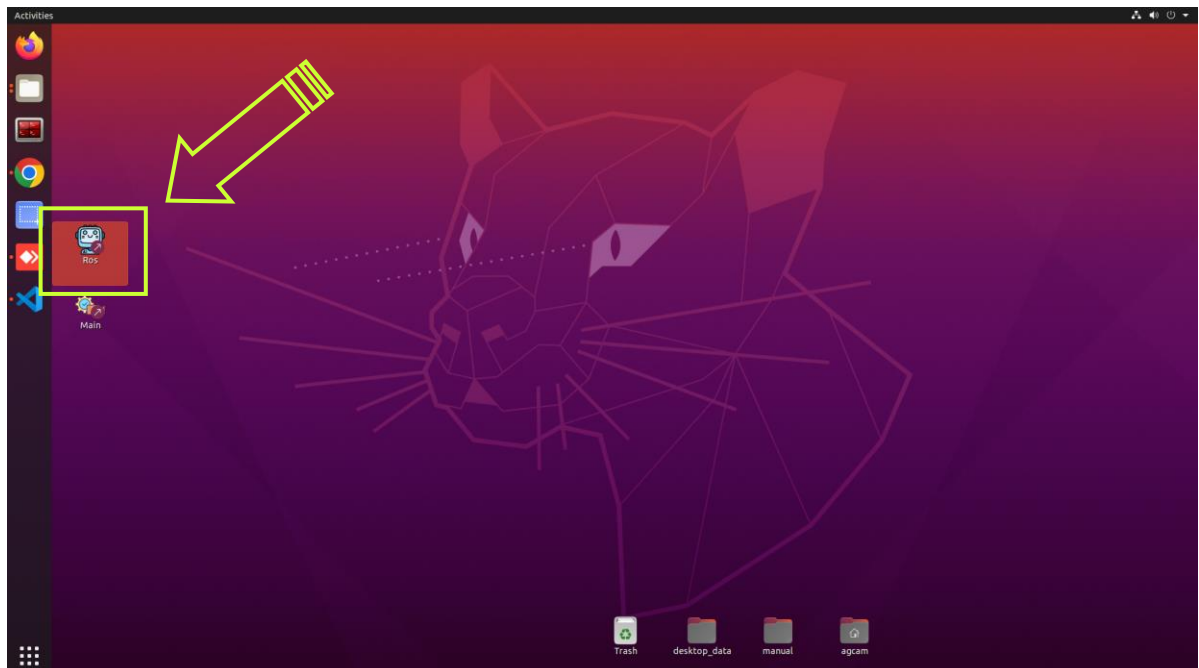
1. Ros Initialization
2. Store camera video stream for post processing
3. Displacement calculation using post processing of stored video stream data.

Following is a comprehensive description of the preceding steps:

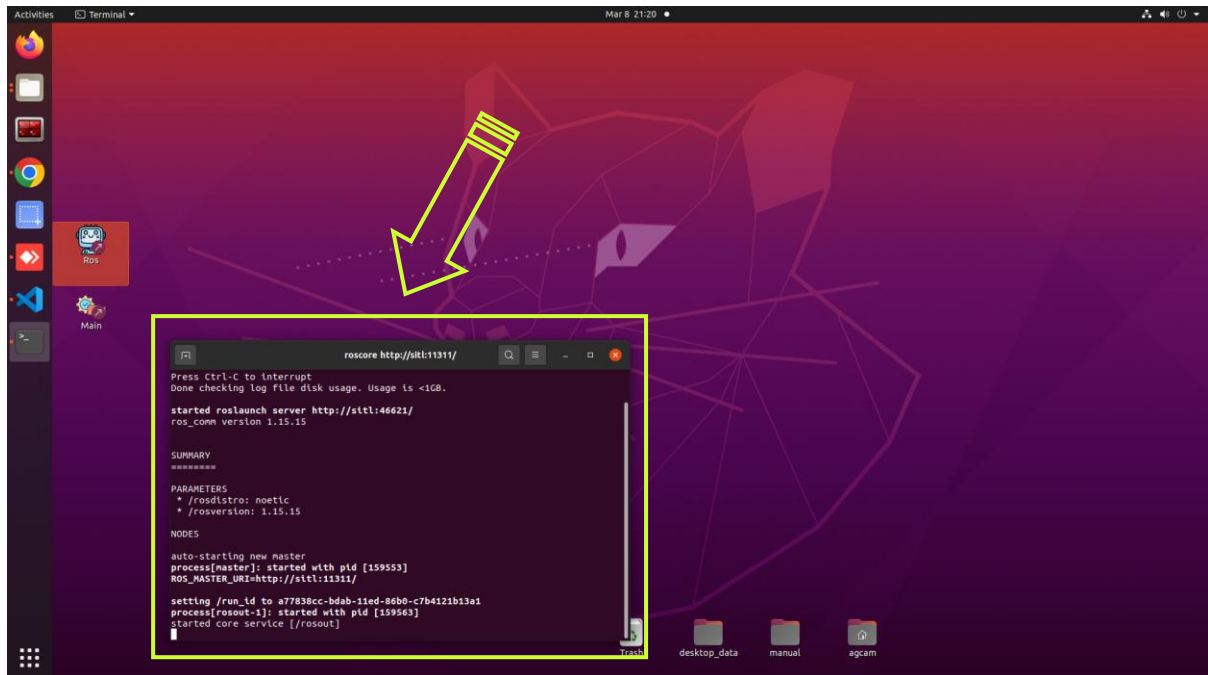
Step No. 01: ROS Initialization

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:

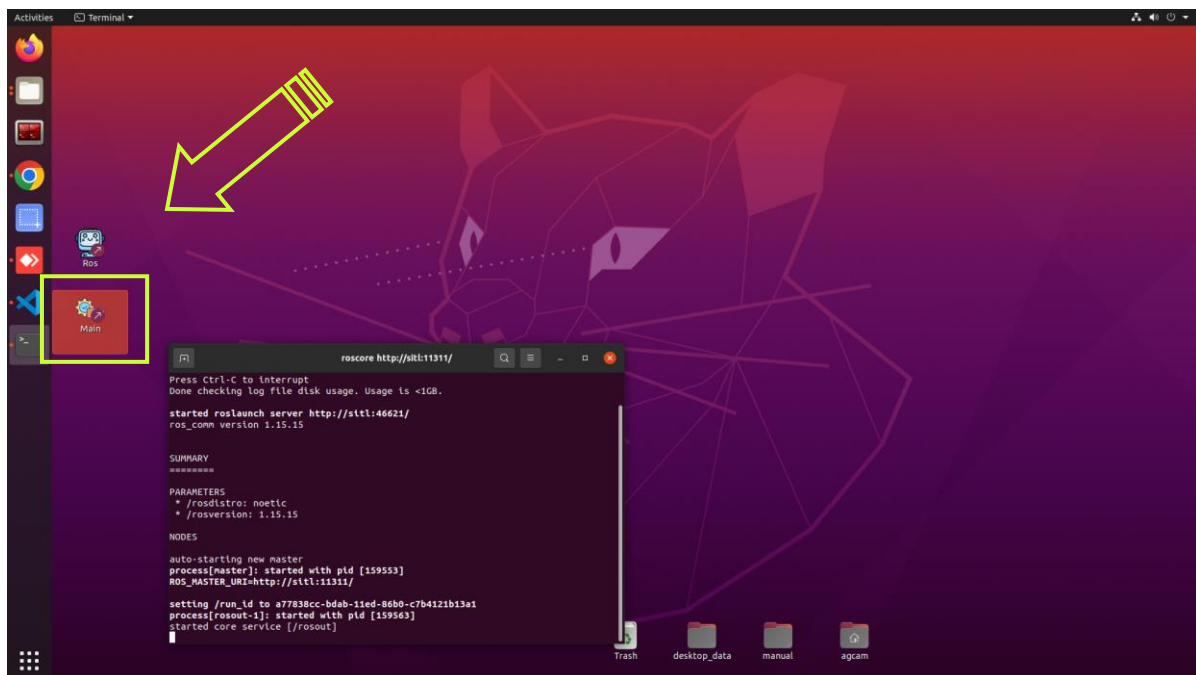


3. Next, we will launch our main program.

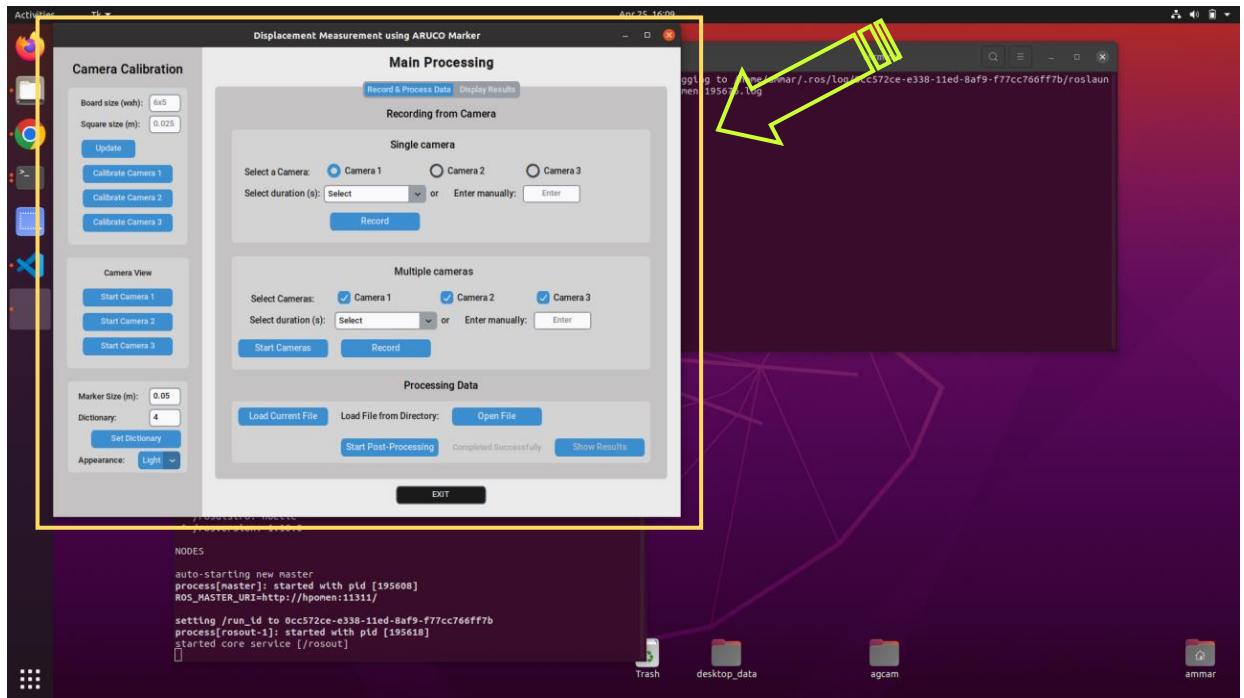
Step No. 02: Main Program Initialization

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:

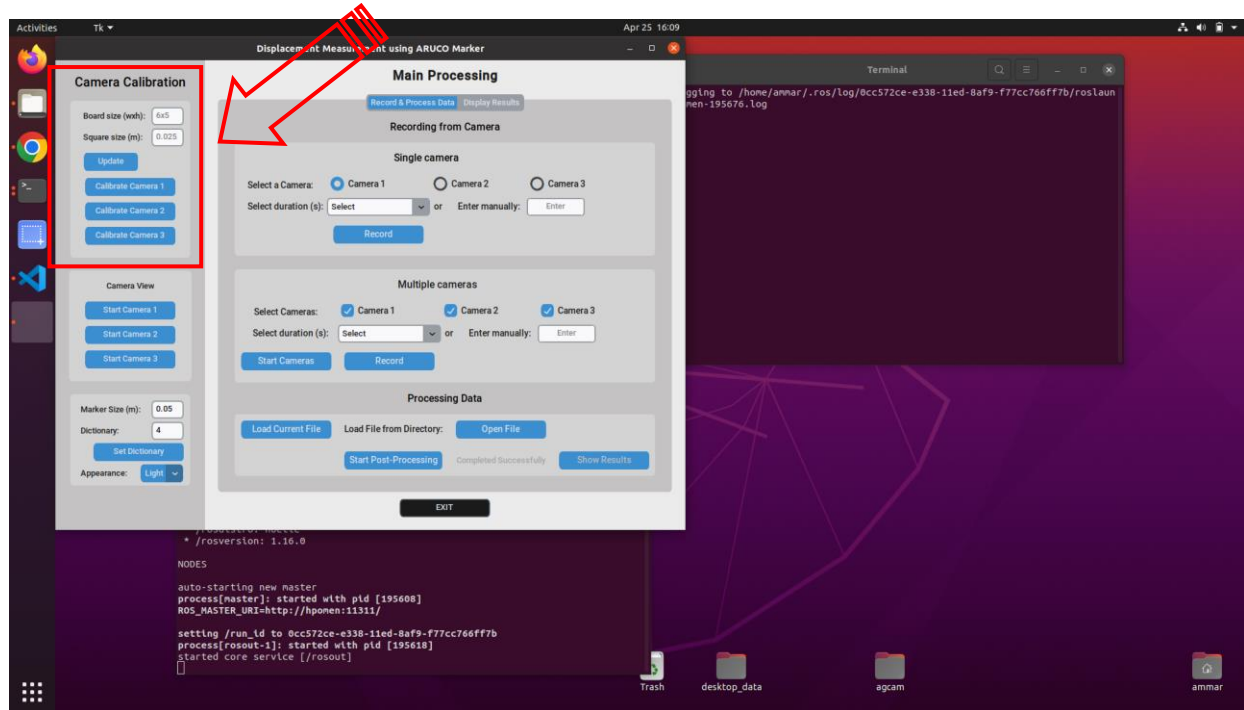


3. Now we may proceed to the next steps.

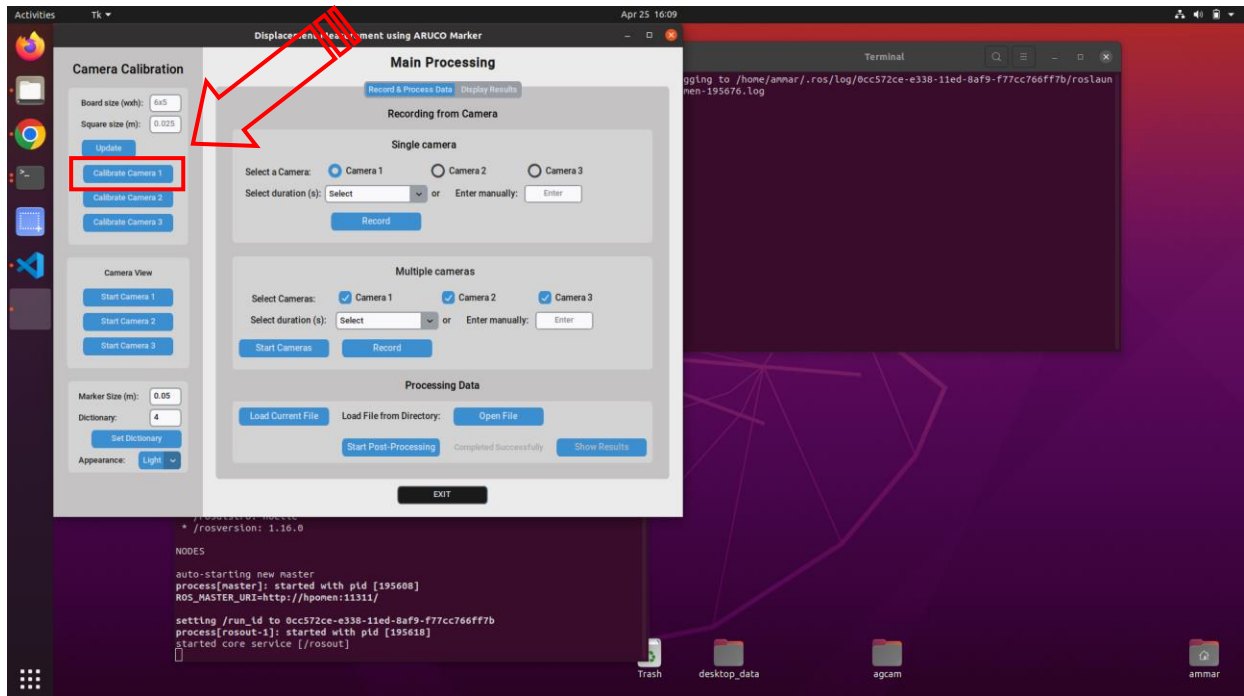
Step No. 03: Camera Calibration

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

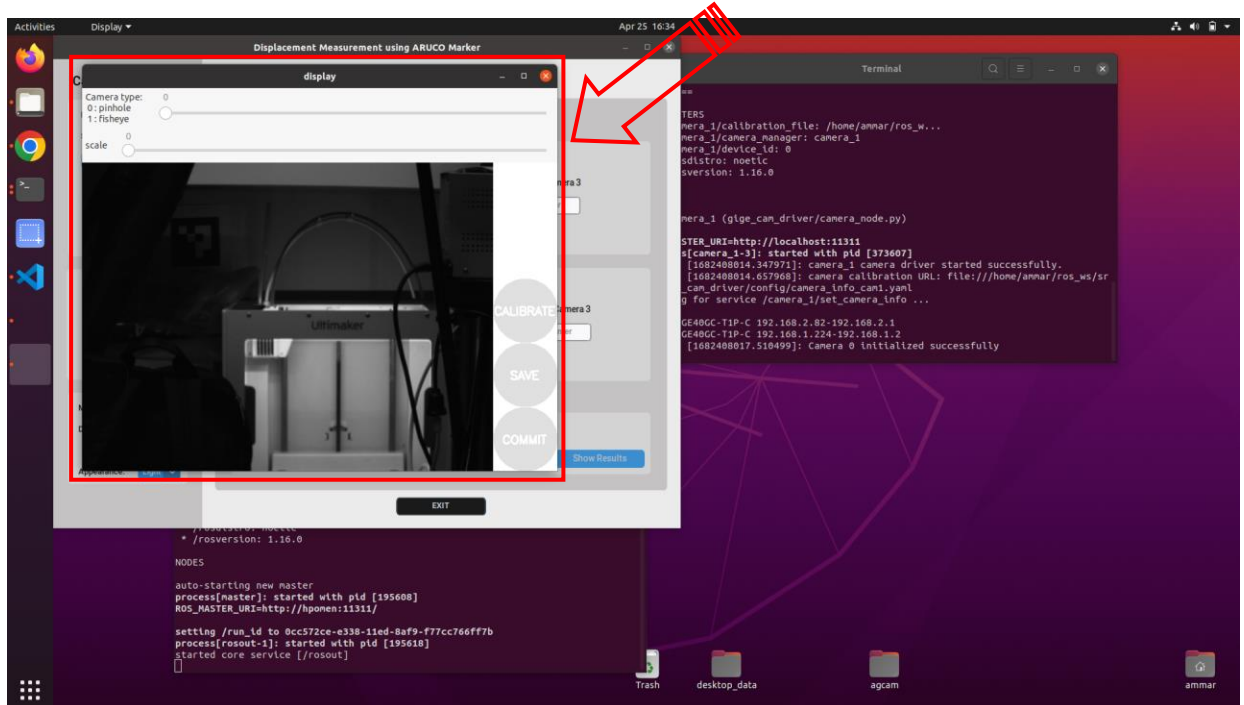
1. The first step is to set the **Camera Calibration** parameters, as depicted in the figure below:
 - a. Enter the **Board size** of the checkerboard in the given format (e.g., 6x5).
 - b. Enter the Checkerboard **Square size** in meters (e.g., 0.020).
 - c. Press the **Update** button to set the Camera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



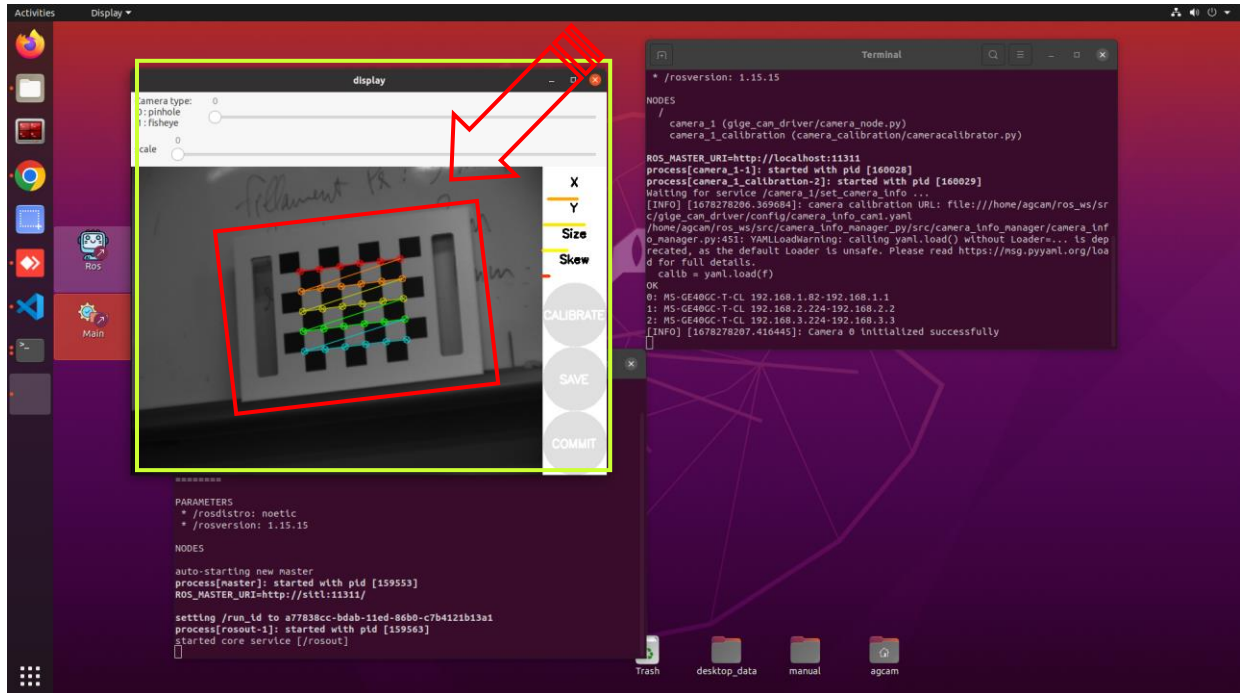
2. To calibrate Camera 1 press, **Calibrate Camera 1** button, as shown below:



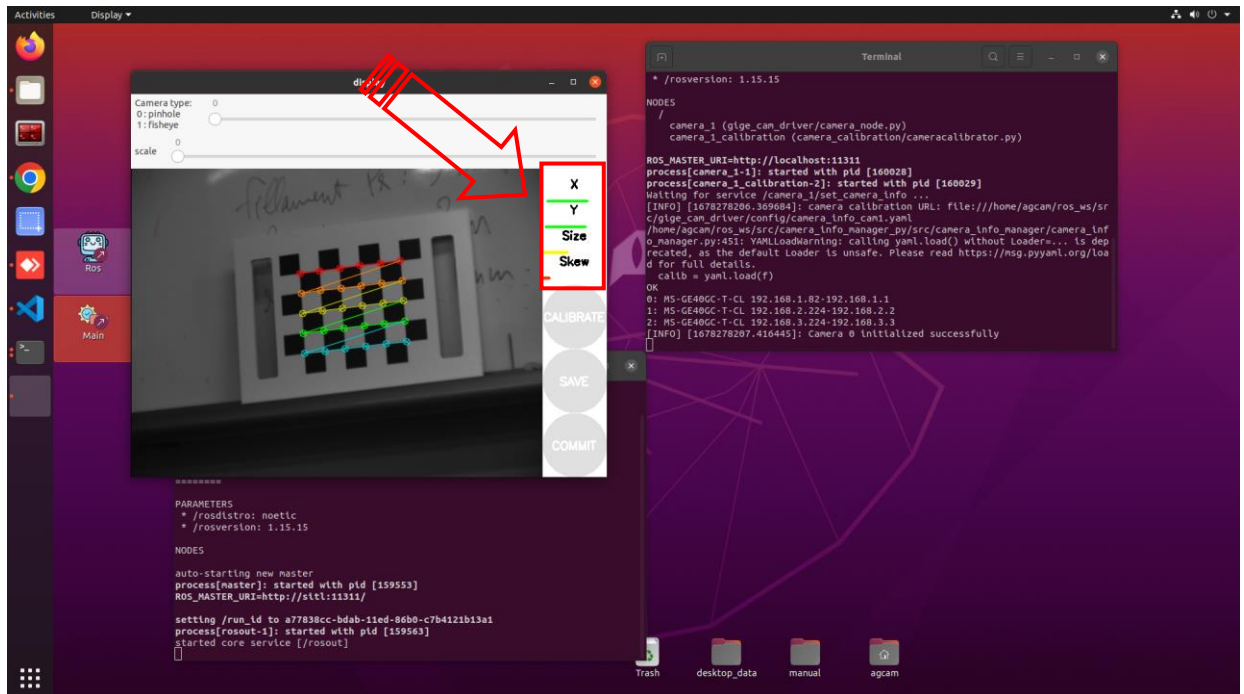
3. The camera calibration window will launch as shown below:



- 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:

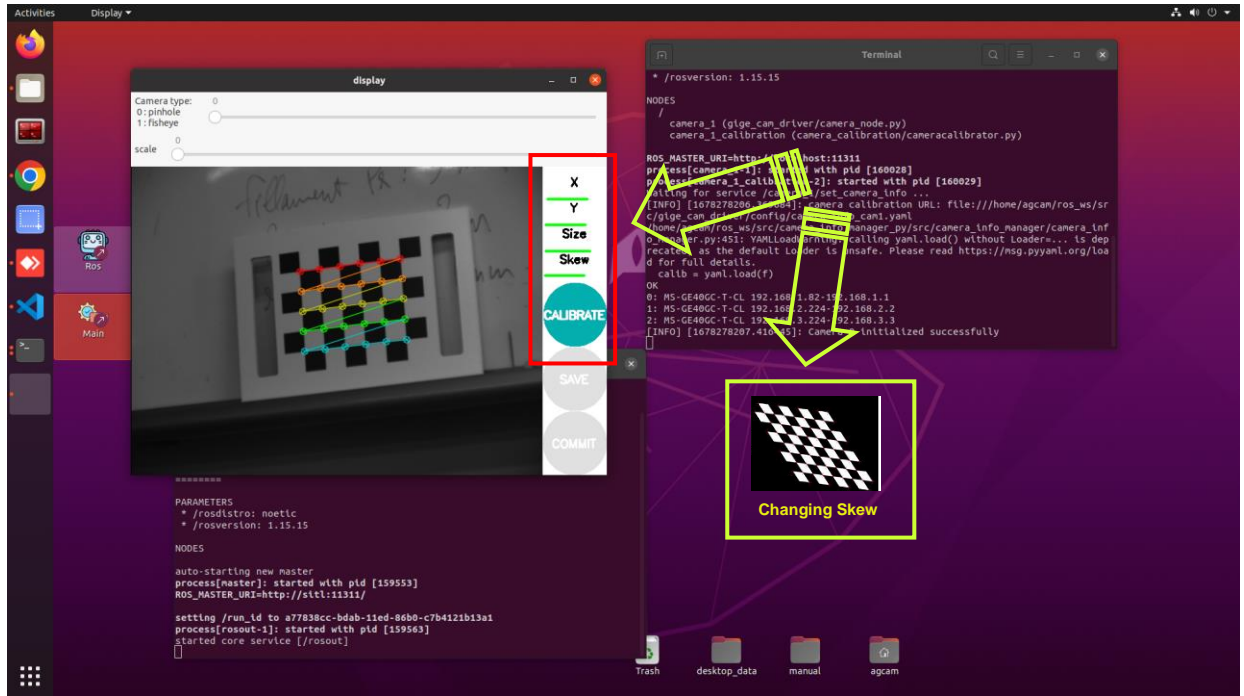


- Move the **Checkerboard** in horizontal and vertical directions until the bars below **X** and **Y** turn **Green**, as depicted in the figure below:

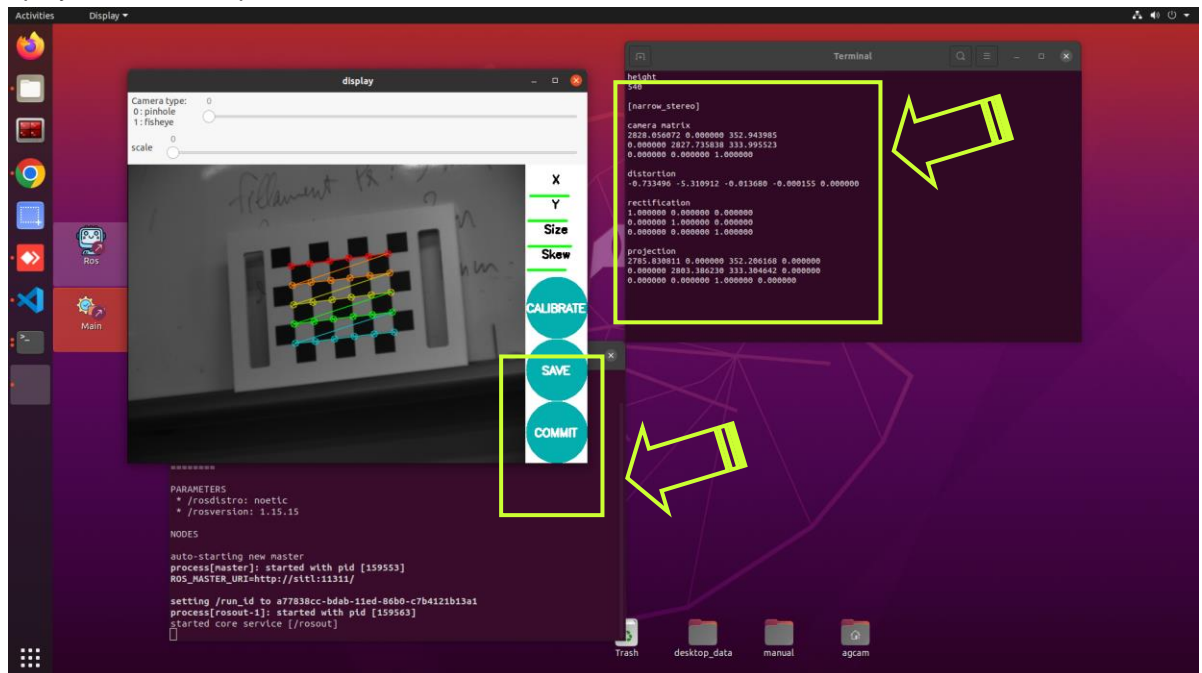


- Move the **Checkerboard** towards and away from the camera for **Size** adjustment, and turn diagonally (changing roll, pitch, and yaw axis) for **Skew** adjustment, until the bars below **Size**

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



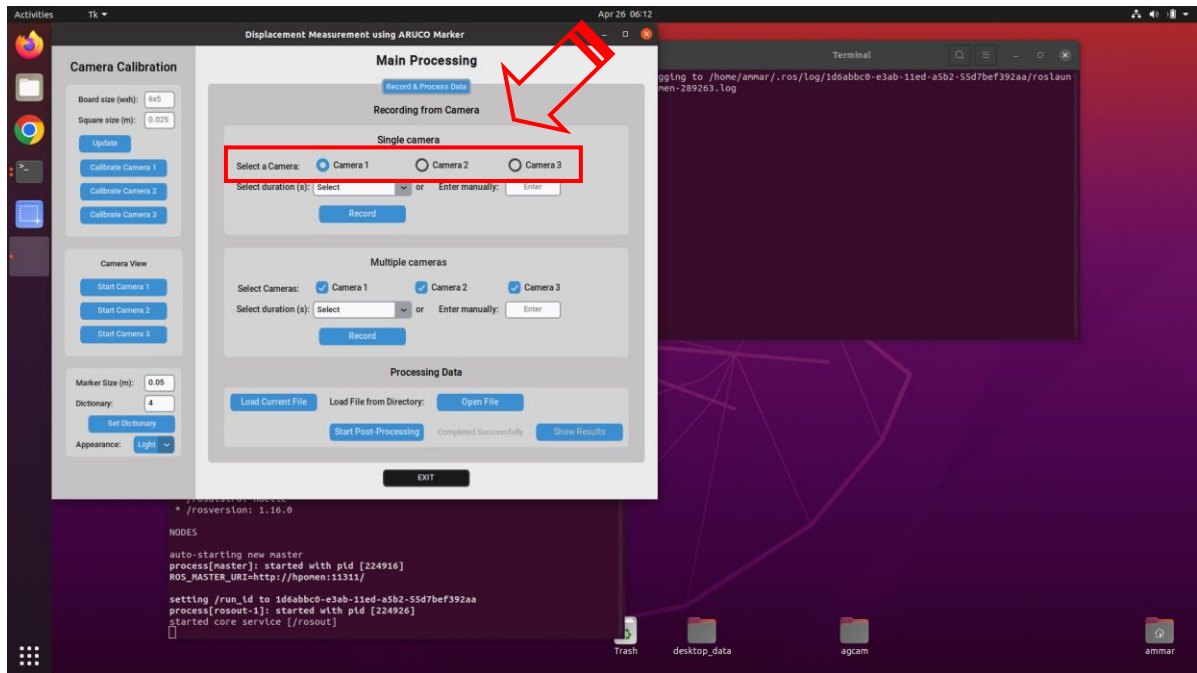
- Press the **SAVE** button to save the camera parameters and calibration images, then press the **COMMIT** button to conclude the **Camera Calibrating** procedure. The terminal screen will display the camera's parameters as shown below:



- Camera Calibration has been completed successfully, close the terminal window and now we may proceed to the next steps.
- Repeat the same steps to calibrate Camera 2 and Camera 3.

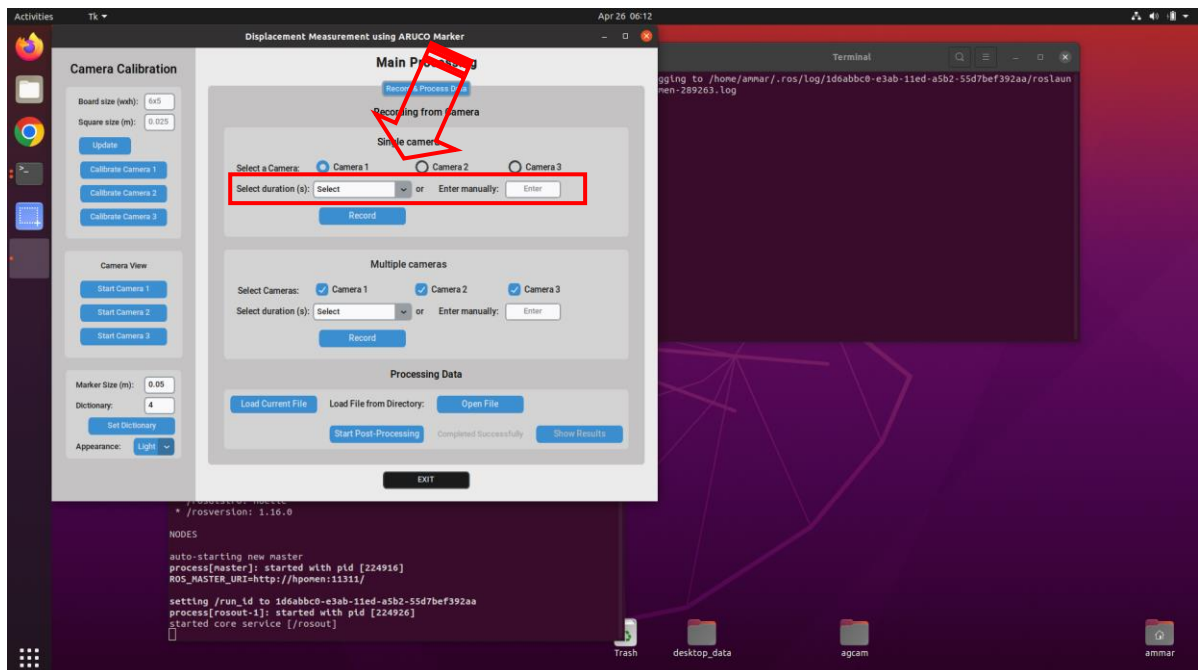
Step No. 04: Recording Camera Data for Post Processing

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:

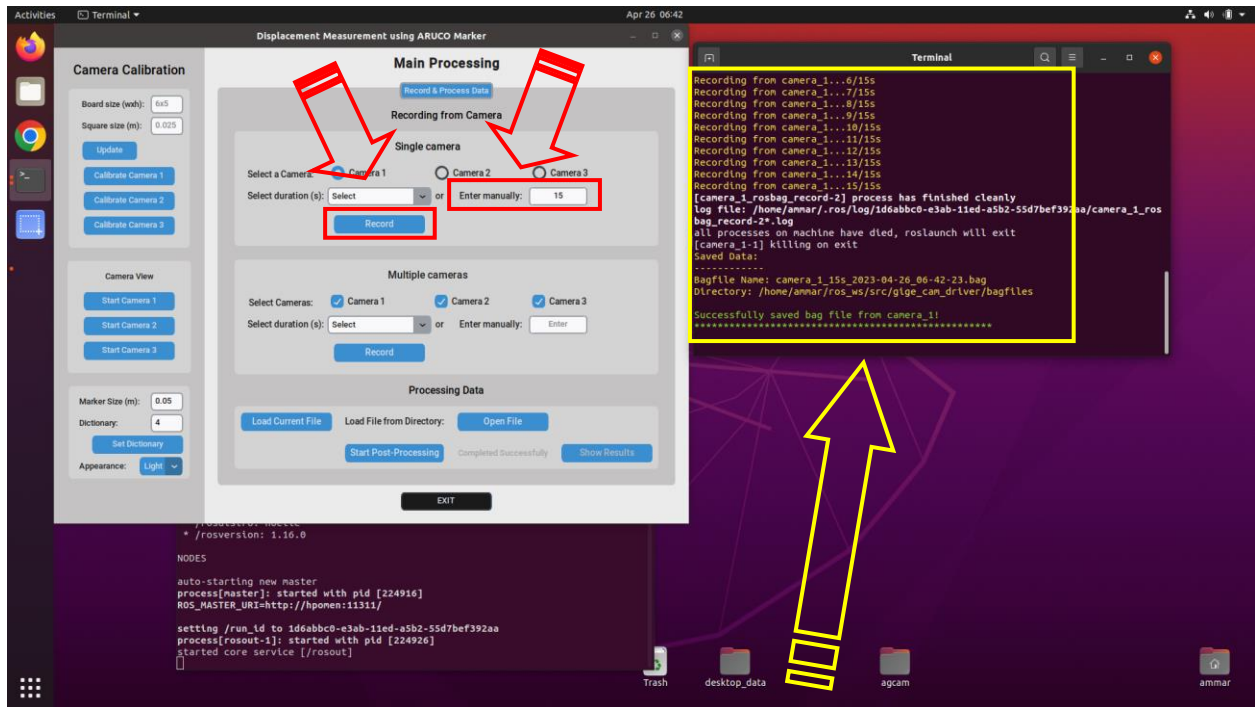


2. Now Select duration in seconds for camera recording

- 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:

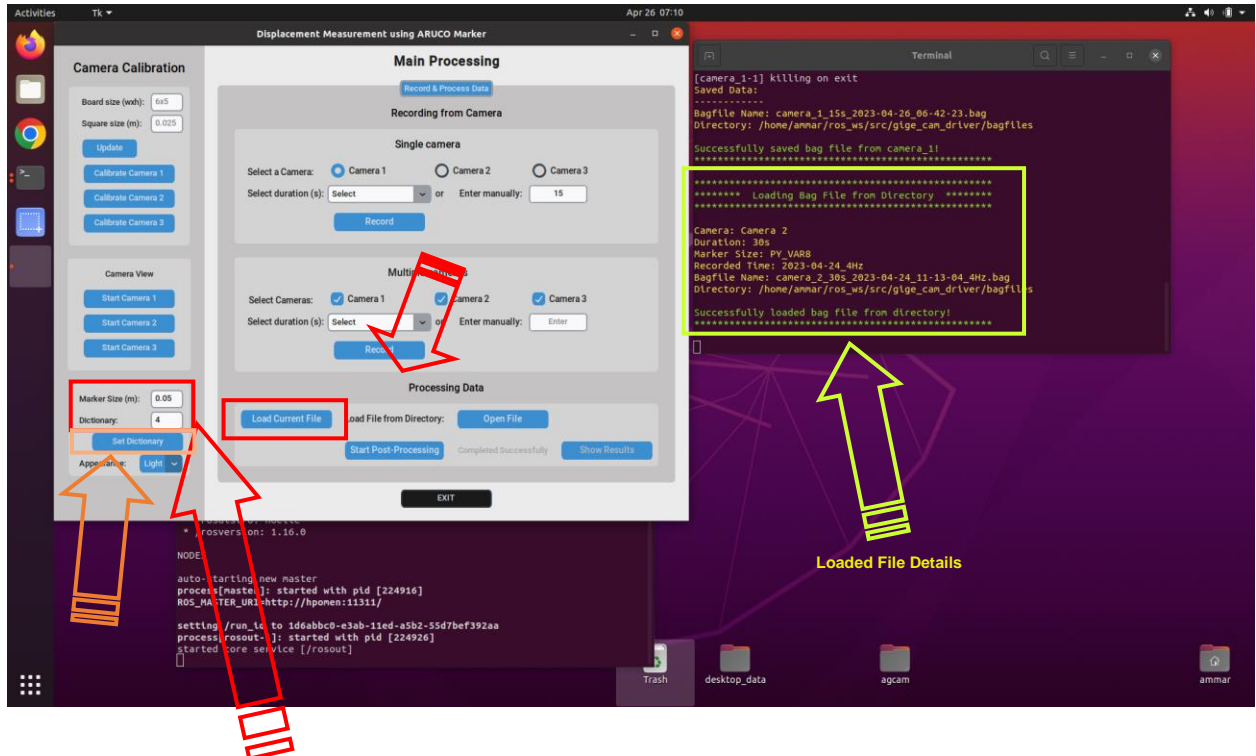


4. A message will be displayed after successful recording or camera data as shown in the figure above:

Now you may proceed to the next step.

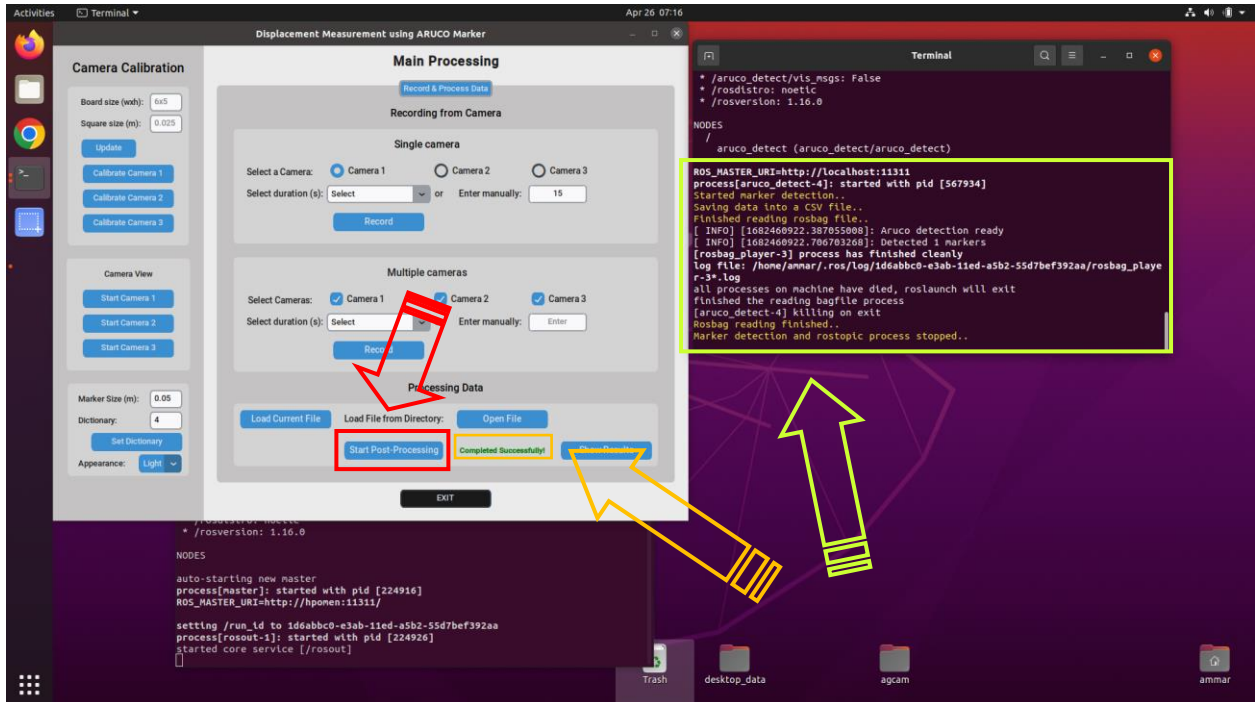
Step No. 05: Post Processing from Saved Camera Data

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:

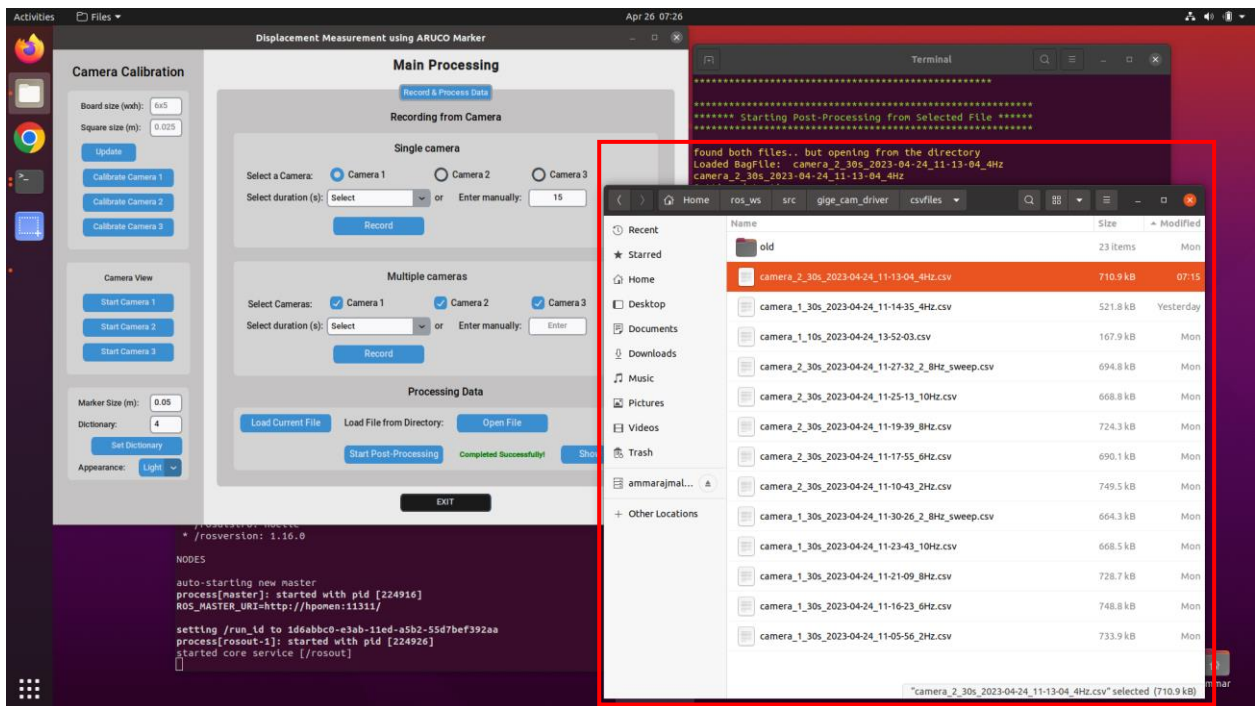


2. The next step in post processing is to set the ARUCO Marker parameters as shown in the above figure:
 - a. Enter the ARUCO **Marker Size** in meters.
 - b. Enter the Dictionary value as per given values:
Dictionary (i.e., **default: 4**)
 - c. The ARUCO dictionary to use. Possible values: 0 (DICT_4X4_50), 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.

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

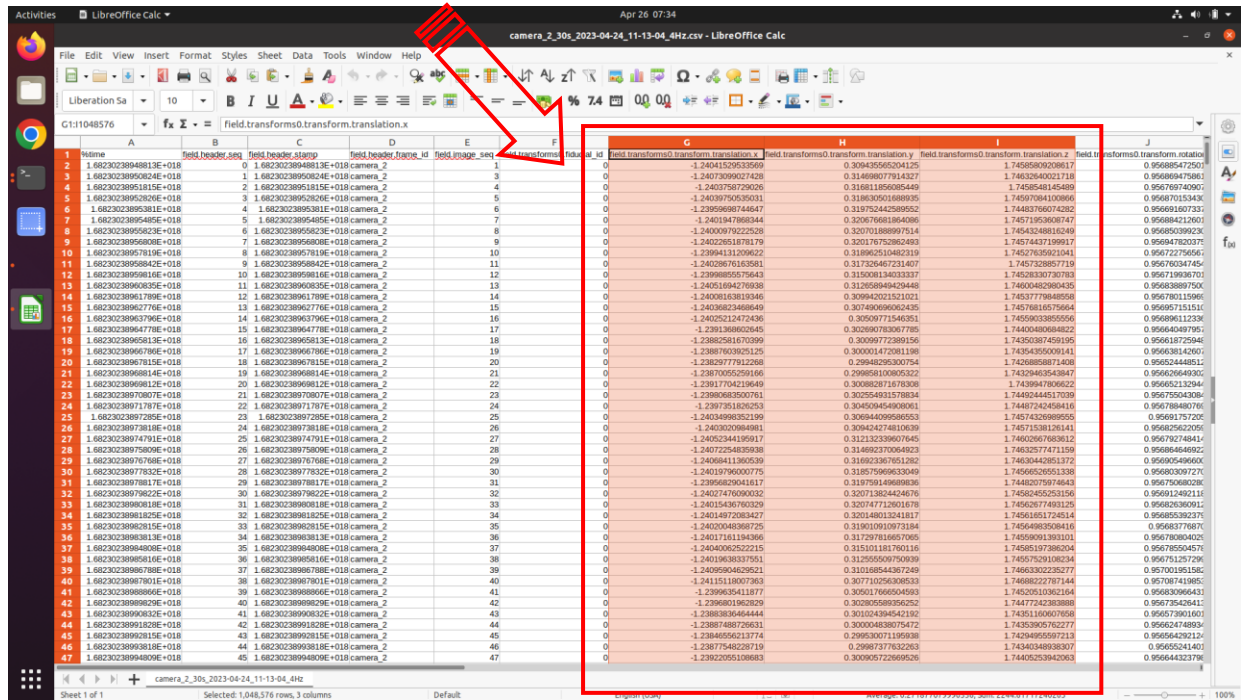


- The three-dimensional displacement data stored as the **.csv** file is stored under the directory **/home/agcam/ros_ws/src/gige_cam_driver/csvfiles/**, as shown below:



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

- field.transforms0.transform.translation.x
- field.transforms0.transform.translation.y
- field.transforms0.transform.translation.z



	A	B	C	D	E	F	G	H	I	J
	time	field.header.seq	field.header.stamp	field.header.frame_id	field.header.seq	field.transforms0.transform.translation.x	field.transforms0.transform.translation.y	field.transforms0.transform.translation.z	field.transforms0.transform.rotation.x	field.transforms0.transform.rotation.y
1	1.6823023894813E+018	0	1.6823023894813E+018	camera_2	1	-1.24041529533569	0.309439565204125	1.74585802096157	0.95688472501	0.95688472501
2	1.6823023895024E+018	1	1.6823023895024E+018	camera_2	2	-1.24073090071428	0.314968077914327	1.74632840021718	0.95688472501	0.95688472501
3	1.6823023895181E+018	2	1.6823023895181E+018	camera_2	3	-1.24073582730026	0.31681185085449	1.745848145489	0.95676974007	0.95676974007
4	1.6823023895262E+018	3	1.6823023895262E+018	camera_2	4	-1.24039750520031	0.31863050168905	1.74597094103096	0.95687015343	0.95687015343
5	1.6823023895381E+018	4	1.6823023895381E+018	camera_2	5	-1.23958698744647	0.31875244269952	1.74483766743282	0.95681607331	0.95681607331
6	1.6823023895485E+018	5	1.6823023895485E+018	camera_2	6	-1.2401947868344	0.32067668186408	1.74571953068747	0.95684212601	0.95684212601
7	1.6823023895582E+018	6	1.6823023895582E+018	camera_2	7	-1.24003979222528	0.32070188897514	1.7454348816249	0.95685039923	0.95685039923
8	1.6823023895680E+018	7	1.6823023895680E+018	camera_2	8	-1.2402255187179	0.32017673282493	1.745744371399317	0.95684782027	0.95684782027
9	1.6823023895781E+018	8	1.6823023895781E+018	camera_2	9	-1.23994131206522	0.318962510482319	1.74527835921041	0.956722756567	0.956722756567
10	1.6823023895884E+018	9	1.6823023895884E+018	camera_2	10	-1.24028676163581	0.317328467231407	1.7457228897719	0.956760347455	0.956760347455
11	1.6823023895981E+018	10	1.6823023895981E+018	camera_2	11	-1.23998555764643	0.315003013403337	1.74528230730788	0.95671989701	0.95671989701
12	1.6823023896083E+018	11	1.6823023896083E+018	camera_2	12	-1.24011694276938	0.312658945429448	1.746004829630435	0.95683897504	0.95683897504
13	1.6823023896179E+018	12	1.6823023896179E+018	camera_2	13	-1.24006163819346	0.3099420021521021	1.74537778948558	0.956780115966	0.956780115966
14	1.6823023896277E+018	13	1.6823023896277E+018	camera_2	14	-1.24036823486649	0.307400999902435	1.74578816575664	0.956857151511	0.956857151511
15	1.6823023896379E+018	14	1.6823023896379E+018	camera_2	15	-1.2402512427436	0.30509771546351	1.74595803850556	0.956896112338	0.956896112338
16	1.6823023896477E+018	15	1.6823023896477E+018	camera_2	16	-1.2391368062645	0.302806783067785	1.74400480684822	0.95640497975	0.95640497975
17	1.6823023896581E+018	16	1.6823023896581E+018	camera_2	17	-1.23882581673999	0.30090772289156	1.74350280745916	0.95618725944	0.95618725944
18	1.6823023896678E+018	17	1.6823023896678E+018	camera_2	18	-1.2386763925125	0.300003475981198	1.743545850590141	0.956038142601	0.956038142601
19	1.6823023896781E+018	18	1.6823023896781E+018	camera_2	19	-1.23829777781268	0.29948295300754	1.74268858871438	0.95624448511	0.95624448511
20	1.6823023896881E+018	19	1.6823023896881E+018	camera_2	20	-1.23770055259166	0.29865810385322	1.7412943543847	0.95626949303	0.95626949303
21	1.6823023896981E+018	20	1.6823023896981E+018	camera_2	21	-1.23911704219649	0.300882871478308	1.7439847806652	0.95652132944	0.95652132944
22	1.6823023897080E+018	21	1.6823023897080E+018	camera_2	22	-1.2396863500761	0.302554831578834	1.74492444517039	0.95675543084	0.95675543084
23	1.6823023897178E+018	22	1.6823023897178E+018	camera_2	23	-1.237351626253	0.30450045490961	1.74487242458416	0.95678848706	0.95678848706
24	1.6823023897295E+018	23	1.6823023897295E+018	camera_2	24	-1.2403496932199	0.30684426956553	1.7457432689555	0.95691757206	0.95691757206
25	1.6823023897381E+018	24	1.6823023897381E+018	camera_2	25	-1.2402302084881	0.308424274810639	1.74571538126141	0.956825622056	0.956825622056
26	1.6823023897479E+018	25	1.6823023897479E+018	camera_2	26	-1.24052344195917	0.312132339607645	1.74602676839512	0.956792748414	0.956792748414
27	1.6823023897580E+018	26	1.6823023897580E+018	camera_2	27	-1.2407225483939	0.31489237304833	1.74632817471138	0.95684644952	0.95684644952
28	1.6823023897678E+018	27	1.6823023897678E+018	camera_2	28	-1.2408841360539	0.31682367651282	1.74630442851372	0.95650549660	0.95650549660
29	1.6823023897783E+018	28	1.6823023897783E+018	camera_2	29	-1.24019796000775	0.318579969633049	1.7466626953338	0.95680399727	0.95680399727
30	1.6823023897881E+018	29	1.6823023897881E+018	camera_2	30	-1.2395629041817	0.31975914968826	1.74480275974842	0.9567508628	0.9567508628
31	1.6823023897982E+018	30	1.6823023897982E+018	camera_2	31	-1.24027476006329	0.32071382424676	1.74582455253156	0.95691249211	0.95691249211
32	1.6823023898081E+018	31	1.6823023898081E+018	camera_2	32	-1.24015436760332	0.320747712601678	1.74562877493125	0.956826360911	0.956826360911
33	1.6823023898182E+018	32	1.6823023898182E+018	camera_2	33	-1.2401497203427	0.320148031241817	1.74561651724314	0.9568539237	0.9568539237
34	1.6823023898281E+018	33	1.6823023898281E+018	camera_2	34	-1.2400448366725	0.319010910973184	1.74564983508416	0.95683776877	0.95683776877
35	1.6823023898381E+018	34	1.6823023898381E+018	camera_2	35	-1.24017181184366	0.317297816657065	1.74589813933011	0.956780804025	0.956780804025
36	1.6823023898480E+018	35	1.6823023898480E+018	camera_2	36	-1.24040002522215	0.315103118176016	1.74585187786204	0.95678594871	0.95678594871
37	1.6823023898581E+018	36	1.6823023898581E+018	camera_2	37	-1.2401963837551	0.31255500976039	1.7456730108324	0.95675125729	0.95675125729
38	1.6823023898678E+018	37	1.6823023898678E+018	camera_2	38	-1.24059504629521	0.310168544367249	1.74466332235277	0.95700151582	0.95700151582
39	1.6823023898780E+018	38	1.6823023898780E+018	camera_2	39	-1.24115118007983	0.30771025305533	1.74488227787144	0.957087419853	0.957087419853
40	1.6823023898880E+018	39	1.6823023898880E+018	camera_2	40	-1.239625411877	0.305017666504983	1.74529510362164	0.95683966431	0.95683966431
41	1.6823023898982E+018	40	1.6823023898982E+018	camera_2	41	-1.2396801962829	0.30280585956252	1.7447724283888	0.95673526411	0.95673526411
42	1.6823023899083E+018	41	1.6823023899083E+018	camera_2	42	-1.23883836454444	0.301024394542192	1.7451160607698	0.95673901603	0.95673901603
43	1.6823023899182E+018	42	1.6823023899182E+018	camera_2	43	-1.23871489729631	0.300004638075472	1.74535305152277	0.95624748854	0.95624748854
44	1.6823023899281E+018	43	1.6823023899281E+018	camera_2	44	-1.23846556213774	0.299530071195938	1.74294955587213	0.9564249212	0.9564249212
45	1.6823023899381E+018	44	1.6823023899381E+018	camera_2	45	-1.2387548229719	0.29987377632263	1.74340348938307	0.95655241403	0.95655241403
46	1.6823023899480E+018	45	1.6823023899480E+018	camera_2	46	-1.23922555108693	0.30005722669626	1.74405253942063	0.9564432378	0.9564432378
47					47					

6. The post-processing has completed effectively.