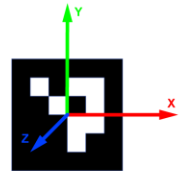


3D Displacement Measure using ARUCO Marker Detection

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
2. GigE Cameras
3. Quad Network Interface Card
4. Ubuntu 20.04 LTE
5. ROS Noetic

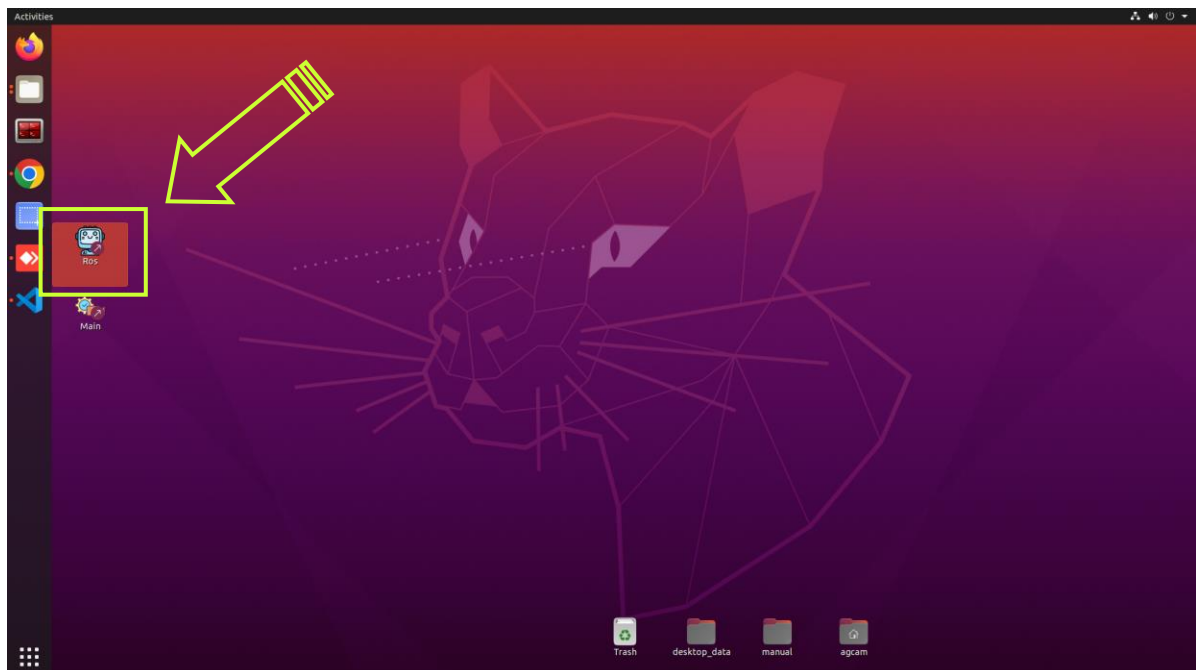
Working Instructions

The following steps describe the working of the system:

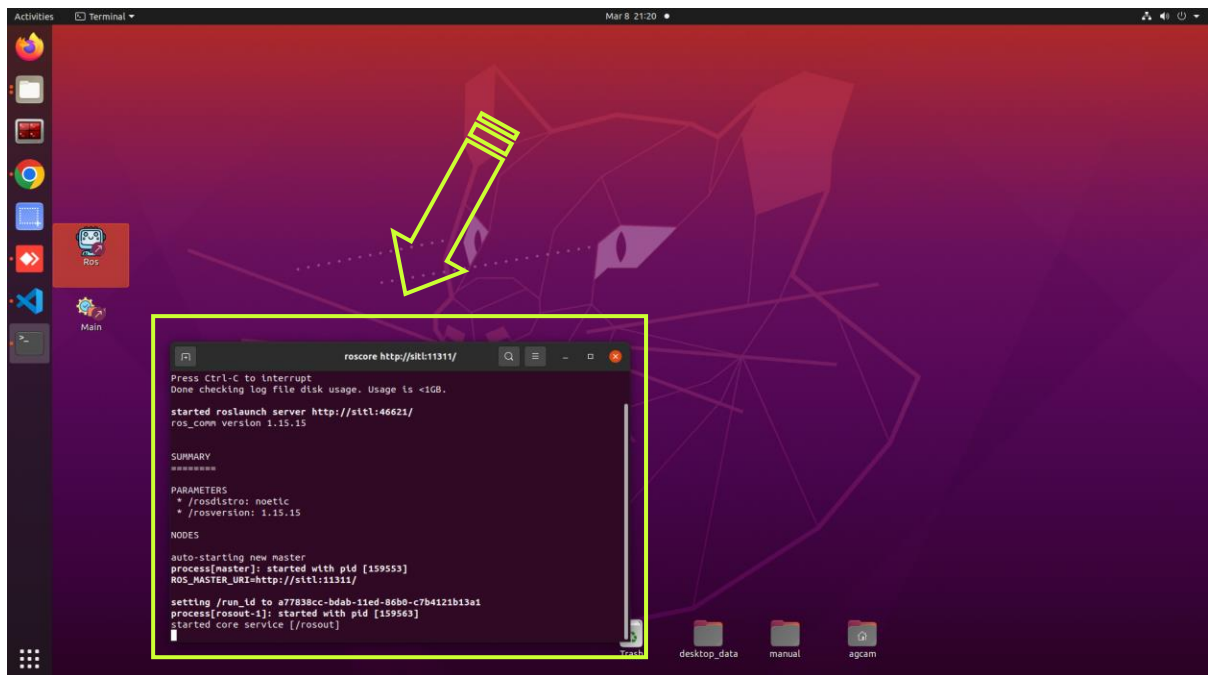
Step No. 01: ROS Initialization

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:




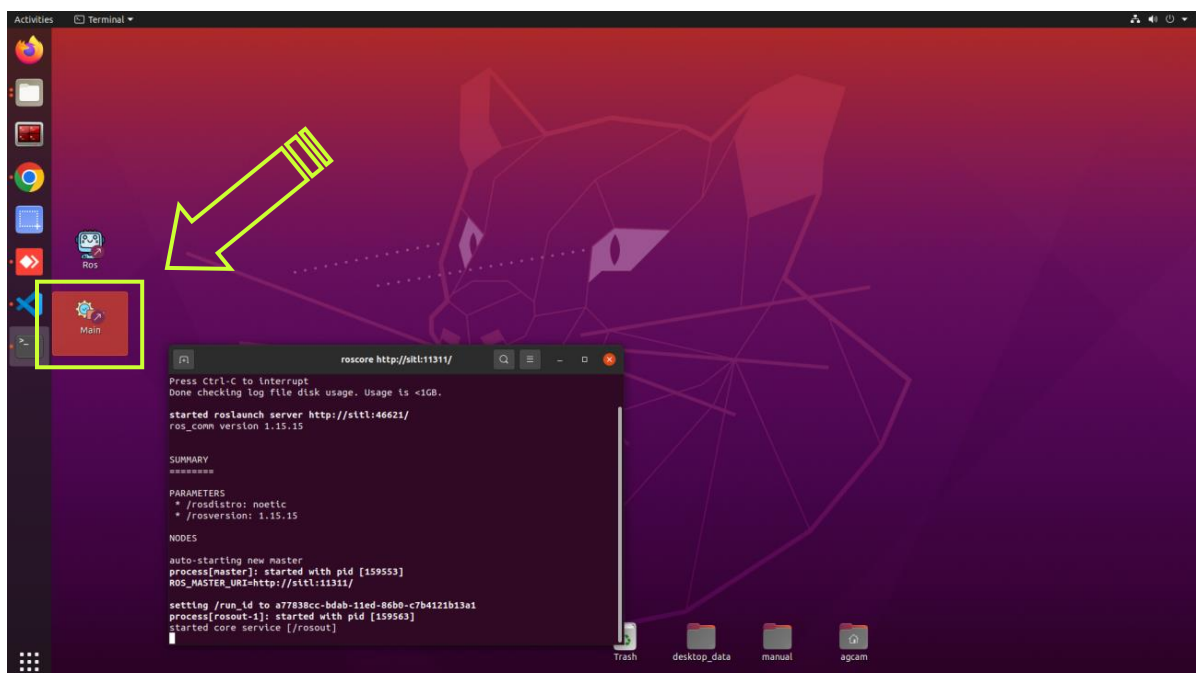
2. The **ROS node** is now operational, as illustrated in the following figure:



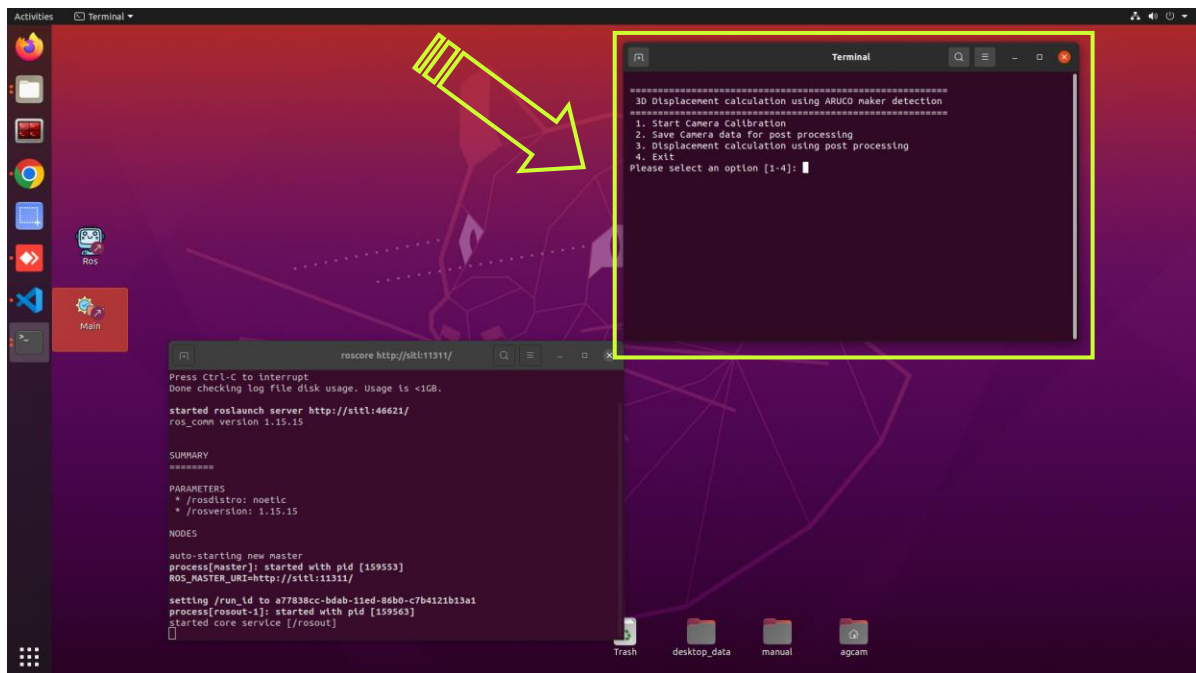
3. Next, we will launch our main program.

Step No. 02: Main Program Initialization

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



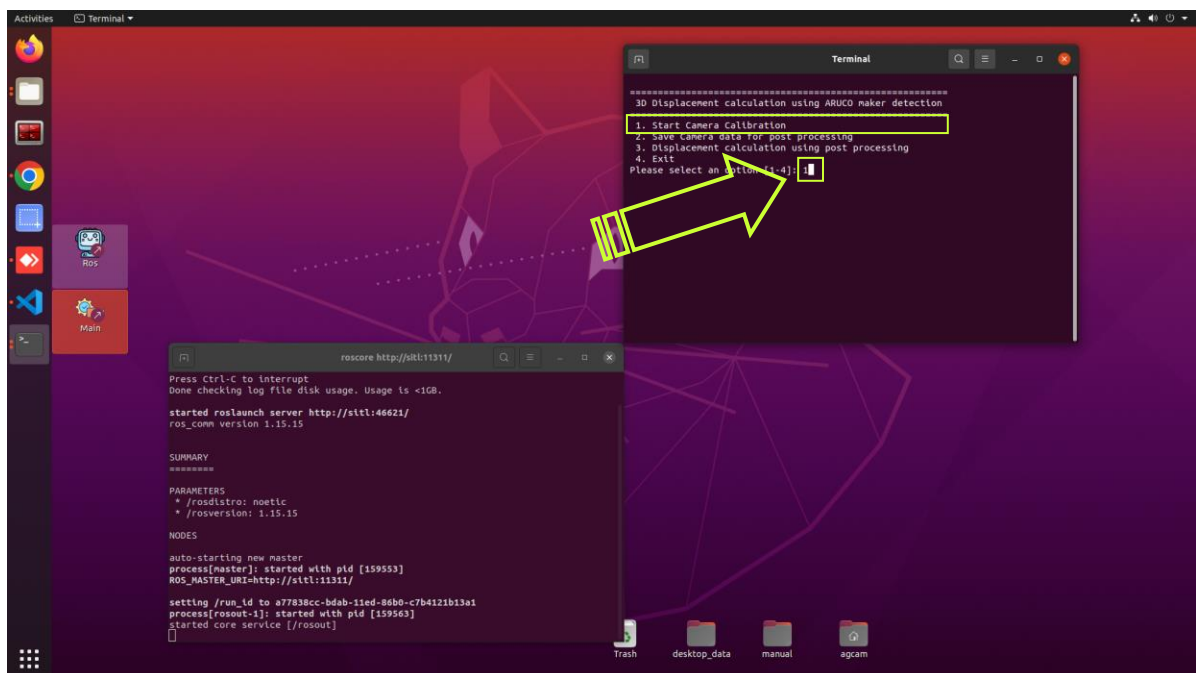
2. Now the **Main program** node is running, as showing in the following figure:



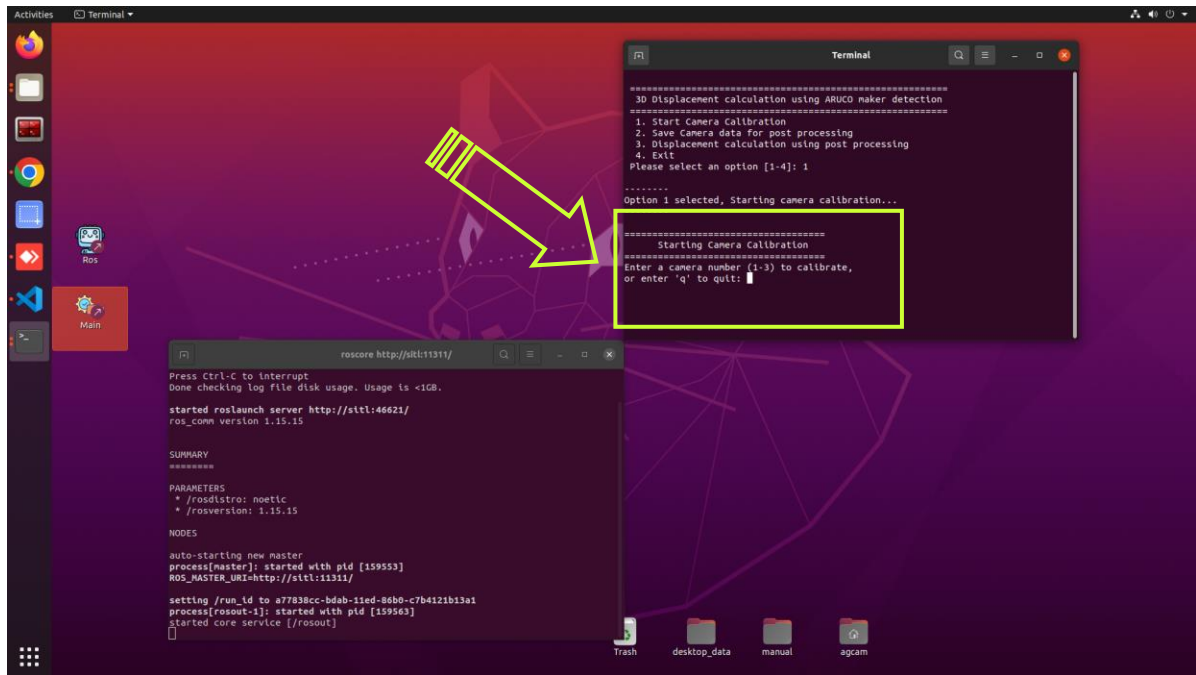
3. Now we may proceed to the next steps.

Step No. 03: Camera Calibration

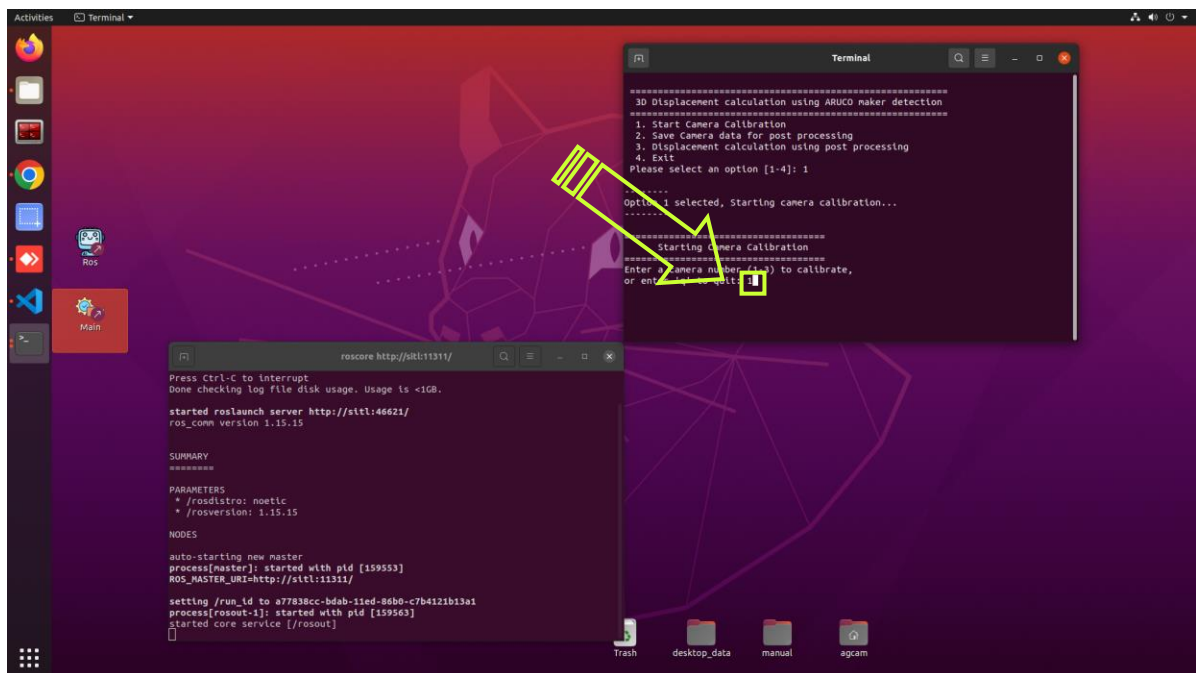
1. Please select option “1” to begin **Camera Calibration**, as depicted in the figure below:



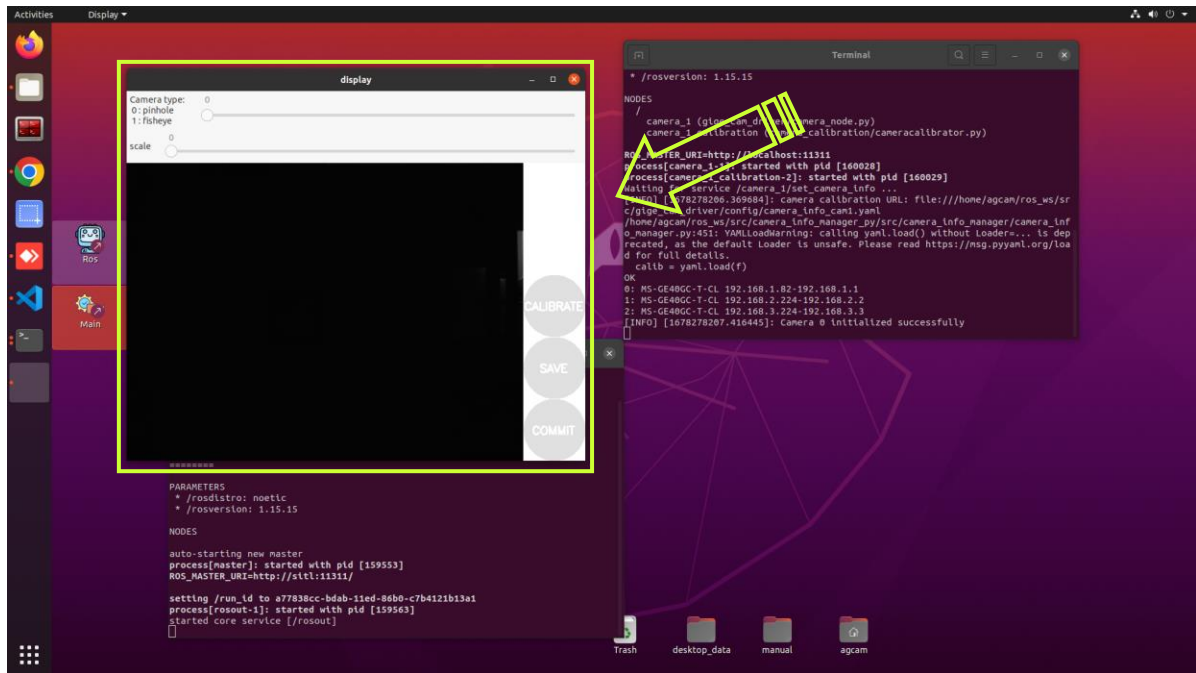
2. The **Camera Calibration** process has started as depicted in the figure:



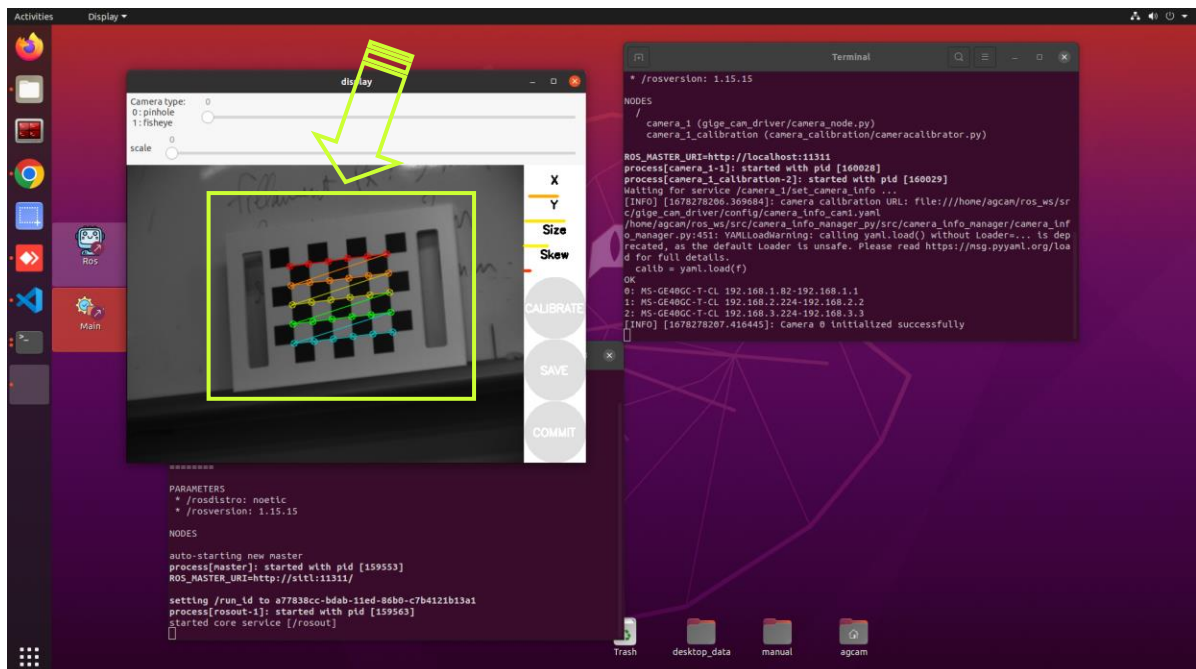
3. Please select “1” to calibrate **Camera 1**, as depicted in the figure below:



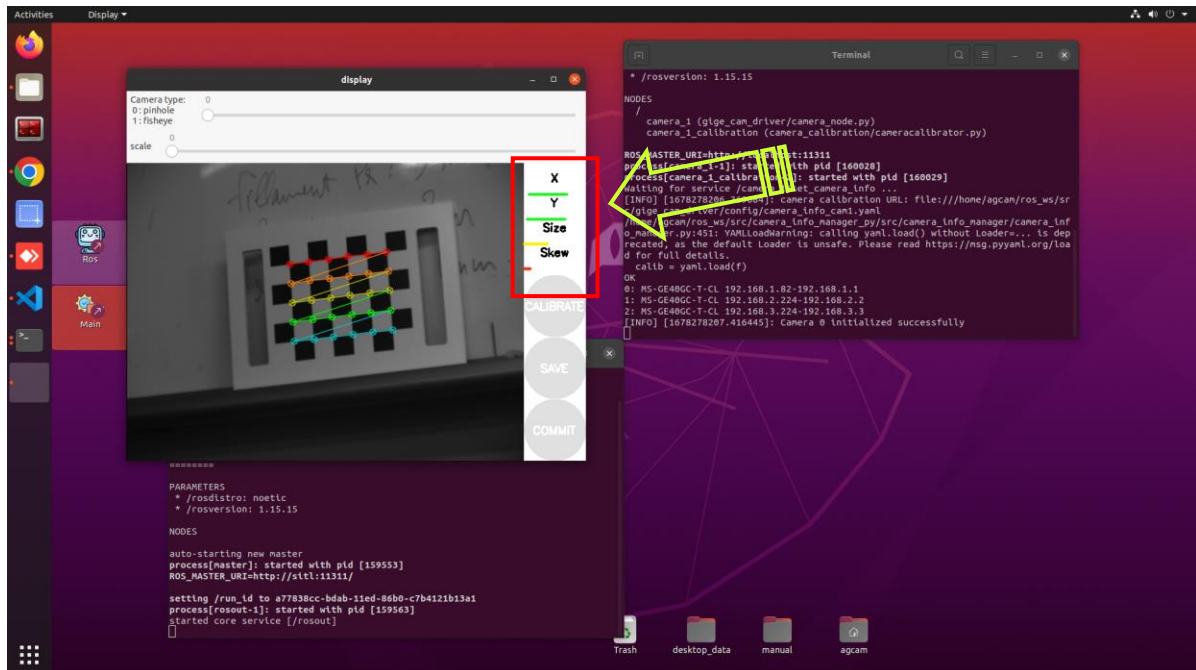
4. The **Camera Calibration** window will launch as depicted in the following figure:



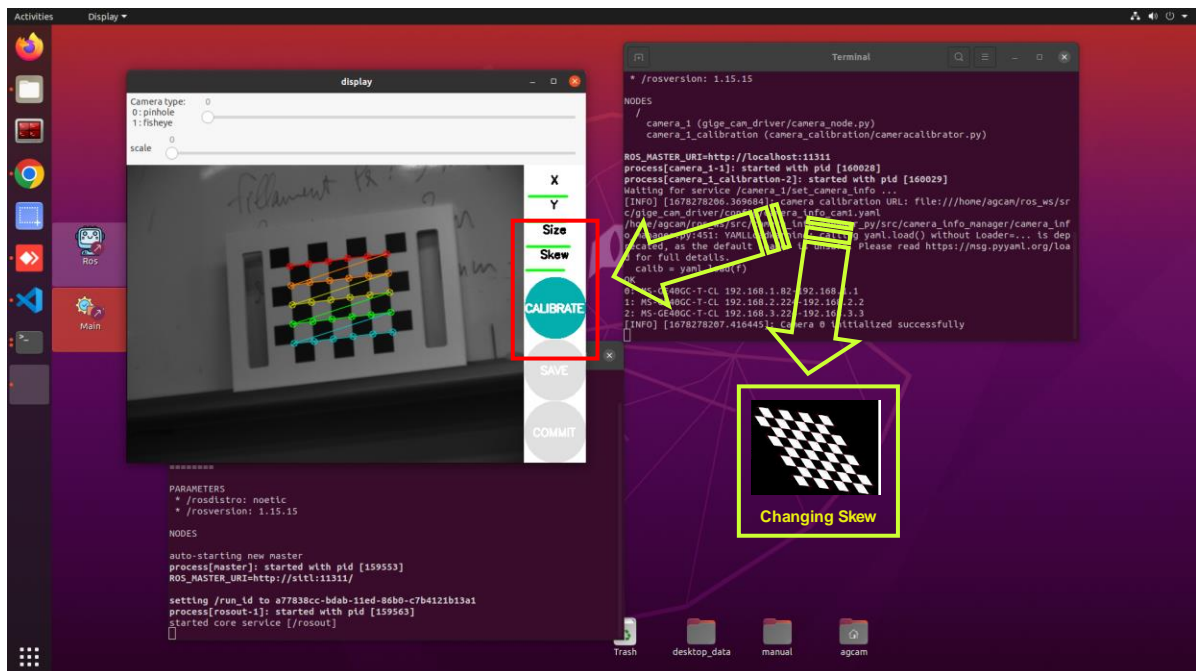
5. Place a **6x4 Checkerboard** in front of the **Camera 1** to initiate the **Calibration** process. As depicted in the figure below, if the checkerboard is identified, a **colorful pattern** will appear:



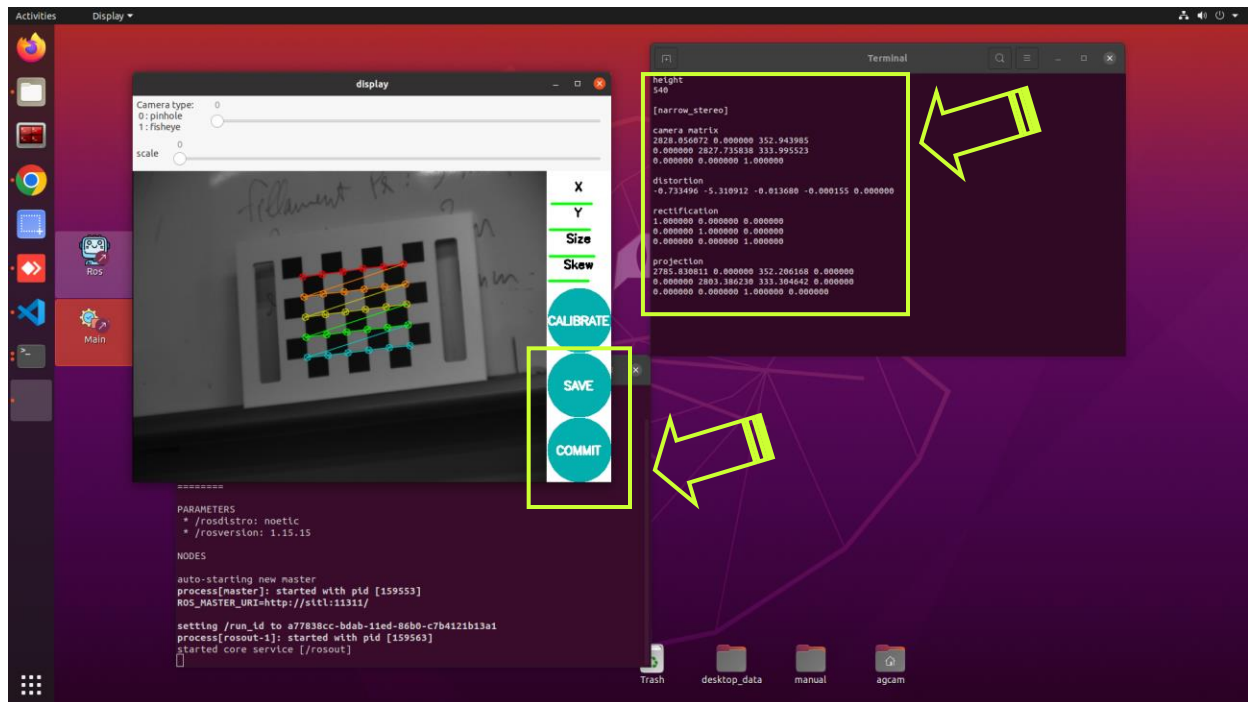
- Move the **Checkerboard** in horizontal and vertical directions until the bars below **X** and **Y** turn **Green**, as depicted in the figure below:



- 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:




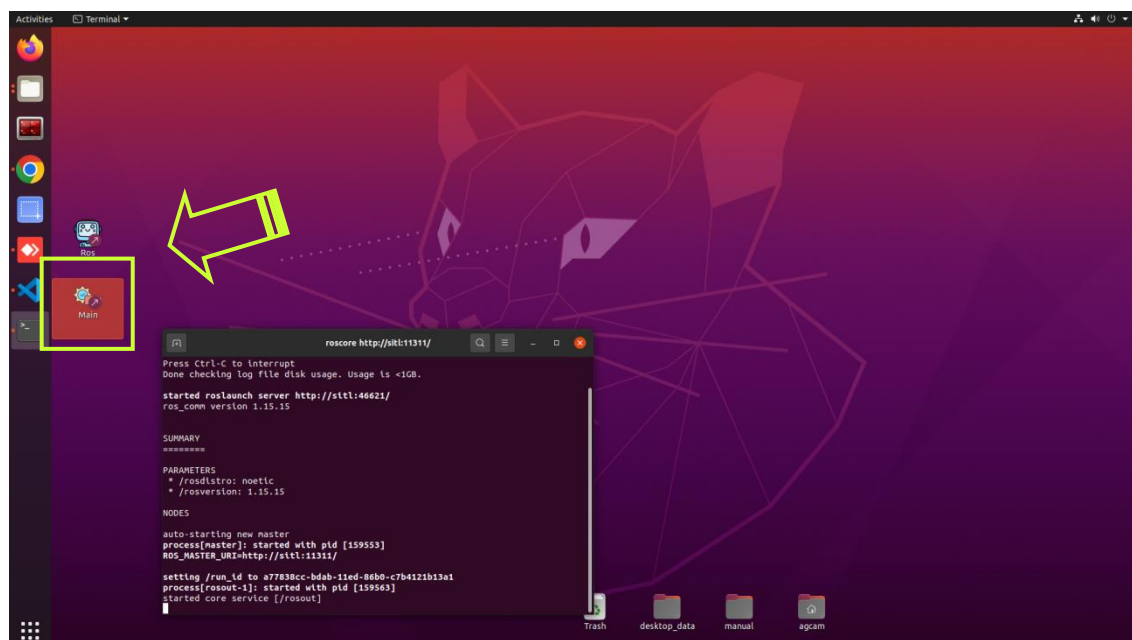
- Press the **SAVE** button to save the camera parameters and calibration images, then press the **COMMIT** button to conclude the **Camera Calibrating** procedure. The terminal screen will display the camera's parameters as shown below:



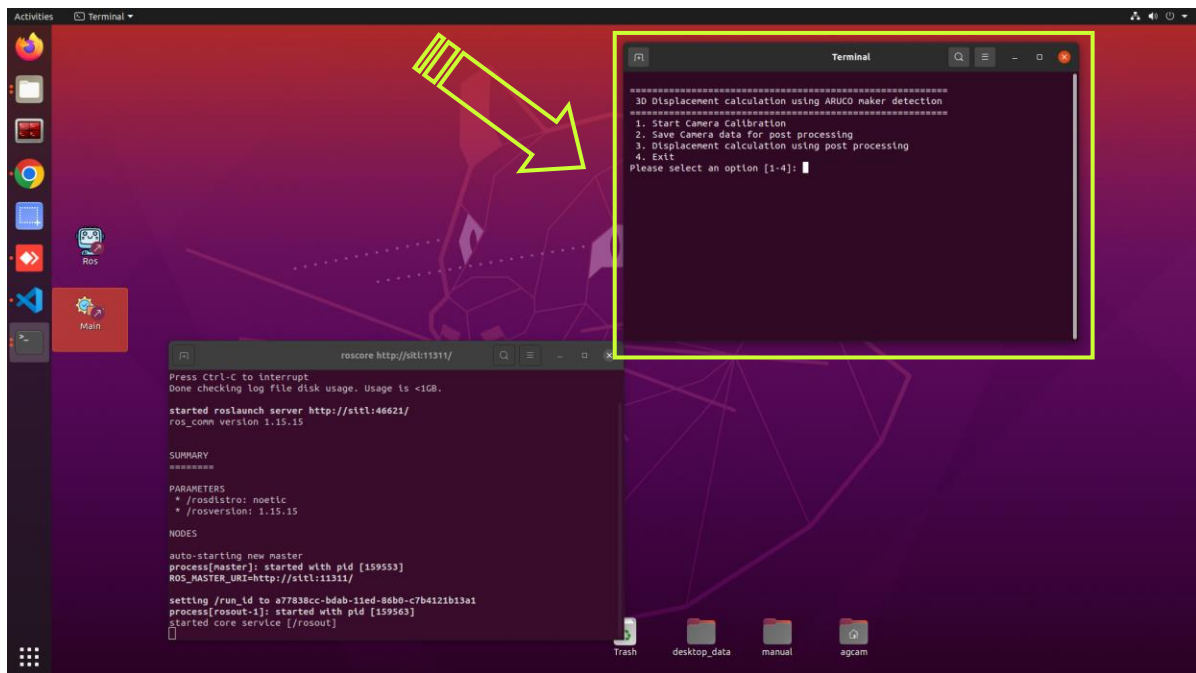
- Camera Calibration has completed successfully, close the terminal window and now we may proceed to the next steps.

Step No. 04: Storing Camera Data for Post Processing

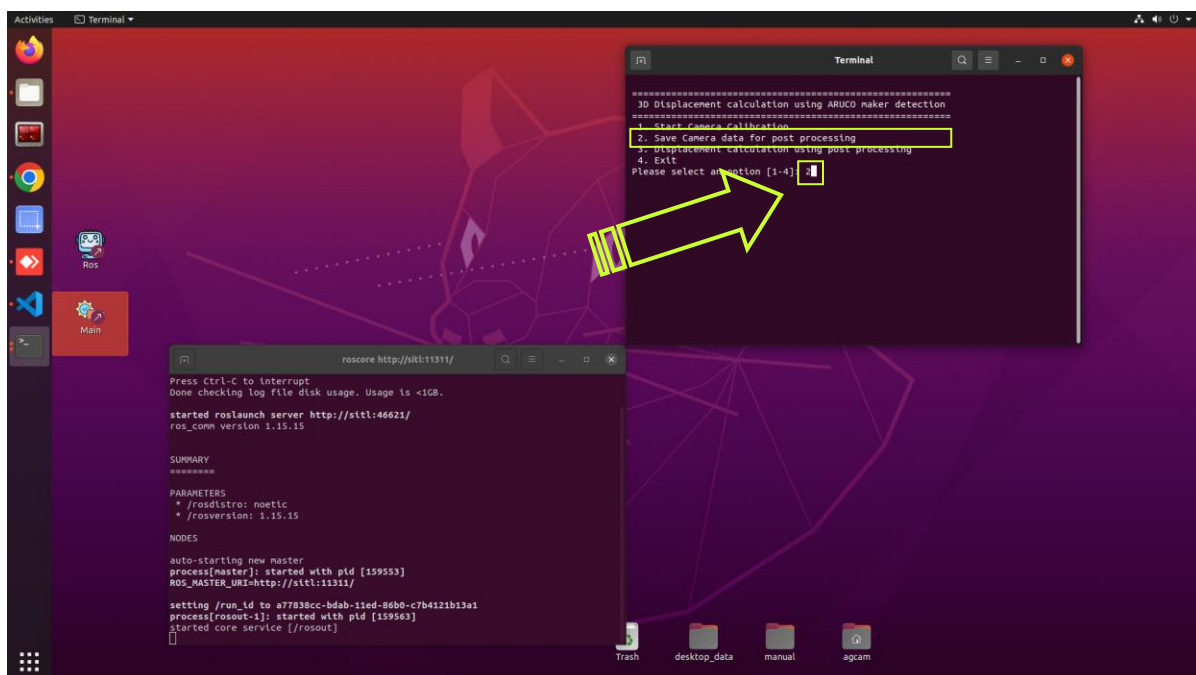
- Initialize the **Main** program node by pressing the **Main** desktop icon () as shown in the following figure:



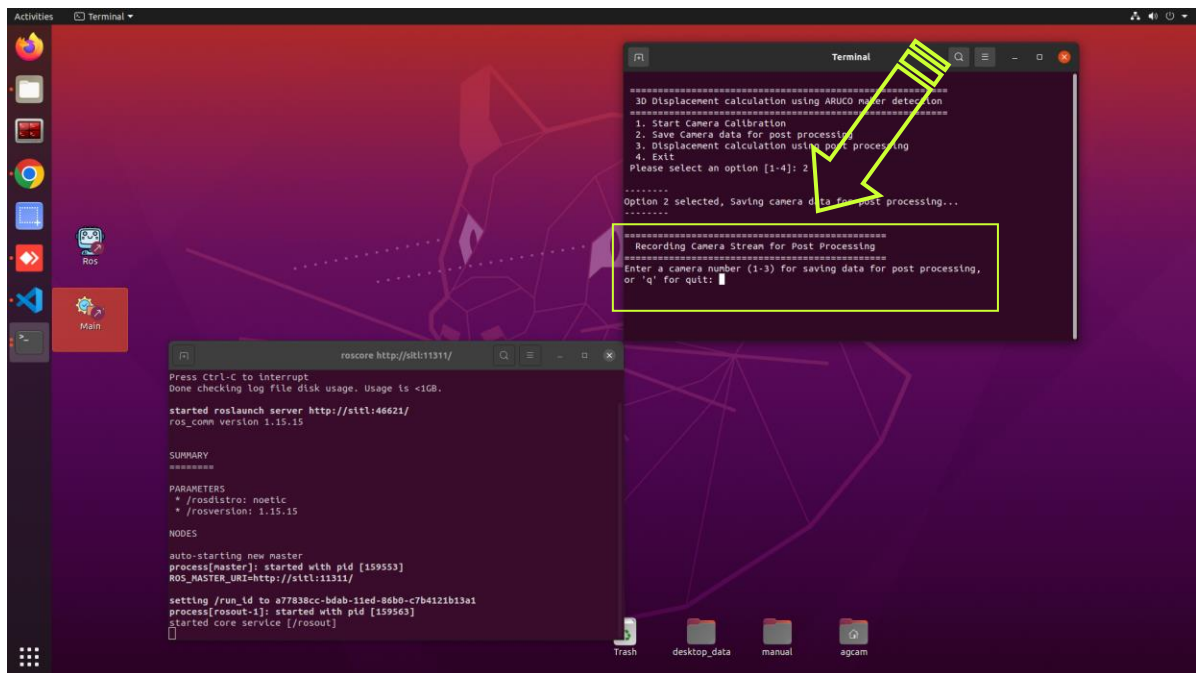
2. Now the **Main program** node is running, as showing in the following figure:



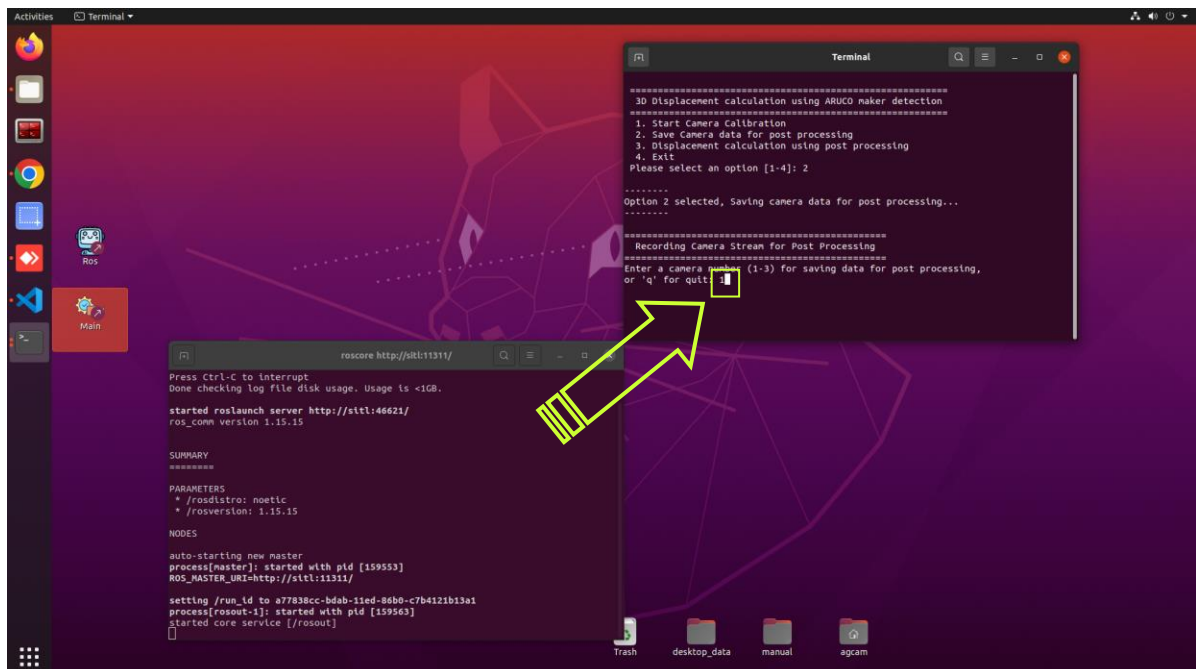
3. Now select option "2" to **store** camera data for **Post Processing**, as depicted in the figure below:



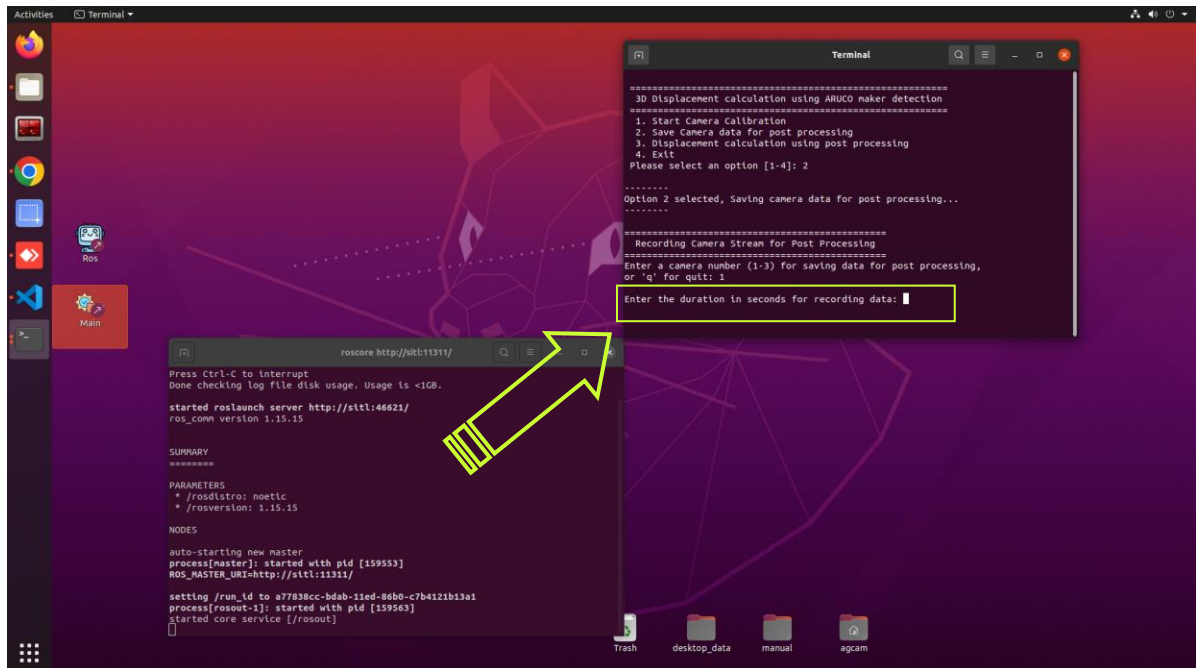
4. The **Storing Camera Data** process has started as depicted in the figure:



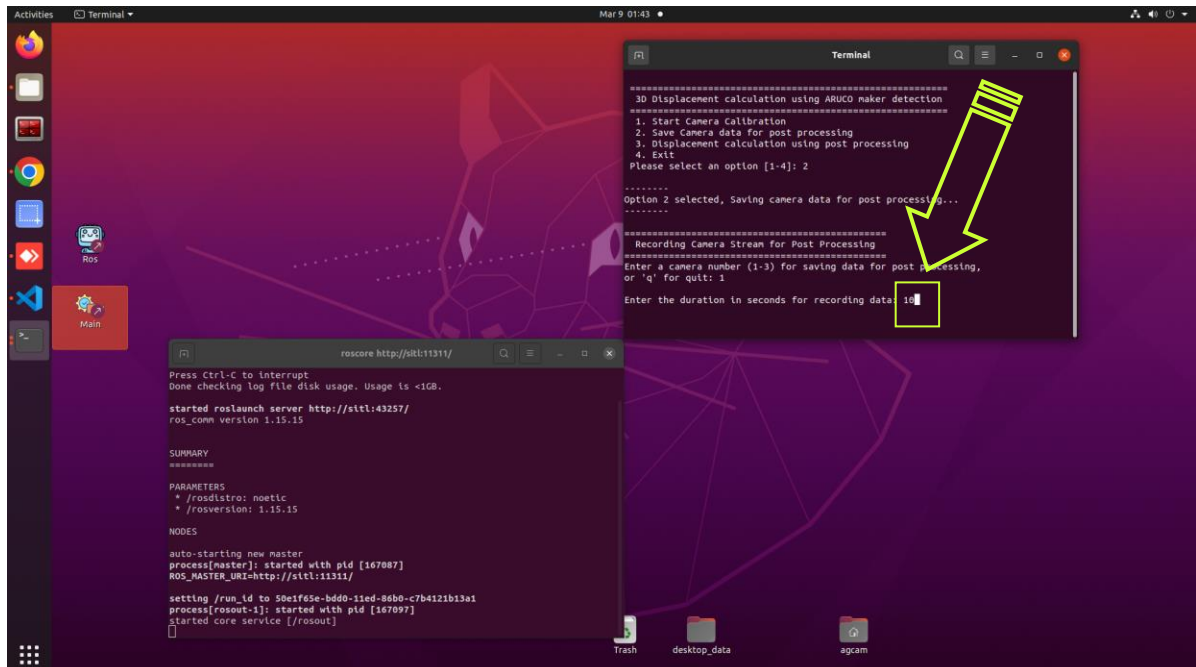
5. Please enter "1" to record the camera stream from **Camera 1** for post-processing, as shown in the figure below:



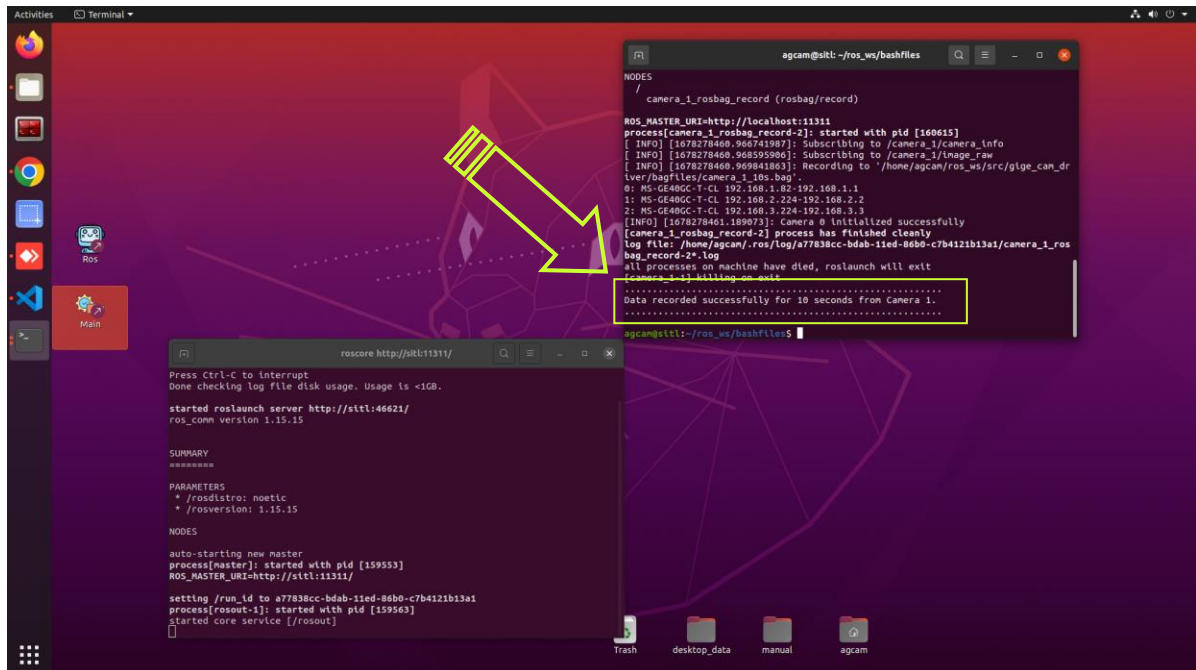
- Enter the duration for which the camera data should be recorded for post-processing from Camera 1.



- Please enter "10" to capture 10 seconds of video stream from **Camera 1** for post-processing, as depicted in the figure below:




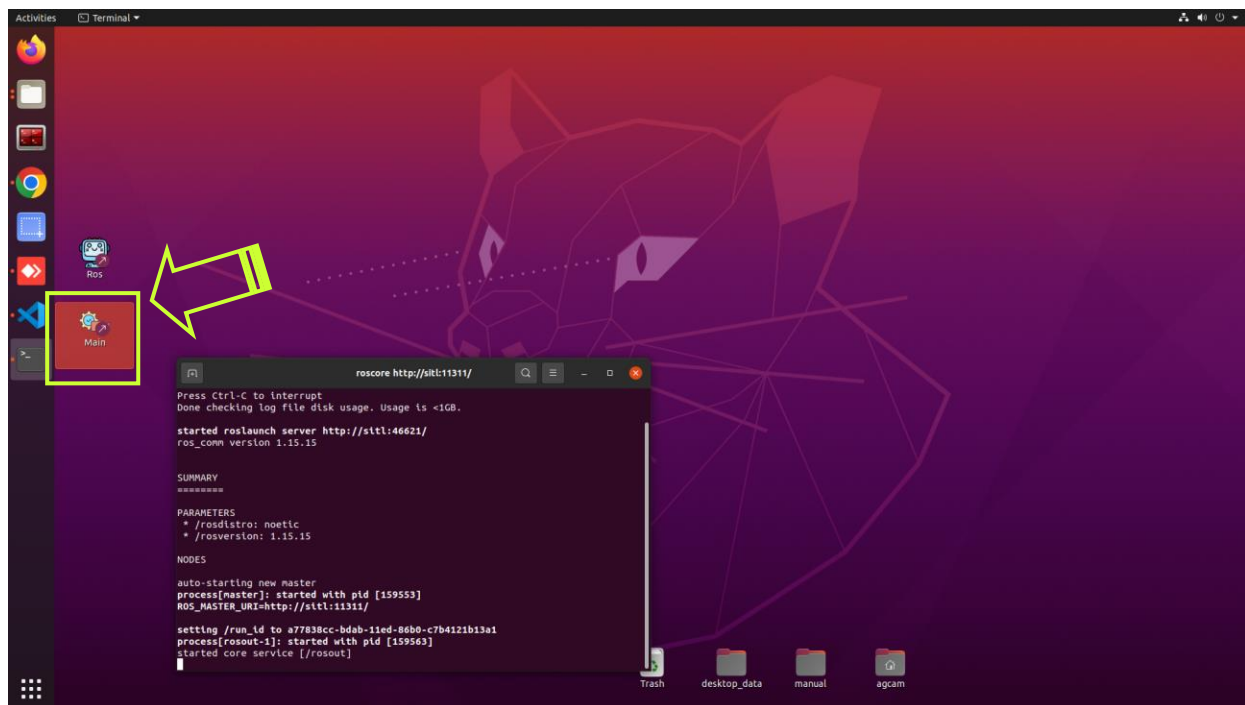
8. Now a 10 seconds of video stream from **Camera 1** for post-processing has been successfully saved as shown in the following figure:



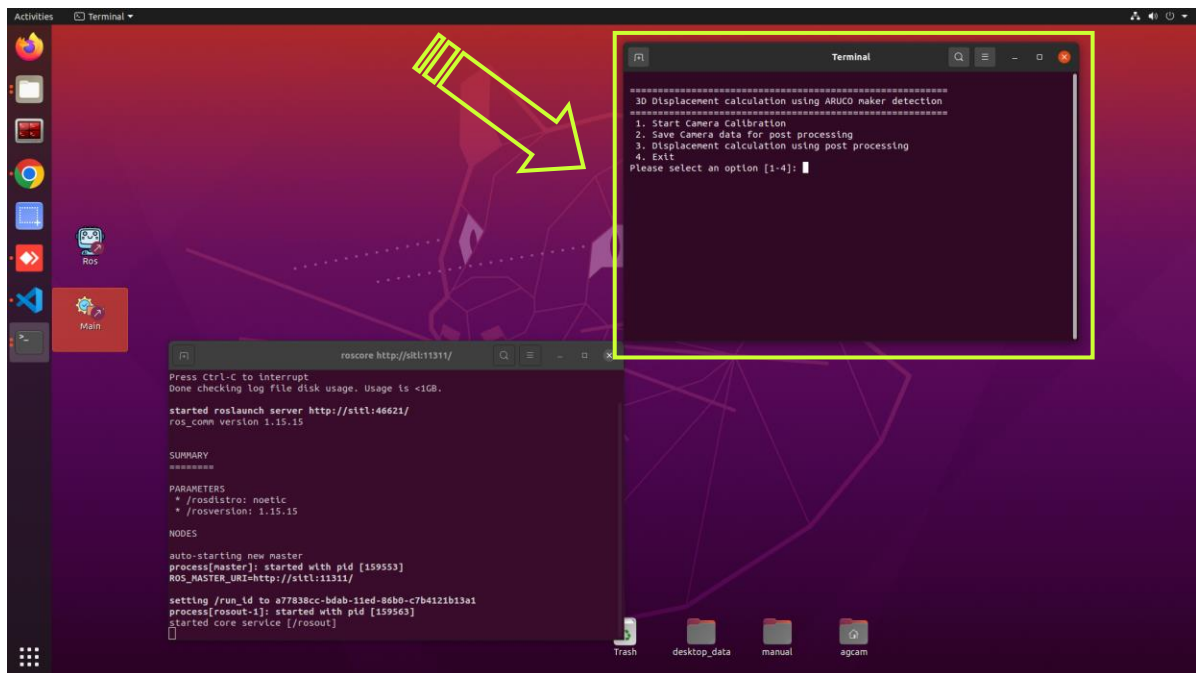
9. Now you may close the terminal window and proceed to the next step.

Step No. 05: Post Processing from Saved Camera Data

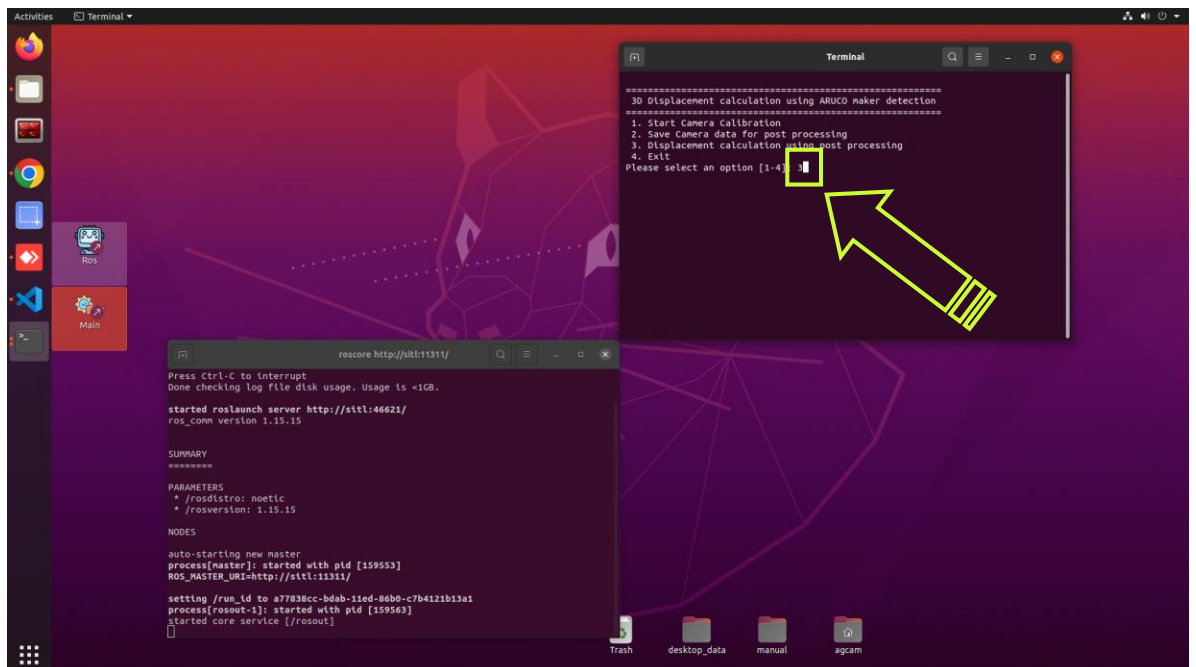
1. Initialize the **Main** program by pressing the **Main** desktop icon () as shown in the following figure:



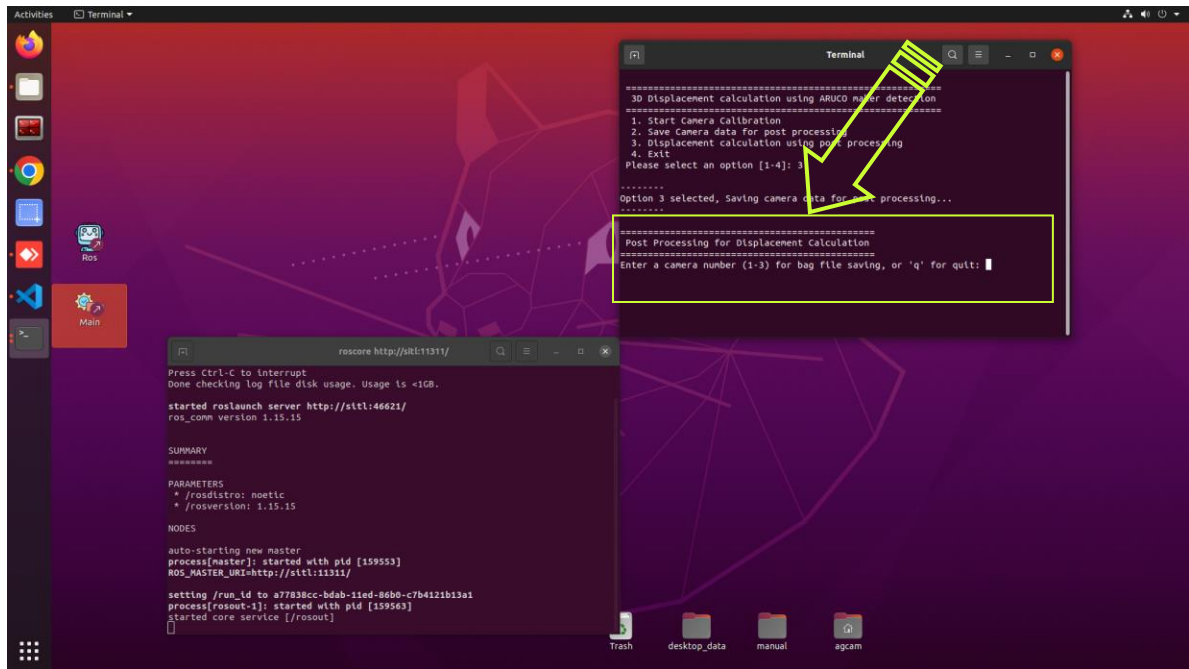
2. Now the **Main program** node is running, as showing in the following figure:



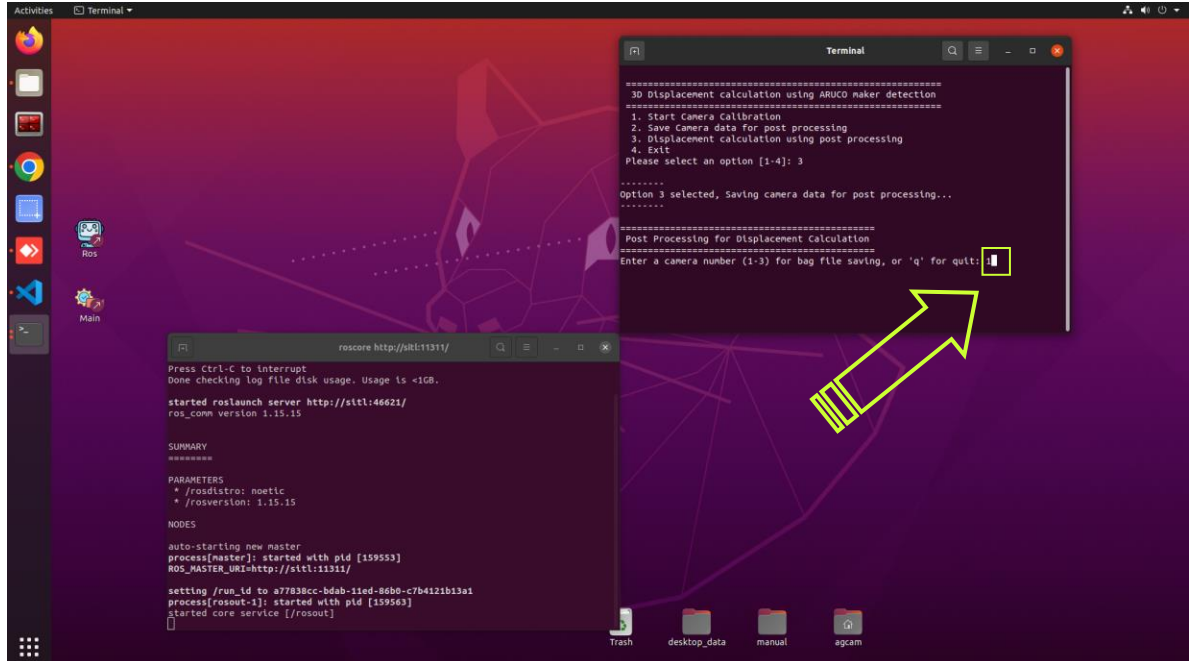
3. Now select option “3” to start **Displacement Calculation** from camera data, as depicted in the figure below:



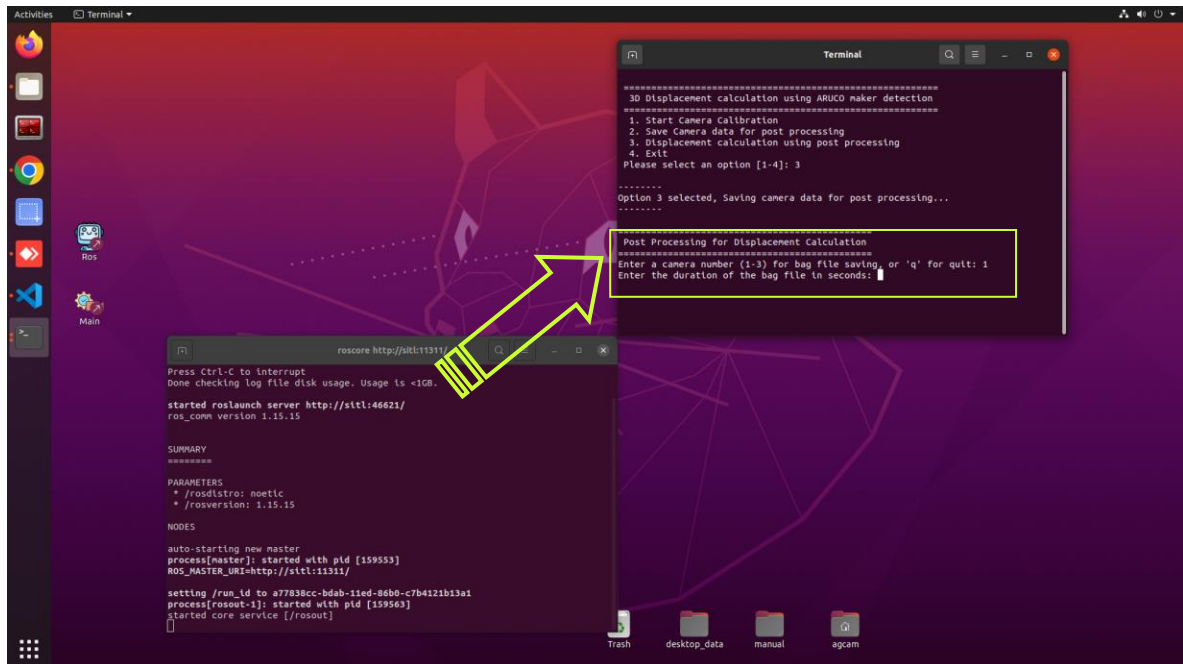
4. The **Displacement Calculation** process has started as depicted in the figure:



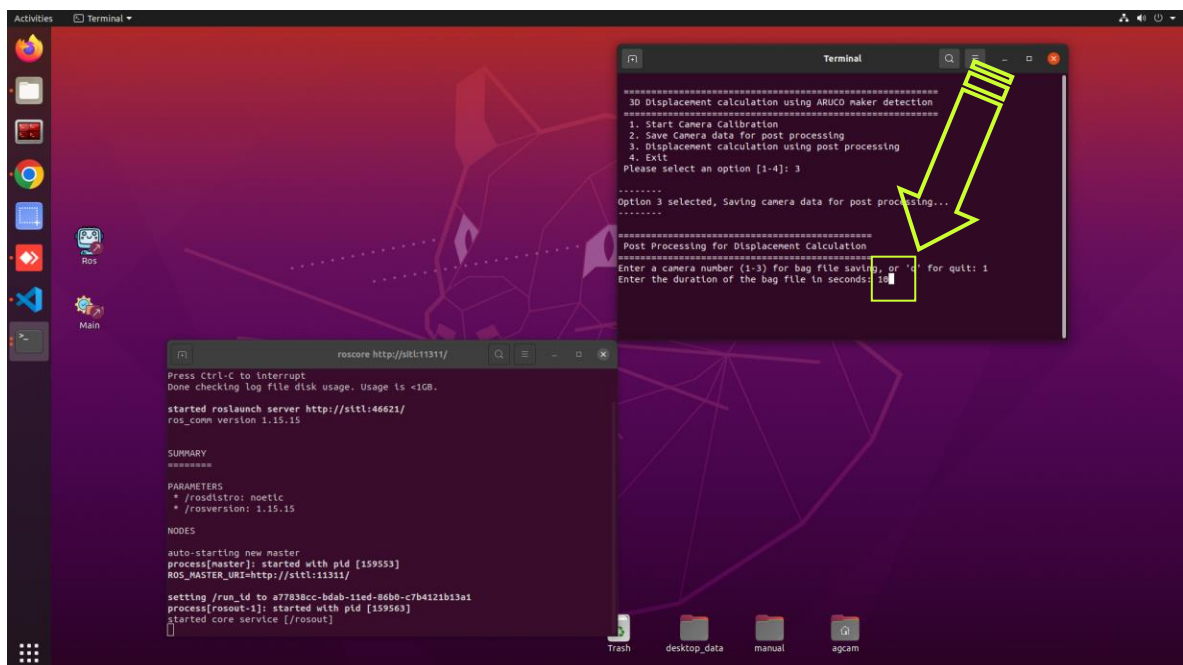
5. Please enter "1" to use the **Camera 1** recorded stream for post-processing, as shown in the figure below:



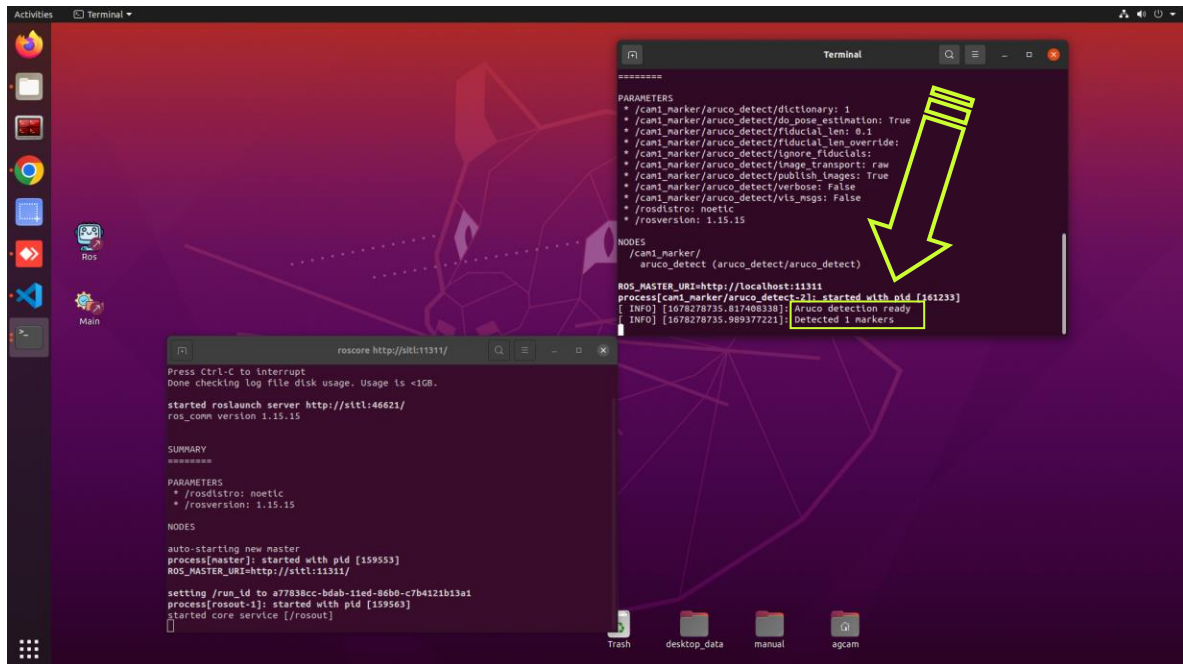
6. Enter the duration of the stored video stream from **Camera 1** to be used for post-processing, as depicted in the figure below:



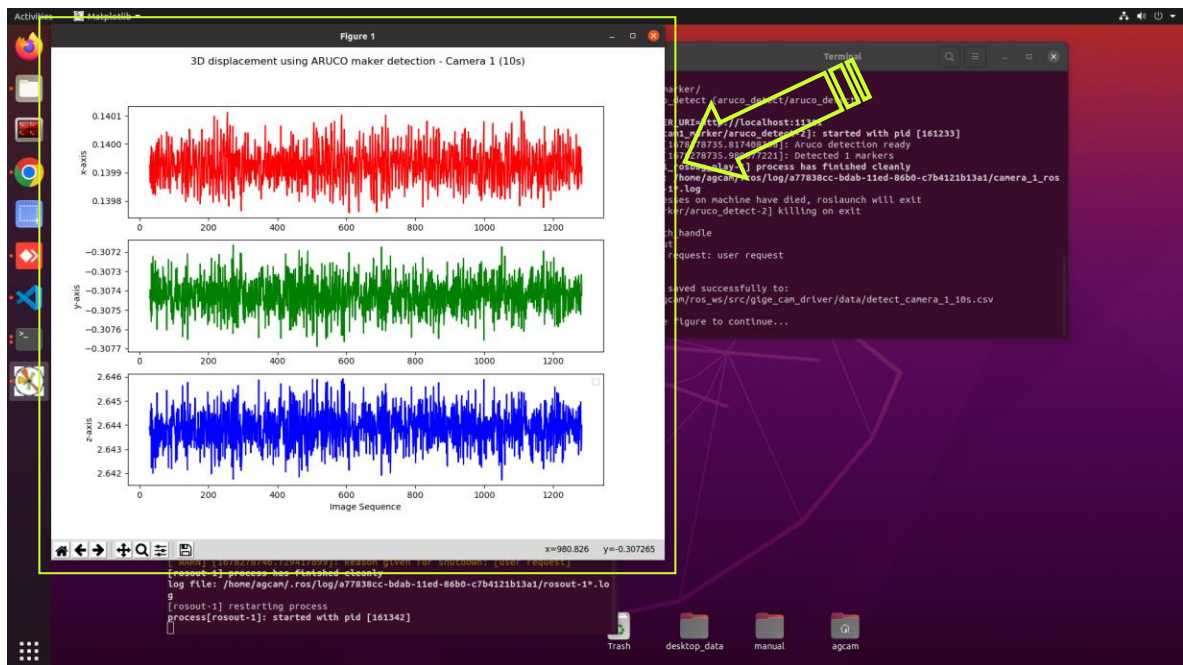
7. Please enter "10" to use 10 seconds video stream stored from **Camera 1** for post-processing, as depicted in the figure below:



8. The following figure demonstrates that the **ARUCO** marker is **detected** in the video captured by **Camera 1**:

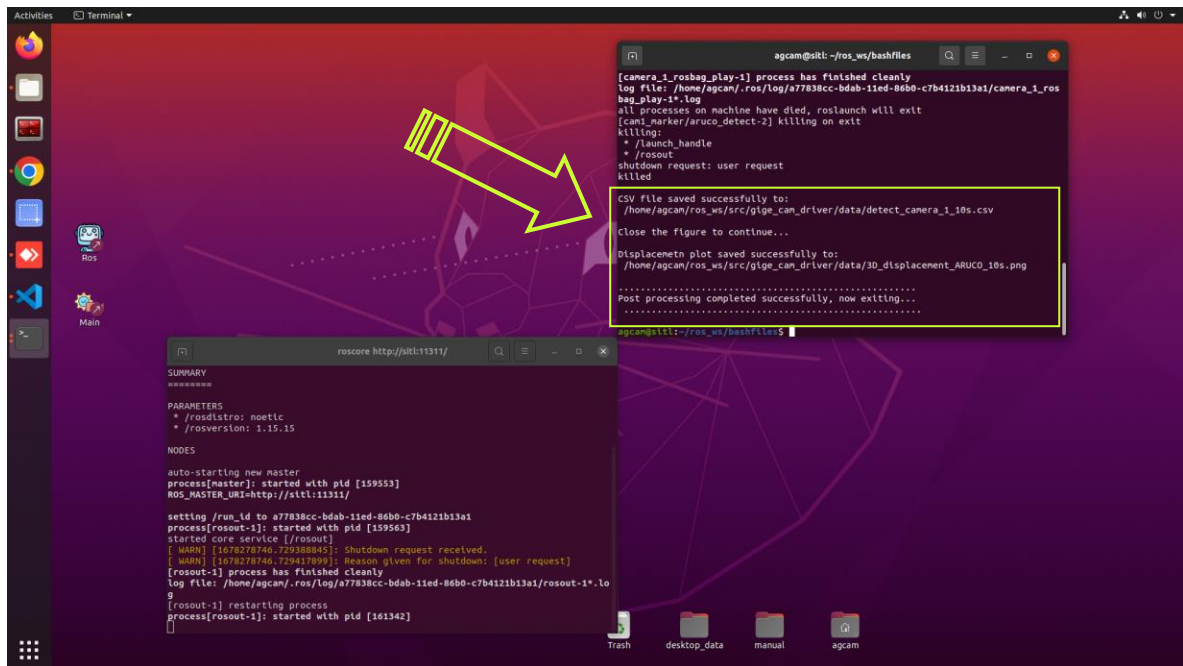


9. The **three-dimensional displacement** plots are then displayed as shown in the subsequent figure:

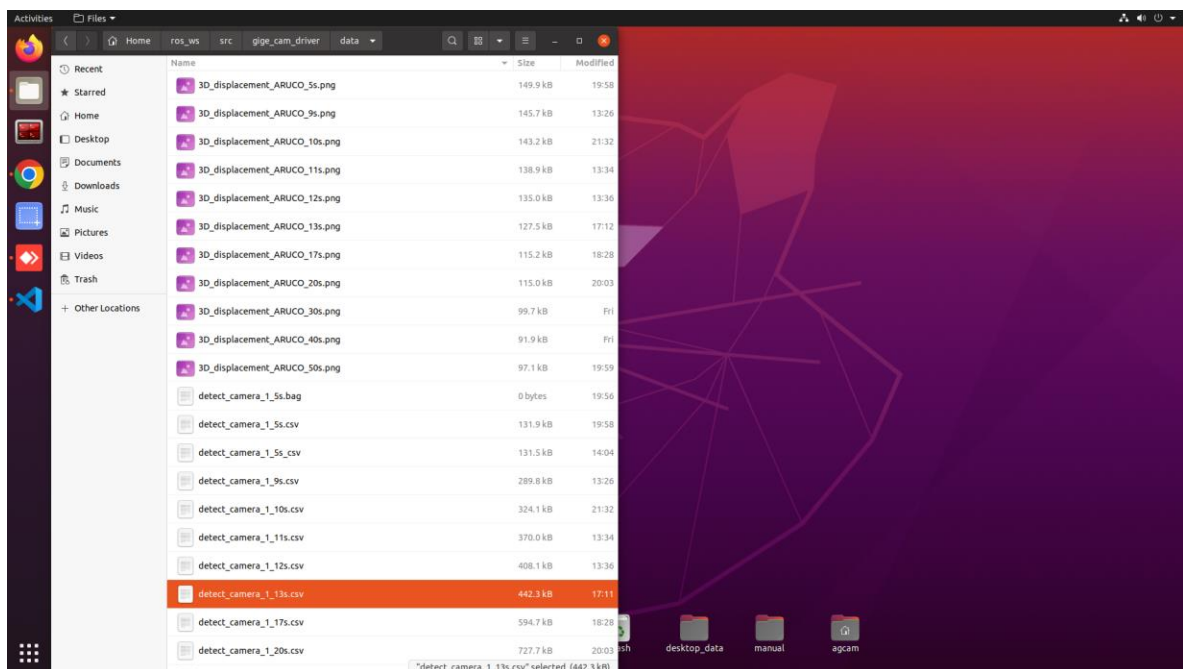


10. To proceed, please close the **Figure** window.

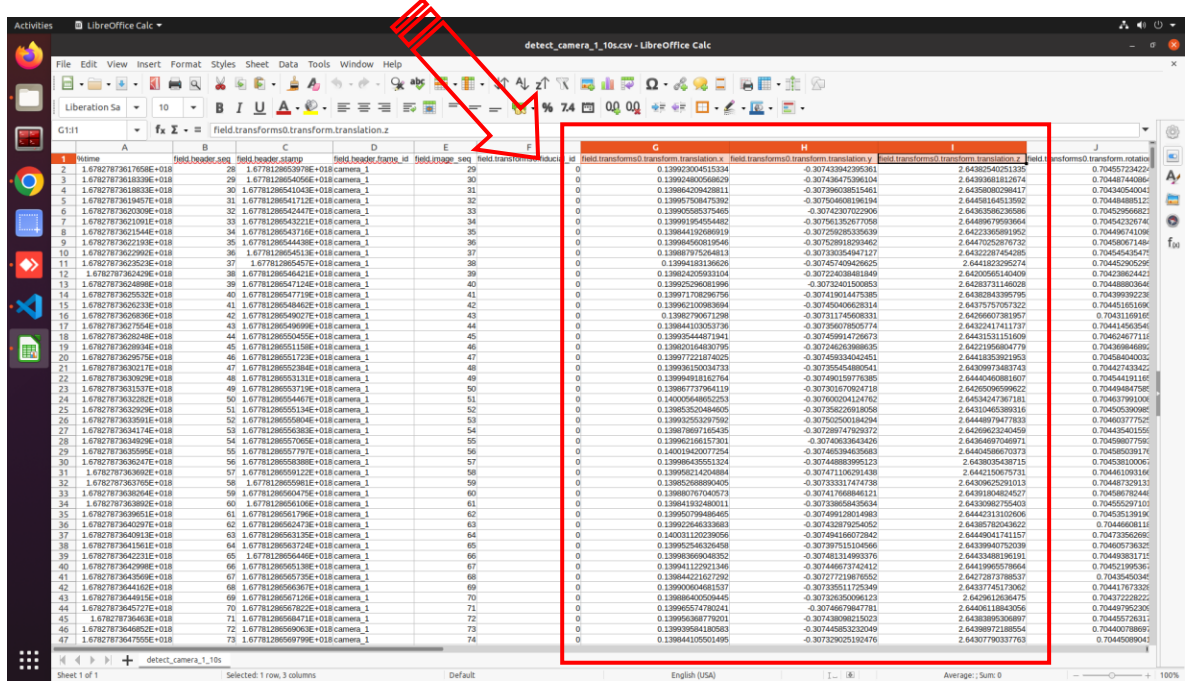
11. The post-processing procedure was completed successfully, displaying the csv file and plot file storage paths as shown in the figure below:



12. The three-dimensional displacement data stored as the.csv files as well as the plot images are stored under the directory `/home/agcam/ros_ws/src/gige_cam_driver/data/`, as shown below:



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



	A	B	C	D	E	F	G	H	I	J
	time	field.transform.translation.x	field.transform.translation.y	field.transform.translation.z	field.transform.rotation.x	field.transform.rotation.y	field.transform.rotation.z	field.transform.rotation.x	field.transform.rotation.y	field.transform.rotation.z
1	1.67827873617696E+018	29	1.6778128653979E+018	camera_1	29	0	0.139923004511334	-0.30743394239361	2.643624621339	7.0457272422
2	1.67827873618339E+018	29	1.6778128654056E+018	camera_1	30	0	0.13992400566620	-0.307436475396104	2.64393681812674	7.0448744096
3	1.67827873618833E+018	30	1.67781286541043E+018	camera_1	31	0	0.139884209429811	-0.307399038515481	2.64298082098417	7.04340540041
4	1.67827873619407E+018	31	1.67781286541121E+018	camera_1	32	0	0.139957509473992	-0.30750490318434	2.64498164813592	7.0444889121
5	1.67827873620009E+018	32	1.67781286542447E+018	camera_1	33	0	0.139925505375465	-0.30742307022006	2.64363586236586	7.0452956821
6	1.67827873621091E+018	33	1.67781286543221E+018	camera_1	34	0	0.139991895455482	-0.307361362677058	2.6448967993964	7.0454232674
7	1.67827873621544E+018	34	1.67781286543146E+018	camera_1	35	0	0.13984410268919	-0.307269265335639	2.6422336881952	7.0448674106
8	1.67827873622193E+018	35	1.67781286544438E+018	camera_1	36	0	0.13998456819546	-0.307528918293462	2.6447025876732	7.045067149
9	1.67827873622992E+018	36	1.6778128654513E+018	camera_1	37	0	0.139887975264813	-0.307303534947127	2.6432287454395	7.045454547
10	1.67827873623529E+018	37	1.677812865457E+018	camera_1	38	0	0.13984105138628	-0.30745740426625	2.644183259274	7.0445296296
11	1.6782787362429E+018	38	1.67781286546421E+018	camera_1	39	0	0.139824205933104	-0.307224038481849	2.6420056514049	7.04238624421
12	1.6782787362488E+018	39	1.67781286547124E+018	camera_1	40	0	0.139925296081996	-0.30731401500553	2.6428371146028	7.044888384
13	1.67827873625532E+018	40	1.67781286547719E+018	camera_1	41	0	0.139871738296756	-0.307419814453385	2.64382841385795	7.0439932238
14	1.67827873626233E+018	41	1.67781286548482E+018	camera_1	42	0	0.139962100683894	-0.307450406628314	2.6437575707322	7.0445165169
15	1.67827873626936E+018	42	1.67781286549027E+018	camera_1	43	0	0.13982790071298	-0.307311745603331	2.6426607781957	7.0431169189
16	1.6782787362754E+018	43	1.67781286549696E+018	camera_1	44	0	0.13984103037396	-0.30736071950774	2.6432147411737	7.044145634
17	1.67827873628248E+018	44	1.67781286550455E+018	camera_1	45	0	0.13992544871841	-0.307459914728673	2.6443151515609	7.0440467171
18	1.67827873628934E+018	45	1.67781286551158E+018	camera_1	46	0	0.13982354803795	-0.307426253889335	2.6422159684779	7.0436848898
19	1.67827873629578E+018	46	1.67781286551728E+018	camera_1	47	0	0.139977224874025	-0.30749334045451	2.6441833821953	7.0450484003
20	1.67827873630217E+018	47	1.67781286552384E+018	camera_1	48	0	0.139936150034733	-0.30735454880541	2.6430997378343	7.044743432
21	1.67827873630929E+018	48	1.6778128655311E+018	camera_1	49	0	0.13994918162784	-0.307399159776395	2.6444840881807	7.0454131116
22	1.67827873631637E+018	49	1.67781286553718E+018	camera_1	50	0	0.13988737964119	-0.307301570524718	2.6426509659622	7.0448484758
23	1.67827873632328E+018	50	1.67781286554467E+018	camera_1	51	0	0.14005648652253	-0.307600204124762	2.645342474781	7.044379100
24	1.67827873632929E+018	51	1.67781286555134E+018	camera_1	52	0	0.13995352484005	-0.30725622693858	2.64310465289318	7.0450539998
25	1.67827873633591E+018	52	1.67781286555804E+018	camera_1	53	0	0.13992355297592	-0.30750050184294	2.64448978477833	7.044607752
26	1.67827873634174E+018	53	1.67781286556383E+018	camera_1	54	0	0.139878697165435	-0.307289147929372	2.64269623240458	7.0443545155
27	1.67827873634829E+018	54	1.67781286557065E+018	camera_1	55	0	0.13996219575301	-0.30740632842426	2.64264697949971	7.045867755
28	1.67827873635595E+018	55	1.67781286557797E+018	camera_1	56	0	0.14001942007254	-0.307485384635683	2.64404586670373	7.045058917
29	1.67827873636247E+018	56	1.67781286558388E+018	camera_1	57	0	0.13986435551324	-0.30744883995123	2.643803538715	7.0453810067
30	1.67827873636932E+018	57	1.67781286559122E+018	camera_1	58	0	0.139958214204884	-0.307471262621438	2.6442150875731	7.0446109316
31	1.67827873637659E+018	58	1.6778128655981E+018	camera_1	59	0	0.13985268890405	-0.307333317474738	2.64309625291013	7.04487229131
32	1.67827873638345E+018	59	1.67781286560475E+018	camera_1	60	0	0.139880767040673	-0.30741768846121	2.6439180424527	7.04486782448
33	1.67827873639032E+018	60	1.67781286561104E+018	camera_1	61	0	0.139841932480111	-0.307338658455634	2.6433086755403	7.04505297101
34	1.67827873639651E+018	61	1.67781286561796E+018	camera_1	62	0	0.13995079846465	-0.307499128014983	2.6444213132066	7.045351919
35	1.67827873640297E+018	62	1.67781286562473E+018	camera_1	63	0	0.139922646333683	-0.307432979254052	2.6438576204382	7.044668111
36	1.67827873640913E+018	63	1.67781286563135E+018	camera_1	64	0	0.140031120239056	-0.3078416672842	2.64449041741137	7.047335626
37	1.67827873641561E+018	64	1.67781286563724E+018	camera_1	65	0	0.139952546326458	-0.307397515104566	2.6433984073039	7.0460573632
38	1.67827873642231E+018	65	1.6778128656440E+018	camera_1	66	0	0.13998369040352	-0.307481314993376	2.64433488196191	7.04483881712
39	1.6782787364298E+018	66	1.67781286565138E+018	camera_1	67	0	0.139841123213146	-0.30744667343412	2.6441969578664	7.04521196361
40	1.67827873643696E+018	67	1.67781286565755E+018	camera_1	68	0	0.13984421627292	-0.307272719676552	2.64272873788537	7.043545034
41	1.6782787364442E+018	68	1.67781286566367E+018	camera_1	69	0	0.139903604681537	-0.307328511725349	2.64337145173062	7.0441787339
42	1.6782787364515E+018	69	1.67781286567126E+018	camera_1	70	0	0.13986407559445	-0.307326320961223	2.6429612634795	7.0457222822
43	1.67827873645872E+018	70	1.67781286567822E+018	camera_1	71	0	0.13996557480241	-0.30748579647781	2.64408118843056	7.0449792206
44	1.6782787364653E+018	71	1.6778128656851E+018	camera_1	72	0	0.139953687786201	-0.307328086215023	2.64383895189897	7.0449572631
45	1.6782787364727E+018	72	1.67781286569263E+018	camera_1	73	0	0.139859561180563	-0.307445853220469	2.64388972188554	7.044078869
46	1.67827873647955E+018	73	1.67781286569799E+018	camera_1	74	0	0.139844105501495	-0.307329025150476	2.64307790337763	7.0445090041

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