



**e-con Systems India Pvt Ltd**

[www.e-consystems.com](http://www.e-consystems.com)

## **ACC-TK1-CUMI0330CAM User Manual**



**Revision 1.0**

**August 16, 2016**

**Customer/Partner**



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## 1 Revision History

Rev No	Date	Major Changes	Edited By
1.0	August 16, 2016	Initial Draft	eSOMTK1 Dev. Team



## 2 Introduction

ACC-TK1-CUMI0330CAM is a MIPI camera daughter board designed by for e-con's Propus - nVIDIA Tegra K1 development platform. ACC-TK1-CUMI0330CAM uses a 3.15M Pixel camera module powered by ON Semiconductor AR0330 CMOS image sensor.

The ACC-TK1-CUMI0330CAM is a two-board solution containing the camera sensor module board containing 1/3" AR0330 CMOS image sensor from Aptina and the other is an interface board for the CN18/CN19 connector on the ESOMTK1. It requires a custom driver for the ESOMTK1 TK1. e-con provides the driver for this camera along with the camera board. e-con also provides the sample application (ecam\_tk1\_guvcview) that demonstrates some of the features of this camera. However, this camera can be utilized by any V4L2 application such as cheese, Skype etc.

Propus -nVIDIA Tegra K1 development platform hyperlink:

<http://www.e-consystems.com/tegra-k1-development-board.asp>

## 3 Scope

This document mainly consists of two sections:

- Hardware Section
- Software (Camera Application) Section

### Scope of the Hardware Section:

This document explains how to interface the ACC-TK1-CUMI0330CAM camera daughter board with Propus- Nvidia Tegra K1 development Kit. The scope of this document is limited to a brief description of this camera daughter board including the mechanical diagram and the steps to be followed while connecting the board with Propus.

### Scope of the Software (Camera Application) Section:

e-con provides a sample V4L2 application, called **ecam\_tk1\_guvcview**, along with the ACC-TK1-CUMI10330CAM camera. ecam\_tk1\_guvcview is a V4L2 video viewer and capture software for the camera driver for ESOMTK1 TK1, customized to demonstrate the features of ACC-TK1-CUMI0330CAM.

This document describes about the usage of the ecam\_tk1\_guvcview application on L4T\_R21.4 (arm 32-bit) Linux operating systems. This document also describes about the special features of ecam\_tk1\_guvcview camera application when it is used with ACC-TK1-CUMI0330CAM.

## 4 Disclaimer

The specifications of the camera daughter board and instructions on how to use this daughter board with Propus – nVIDIA Tegra K1 development Board are provided as reference only and e-con Systems reserves the right to edit/modify this document without any prior intimation of whatsoever.



## Hardware Section

### 5 Description

ACC-TK1-CUMI0330CAM camera daughter board interfaces with Propus -nVIDIA Tegra K1 development Kit through flex cable. ACC-TK1-CUMI0330CAM has 24 pin FFC connector on board to interface with the Propus board. The FFC cable connecting ACC-TK1-CUMI0330CAM camera daughter board and Propus is 4 inch in length.



Figure 1: ACC-TK1-CUMI0330CAM camera board



## 5.1 Block diagram

The following block diagram depicts the ACC-TK1-CUMI0330CAM camera daughter board and Propus.

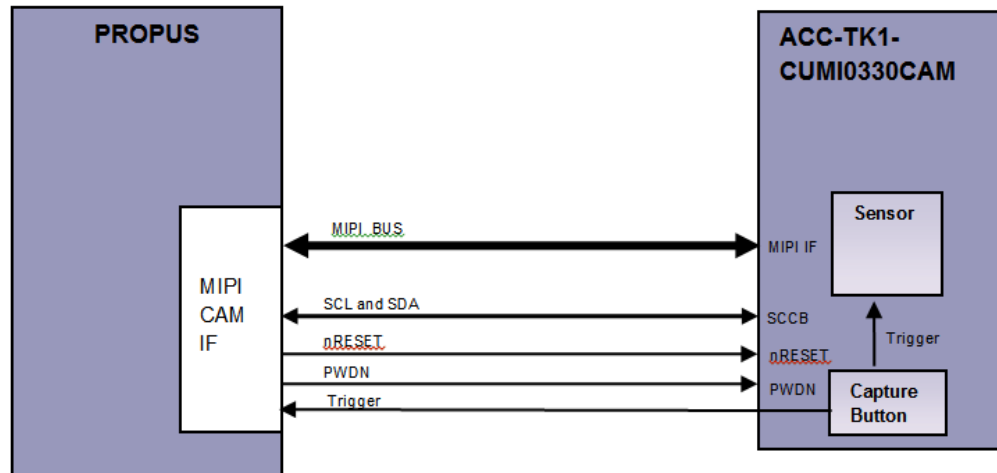


Figure 2: ACC-TK1-CUMI0330CAM daughter board block diagram

## 6 Mechanical Specification

### 6.1 Camera Board outline

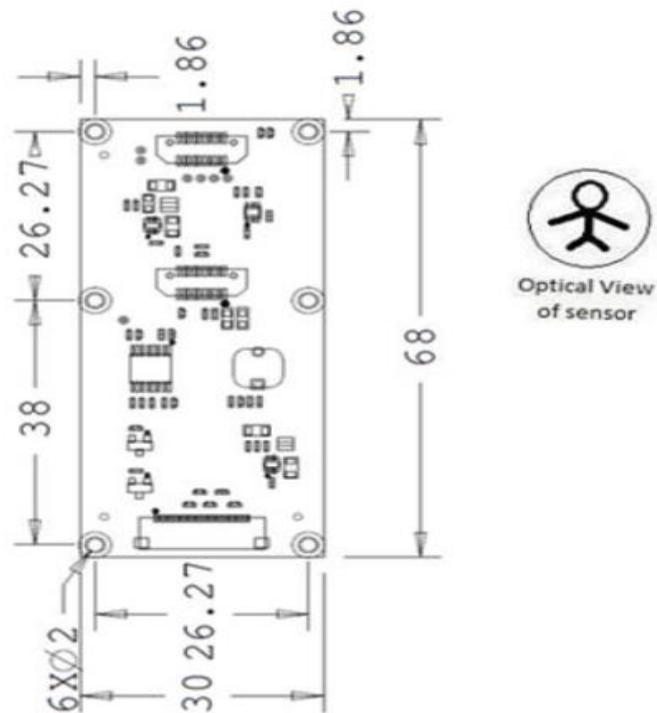


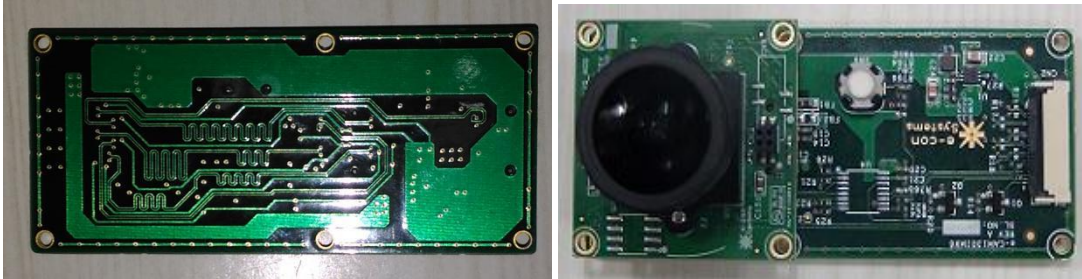
Figure 3: ACC-TK1-CUMI0330CAM board outline dimensions



## 7 Connection Procedure

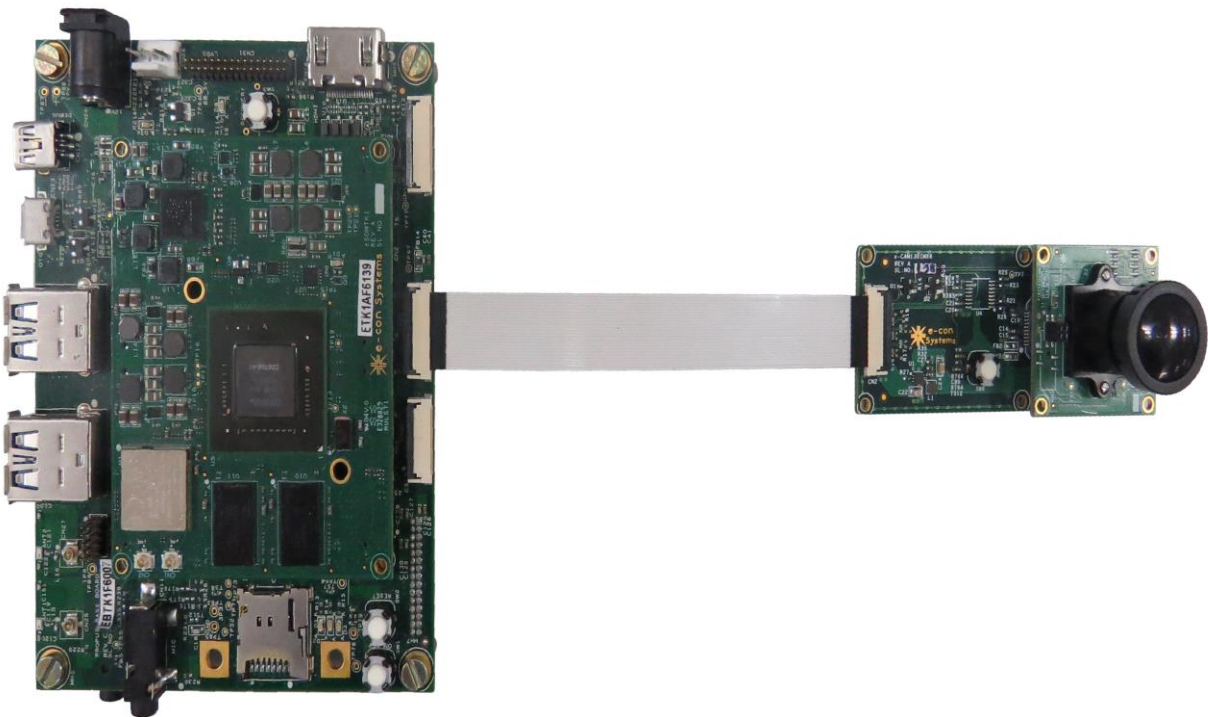
This section provides the step by step procedures to be followed for connecting the ACC-TK1-CUMI0330CAM camera daughter board with the Propus board.

1. The image below shows the front and rear view of the ACC-TK1-CUMI0330CAM board



**Figure 4: ACC-TK1-CUMI0330CAM board top and bottom**

2. The 24 pin connectors on the front side of ACC-TK1-CUMI0330CAM camera daughter board should interface with another 24 pin connector on Propus using FFC cable. The picture below shows the connection between the ACC-TK1-CUMI0330CAM camera daughter board and the Propus.



**Figure 5: 3MP Camera daughter board connected to Propus board**

3. Now the connection between the camera daughter board and the Propus board is done.





## Software (Camera Application) Section

### 8 Description

The ACC-TK1-CUMI0330CAM is capable of streaming the following resolutions and frame rates.

**Table 1: Supported resolutions and frame rates**

Resolution	YUYV	MJPEG
VGA	30	30
HD	30	22
Full HD	30	13
3 MP	30	9
3.4 MP	30	8

**Note:** The frame rates listed in the above table can be achieved easily in manual exposure. When the exposure time period is more than the time period of camera frame, frame rate will drop. In auto exposure, maximum frame rate could be achieved with maximum lighting.

The ACC-TK1-CUMI0330CAM has the following camera controls,

- Brightness
- Contrast
- Saturation
- White Balance (both manual and automatic)
- Gamma
- Gain
- Horizontal Flip
- Vertical Flip
- Sharpness
- Exposure (both manual and automatic)
- Zoom

The **e-CAM\_TK1 guvcviewer** or **ecam\_tk1\_guvcview** is a simple GTK+ interface for capturing and viewing video from the devices supported on the ESOMTK1 TK1. The features provided in the application are as follows:

- a) Enumerating and listing all video devices connected.
- b) Properties of video renderer.
- c) Changing resolution and color space/compression for video stream(if different resolution are supported by the device)



- d) Currently configured values of preview which is being shown.
- e) User can capture still images and set the path where still images will be saved.
- f) Displaying the average frame rate.

All the above listed properties can be configured by attractive and easy to use Graphical User Interface. The application will run in L4T\_R21.4 (arm 32-bit) Linux Distributions.

e-con provides pre-built binaries of the `ecam_tk1_guvcview` application for the following Linux Distributions.

- L4T\_R21.4 (arm 32-bit)

## 9 Camera Modules

- The camera modules for this sensor are available as KERNEL OBJECTS (.ko files) in the rootfs at the location: `/lib/modules/3.10.40_esomtk1_ver_x.x/extras/camera_modules`.
- The .ko's available are
  - `ar0330.ko`
  - `ar0330_csi_B.ko`
- These camera modules are inserted at the system startup by init scripts automatically.
- To check the insertion of modules, try the command `lsmod`.

```
$ lsmod
```

Module	Size	Used by
tegra_camera	22817	0
videobuf2_dma_contig	9227	1 tegra_camera
<b>ar0330_csi_B</b>	<b>58346</b>	<b>0</b>
<b>ar0330</b>	<b>58325</b>	<b>0</b>

- If the camera sensor is inserted, the video node is created according to the csi slots to which it is connected.
- The video nodes can be checked at the location: `/dev/`
- To remove the camera modules, try the command `rmmod`.

```
$ sudo rmmod ar0330.ko ar0330_csi_B.ko
```



## 10 Launching the Application

- Connect the ACC-TK1-CUMI0330CAM MIPI camera to the CN18 (CSI-A)/CN19 (CSI-B) connector on the ESOMTK1 TK1 Development Kit (before powering up the eSOMTK1)
- Power up the eSOMTK1 kit
- Open the terminal application by clicking on the dash board icon on the top left corner and typing 'terminal' in that search panel as shown in the figure 6 below

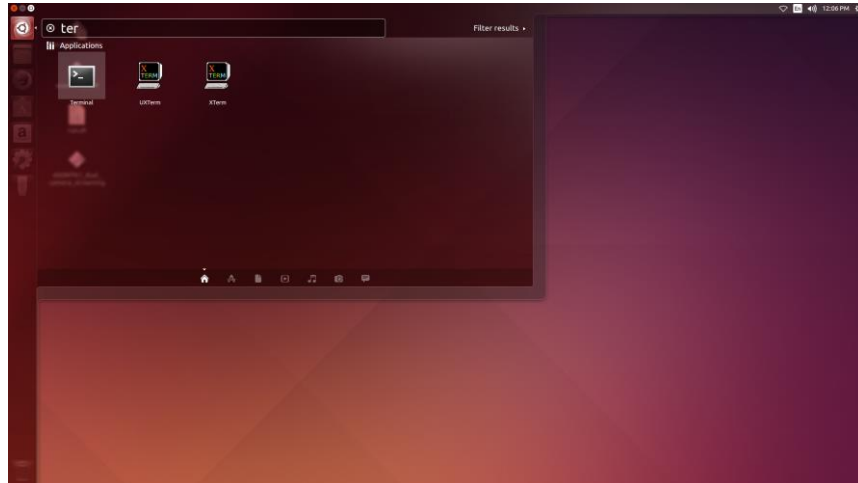


Figure 6: Ubuntu Desktop where Terminal application is launched

- Launch the application `ecam_tk1_guvcview` from the terminal as shown in the figure 7 below

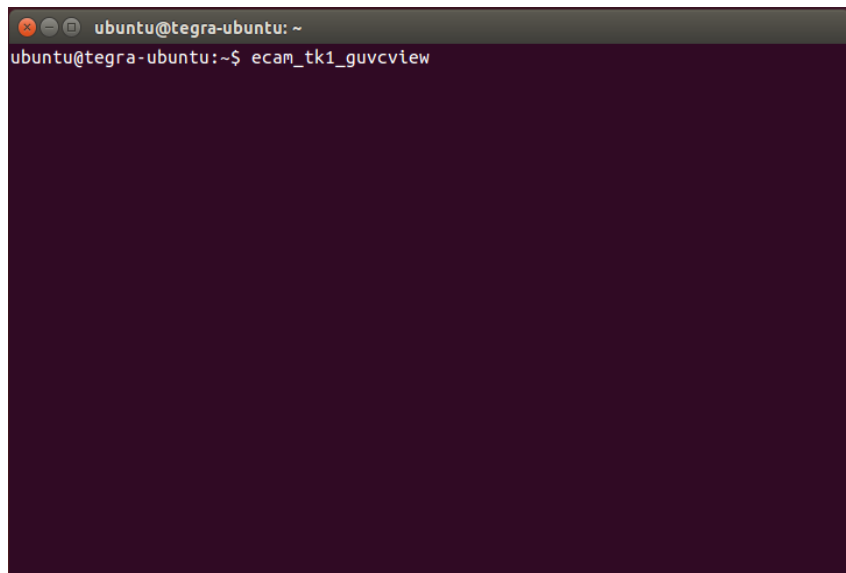
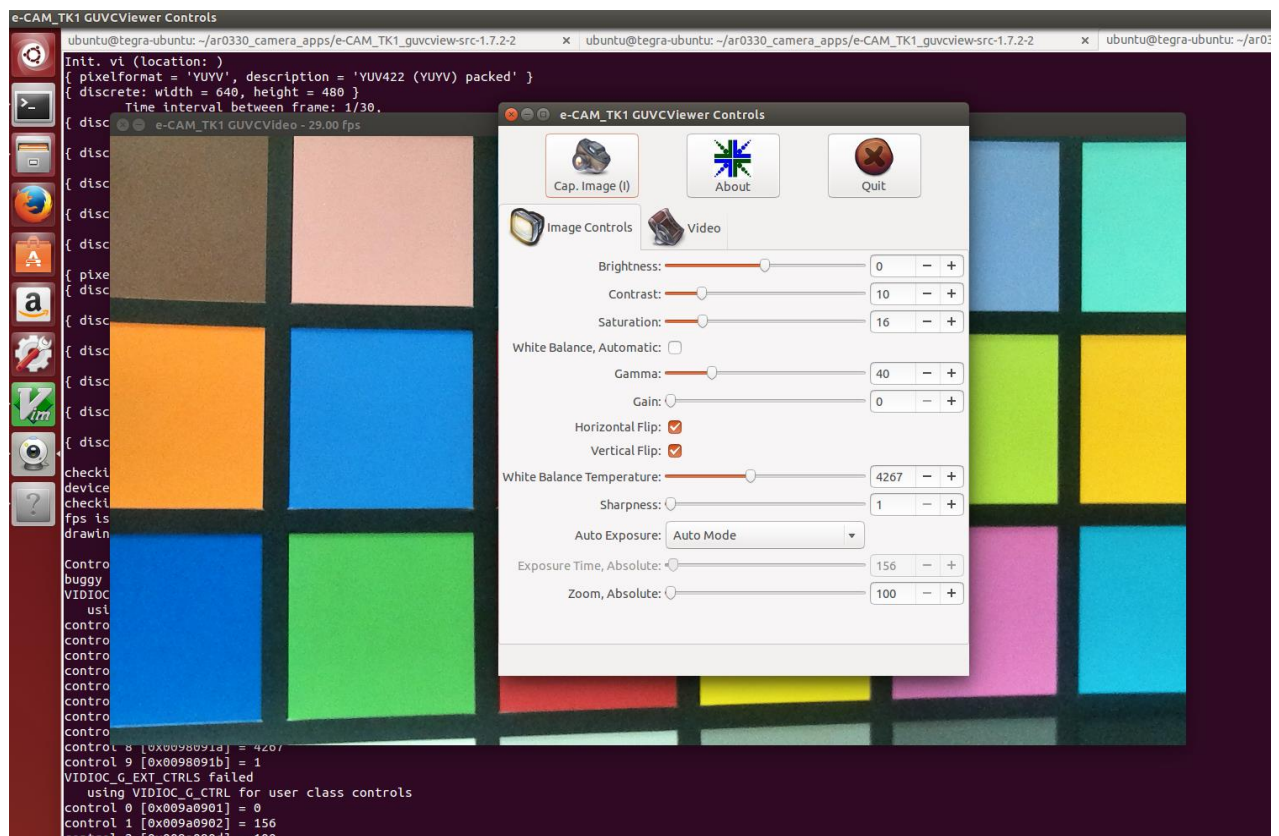


Figure 7: Terminal Window where application is launched



**NOTE:**

1. When more than one camera sensors are connected, the application will throw an error dialog box and prompts the user to choose the camera device. Please choose appropriate device to start streaming (Only applicable when more than one camera sensors are connected to eSOMTK1 development kit)
2. When two ACC-TK1-CUMI0330CAM cameras are connected to eSOMTK1 development kit (one camera in CN18 connector and another camera in CN19 connector), to stream both cameras simultaneously at the same time, launch the application, go to 'Video' tab, click on 'Device' dropdown box and chose second 'vi' in the dropdown box and choose 'New' in the next dialog box.
  - When application is launched, control window and video display window will appear as shown in figure 8 below.



**Figure 8: Initial Window Appearance when application is launched**

## 11 Application Features

The features that are supported in the current version of `ecam_tk1_guvview` are briefly described here. The features are categorized into 2 tab controls. They are

1. Image Controls tab
2. Video & Files tab



## 11.1 Image Control Tab

On selecting Image Controls Tab, control menu will display camera control settings. The user can adjust the video preview settings in the Menu tab. Sliders whose labels are not grayed out can only be configured.

The user can move the slider and configure the preview settings according to their needs. The value being set will be displayed in the text box based on the position of the slider marker. As soon as the slider is moved to configure the values the preview's property will change at that instance.

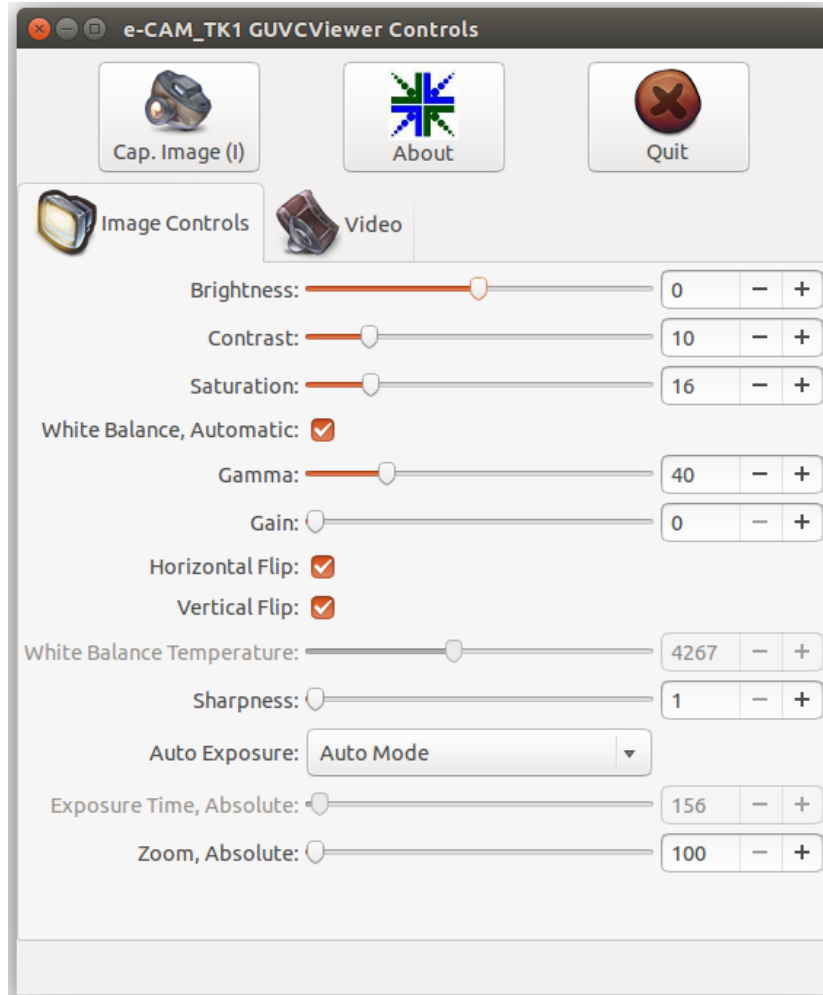


Figure 9: Image control Tab Menu



**Table 2: Values of ACC-TK1-CUMI0330CAM Controls**

Controls	Minimum Value	Maximum Value	Default Value	Manual Control	Auto Control
<b>Brightness</b>	-15	15	0	YES	NO
<b>Contrast</b>	0	60	10	YES	NO
<b>Saturation</b>	0	93	16	YES	NO
<b>Sharpness</b>	1	7	1	YES	NO
<b>Gamma</b>	16	125	40	YES	NO
<b>White balance</b>	1	10000	4200	YES	YES
<b>Gain</b>	0	100	0	YES	NO
<b>Horizontal Flip</b>	0	1	0	YES	NO
<b>Vertical Flip</b>	0	1	0	YES	NO
<b>Zoom</b>	100	750	100	YES	NO
<b>Exposure</b>	1 (100 micro seconds)	10000 (1000 milli seconds)	156 (15.6 milli seconds)	YES	YES

### 11.1.1 Brightness Control

The Brightness values can be changed from a minimum value of -15 to 15 by moving the slider, and the exact changes will be reflected immediately in the preview. This brightness control increases the low light performance of ACC-TK1-CUMI0330CAM. The Default value is 0.

### 11.1.2 Contrast Control

The Contrast values can be changed from a minimum value of 0 to 60 by moving the slider, and the exact changes will be reflected immediately in the preview. Increasing the Contrast control increases the luminance of ACC-TK1-CUMI0330CAM. The Default value is 10.

### 11.1.3 Saturation Control

The Saturation values can be changed from a minimum value of 0 to 93 by moving the slider, and the exact changes will be reflected immediately in the preview. Increasing the Saturation control increases the intensity of the color of ACC-TK1-CUMI0330CAM. The Default value is 16.



### 11.1.4 White balance Control

The Manual White Balance can be selected by unchecking the check box near the white balance control. The Manual White Balance values can be changed from 1 to 10000 by moving the slider, and the exact changes will be reflected immediately in the preview. The Default value is 4200.

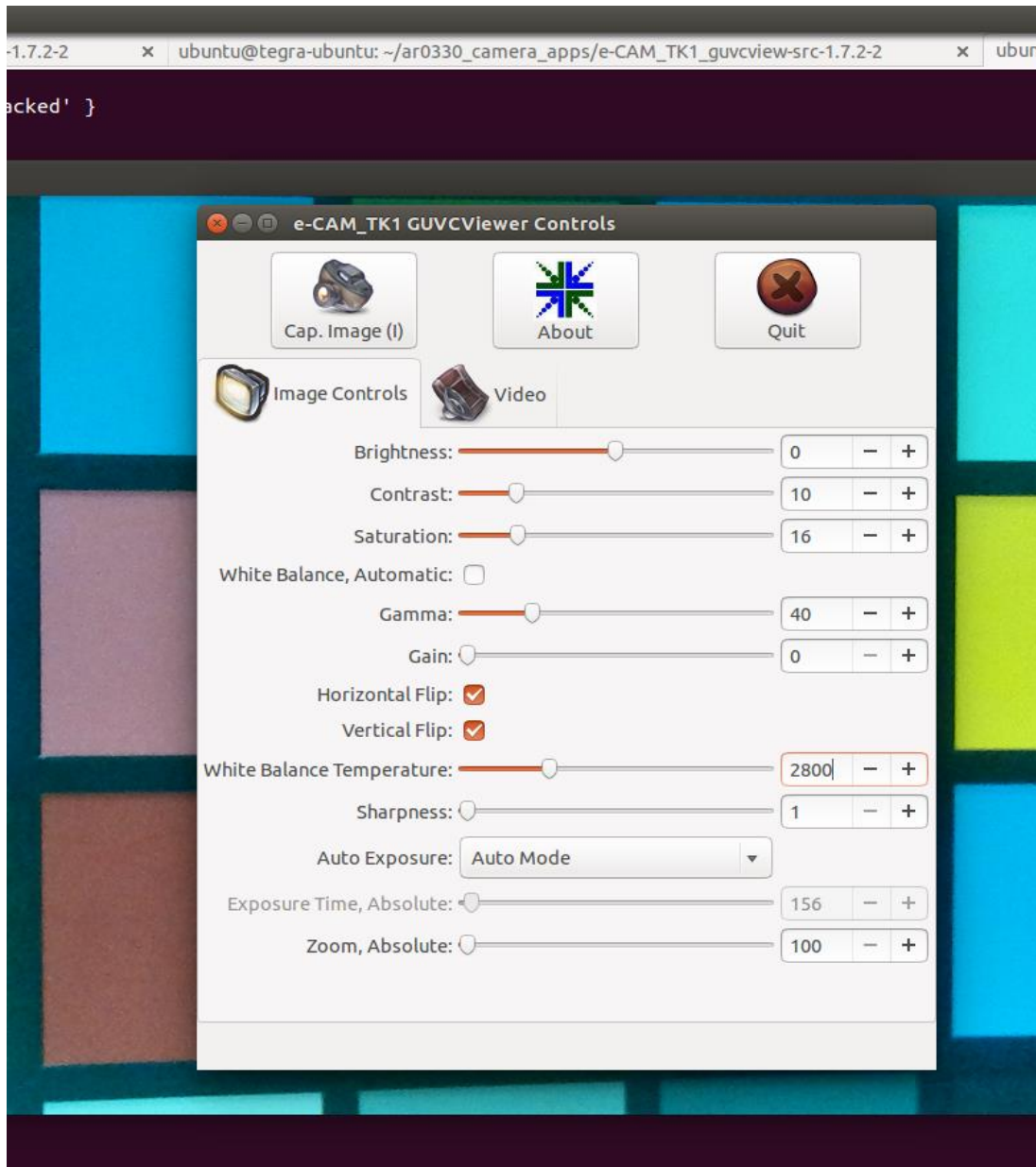


Figure 10: Manual White Balance Temperature





The Manual White Balance can be selected by deselecting the check box near the white balance control. By default the camera is in auto mode.

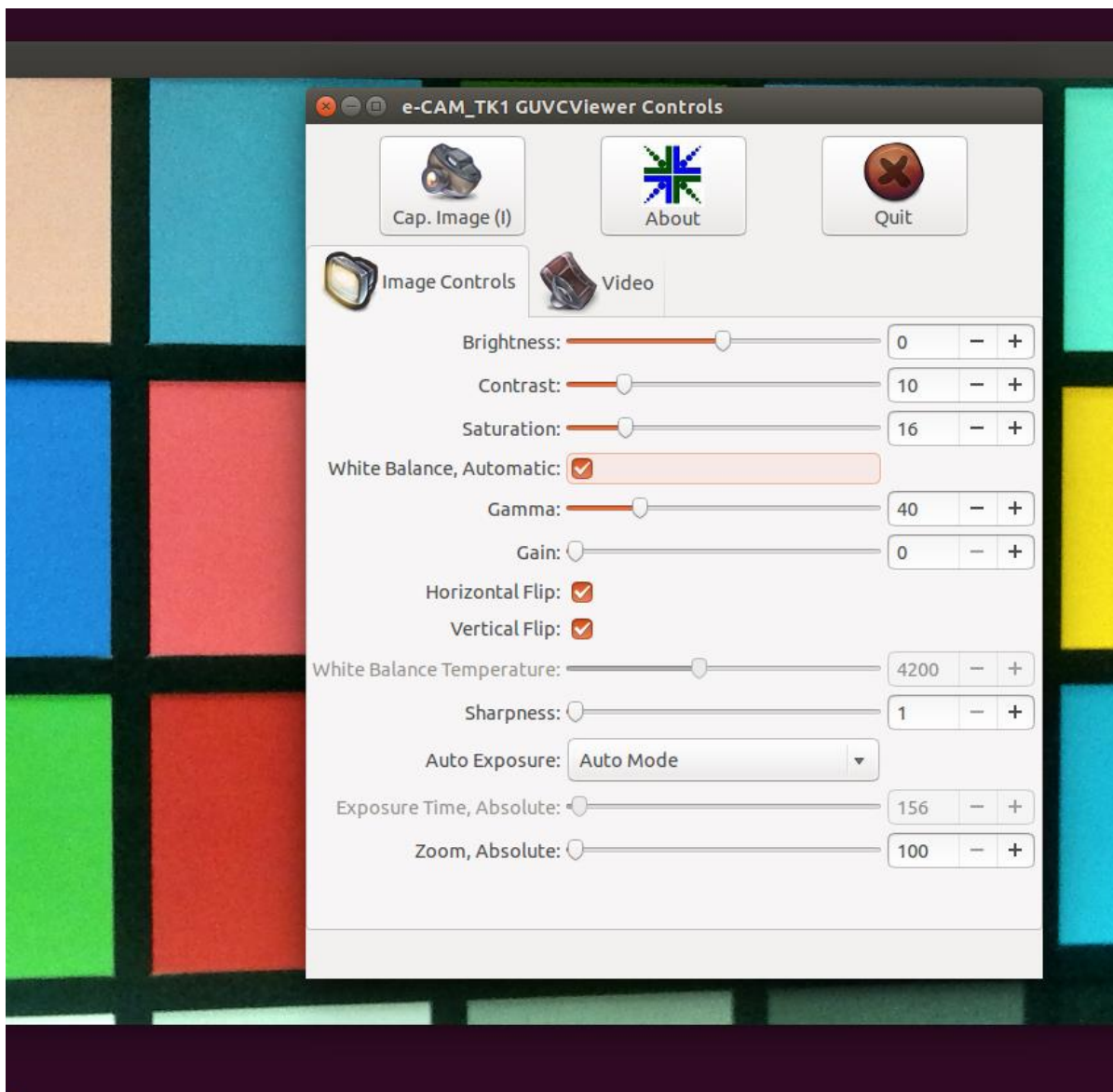


Figure 11: Selecting Auto White Balance Temperature

### 11.1.5 Gamma Control

The Gamma values can be changed from a minimum value of 16 to 125 by moving the slider, and the exact changes will be reflected immediately in the preview. The Default value is 40.

### 11.1.6 Gain Control

The Gain values can be changed from a minimum of 0 to 100 with default value being 0. The changes are updated in the preview immediately. The Default value is 0.





### 11.1.7 Horizontal Flip Control

The preview from the sensor can be horizontally flipped by selecting the check box next to it. By default this control is in off mode.

### 11.1.8 Vertical Flip Control

The preview from the sensor can be vertically flipped by selecting the check box next to it. By default this control is in off mode.

### 11.1.9 Sharpness Control

The Sharpness values can be changed from a minimum value of 1 to 7 by moving the slider, and the exact changes will be reflected immediately in the preview. This Sharpness control increases clarity of ACC-TK1-CUMI0330CAM. The Default value is 1.

### 11.1.10 Exposure Control

The ACC-TK1-CUMI0330CAM supports both auto and manual exposure control which can be controlled using the **Exposure (Absolute)** slider of the **Image Controls** tab of the ecam\_tk1\_guvcview. To use the manual exposure slide the user must first select the **Manual Mode** from the **Exposure,Auto** drop down list box. The exposure value could be manually changed by moving the slider, and the ACC-TK1-CUMI0330CAM supports exposure values ranging from **100 micro seconds** to **1000 milliseconds** represented from **1 to 10000** in the slider. The exposure values are configured inside the CMOS image sensor based on the sensor configuration and clock configuration details.

To obtain a good low light performance it is essential to change the exposure according to the change in lighting conditions. To support this feature the ACC-TK1-CUMI0330CAM has an auto exposure feature, by which the exposure of the camera will be changed according to the lighting conditions giving the best low light performance. To select this auto exposure control the user has to select the checkbox.

The exposure value applied in the sensor in milliseconds is 1/10 of the value shown in the slider.

**Table 3: Exposure range**

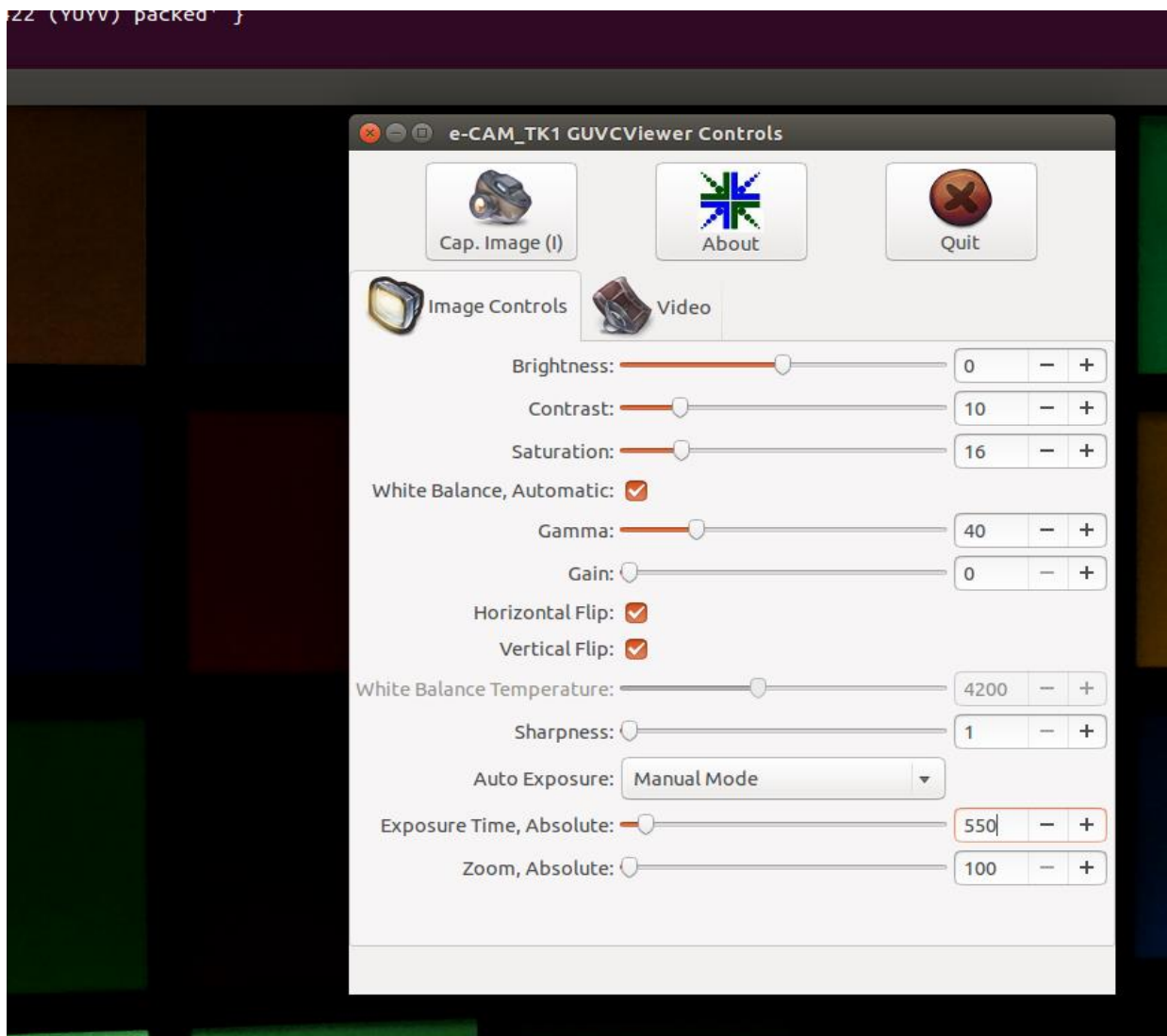
SLIDER VALUE	EXPOSURE TIME
1	0.1 milliseconds
2	0.2 milliseconds
3	0.3 milliseconds
.	.
.	.
10	1 milliseconds
11	11 milliseconds
12	12 milliseconds



.	.
.	.
<b>100</b>	10 milliseconds
.	.
.	.
<b>1000</b>	100 millisecond
.	.
.	.
<b>10000</b>	1000 milliseconds

**Note:** When the exposure time period is more than the time period of camera frame, frame rate will drop.

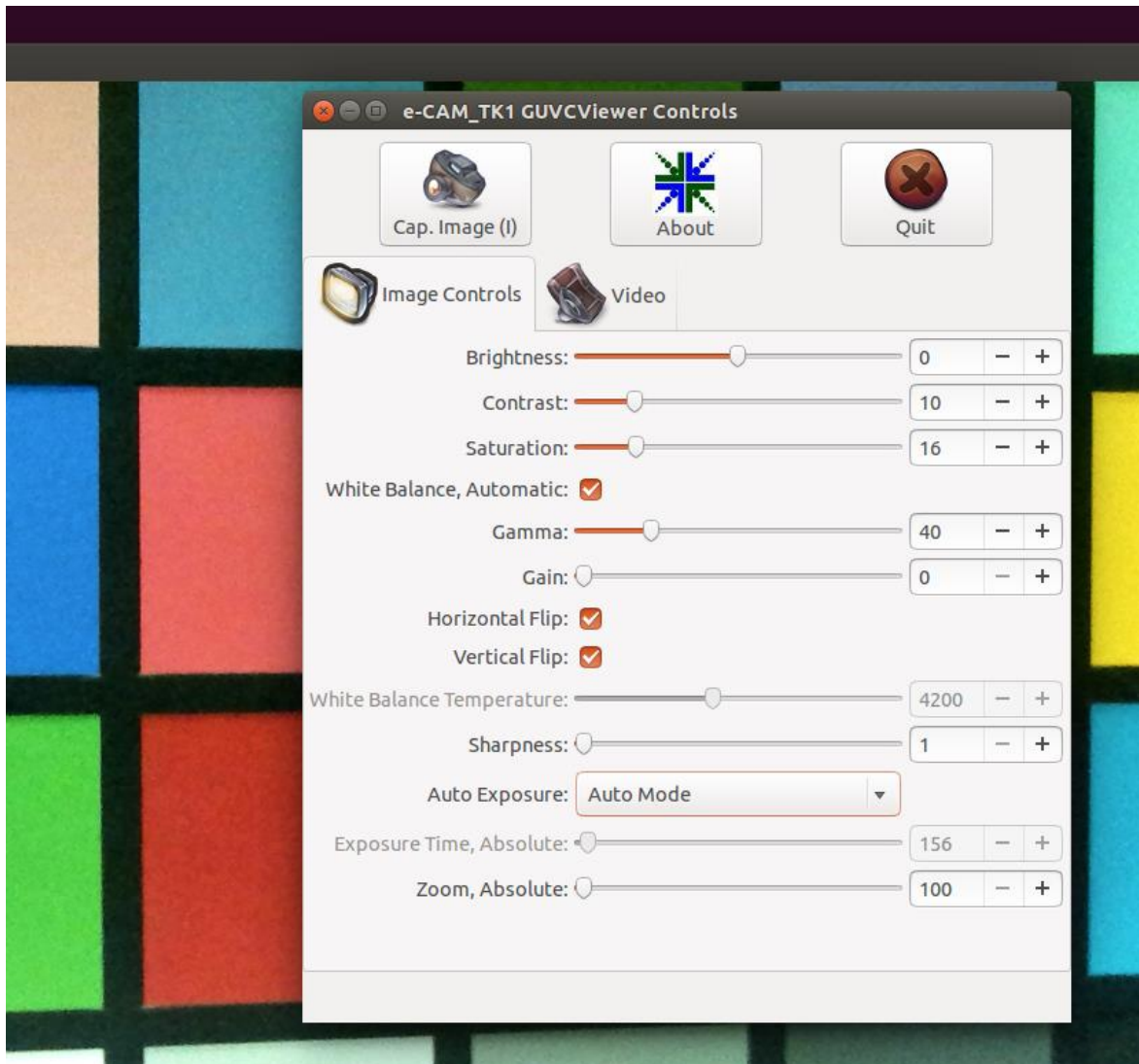




**Figure 12: Changing Manual Exposure**

**Note:** Controls are global across all resolutions and formats, and hence changing the control values will reflect the changes in both the formats and resolutions.





**Figure 13: Selecting Auto Exposure Control**

### 11.1.11 Zoom Control

The preview from the sensor can be zoomed in by changing the slider next to it. The default value of this control is 100.

## 11.2 Video and Files Tab

On selecting Video and Files Tab, video renderer properties will be displayed. The user can adjust the video preview settings in the Menu tab. This tab will have device selection list, frame rate control, resolution control color space control and image capture controls.



When user clicks on Device sub menu in Video and Files Tab all the video devices connected to the ESOMTK1 will be enumerated and listed out.

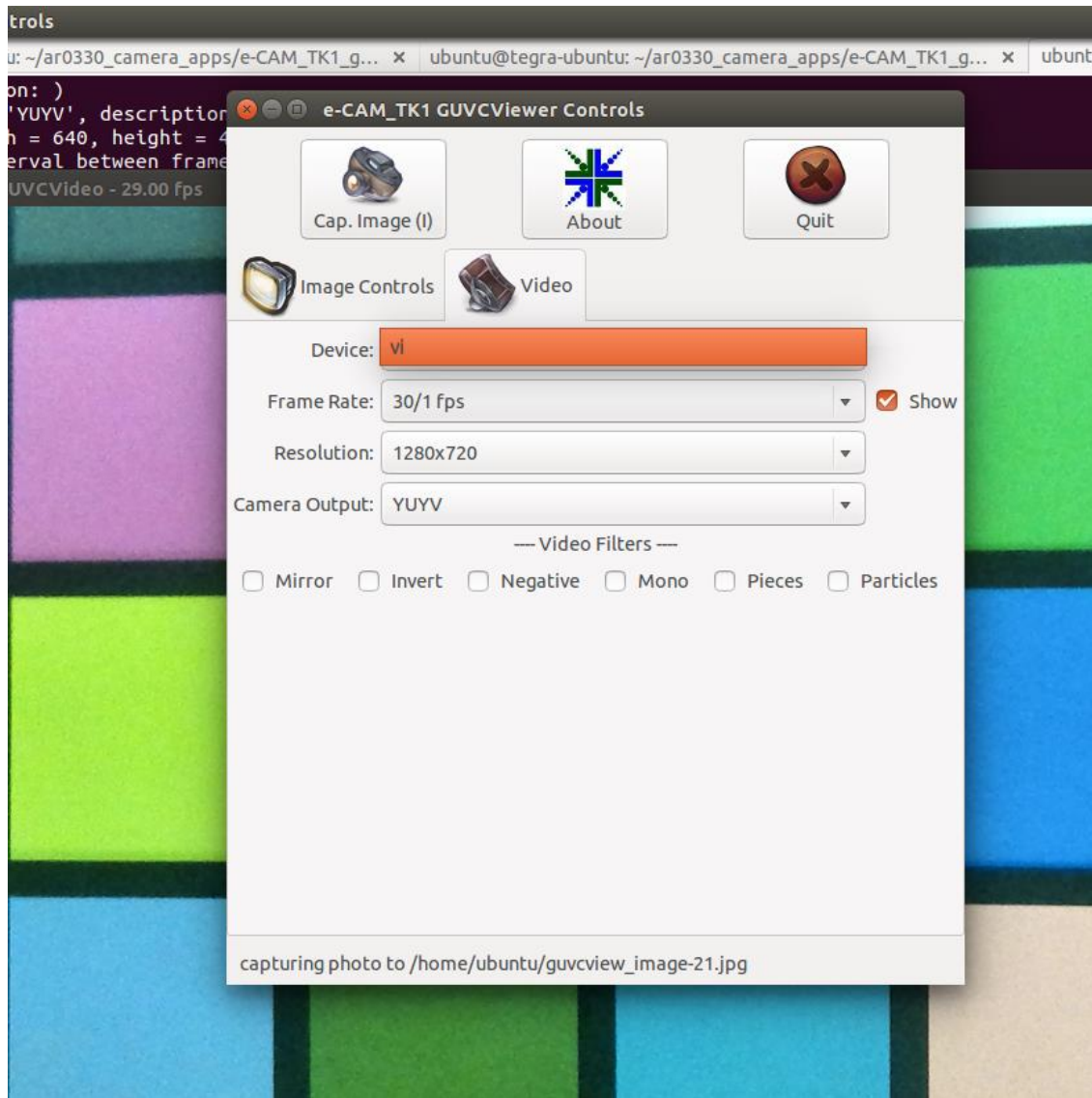


Figure 14: Enumerated Device List

### 11.2.1 Video Capture Properties

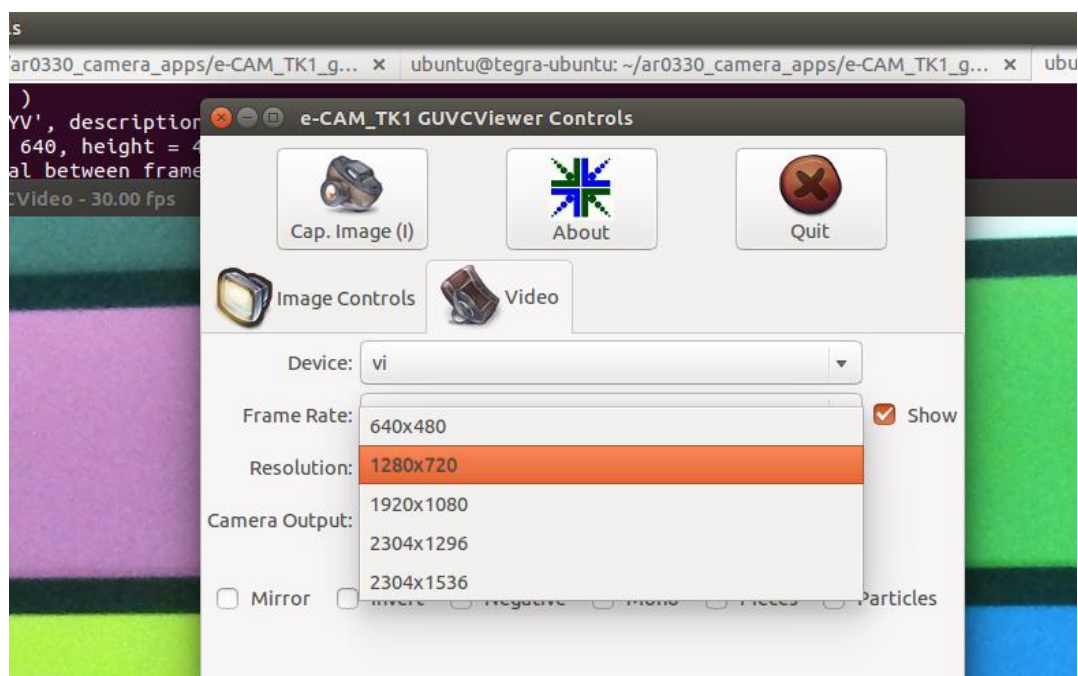
The user can configure the output size (Resolution) of stream format. The available output size and color spaces will be listed in the combo box.

Currently ACC-TK1-CUMI0330CAM supports **YUYV** and **MJPEG** format and in each format five resolutions are supported.



**Table 4: Supported resolutions, formats and frame rates**

Format	Resolution	Frame rate
YUYV	3.4 MP	30
	3 MP	30
	Full HD	30
	HD	30
	VGA	30
MJPG	3.4 MP	8
	3 MP	9
	Full HD	13
	HD	22
	VGA	30

**Figure 15: Supported video resolutions in Video tab page**

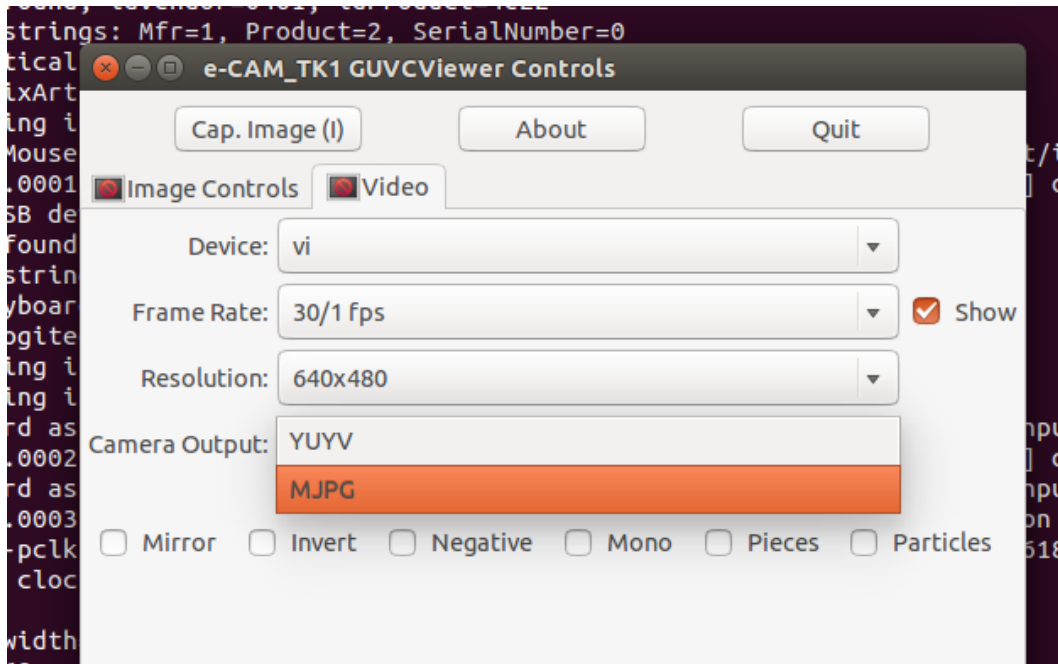


Figure 16: Supported video formats in Video tab page

### 11.2.2 Frame Rate

Frame rate of the preview can be viewed by selecting the 'show' check button in the Video & Files Tab. After selecting Show button, frame will be displayed in the top of the preview window. Frame rate will be affected by various environmental parameters.

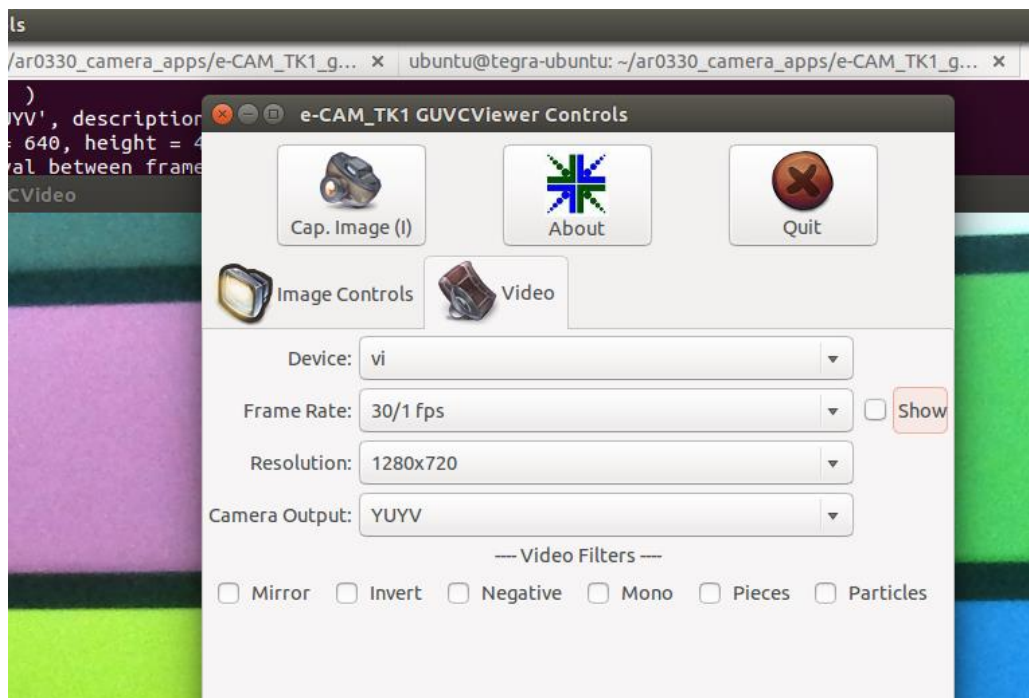
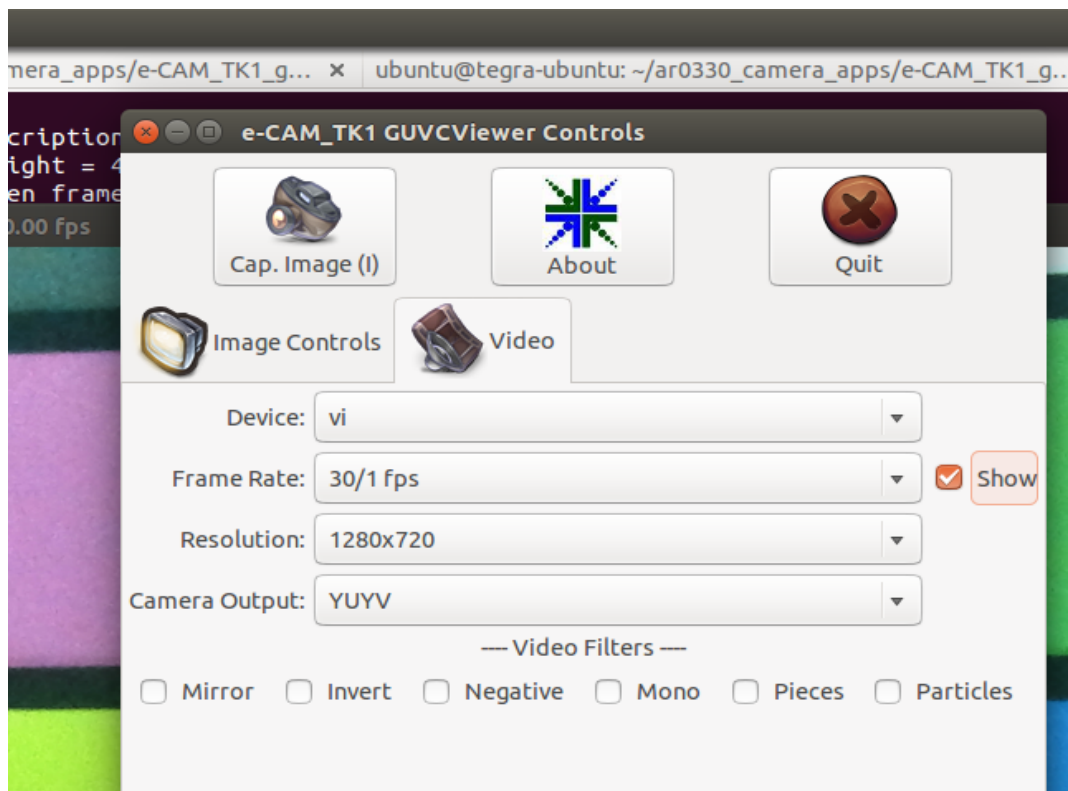


Figure 17: Select Show to display frame rate







**Figure 18: Display of frame rate in the preview window**

### 11.2.3 Capture Menu

The user can capture still image from the selected device in the Device Menu.

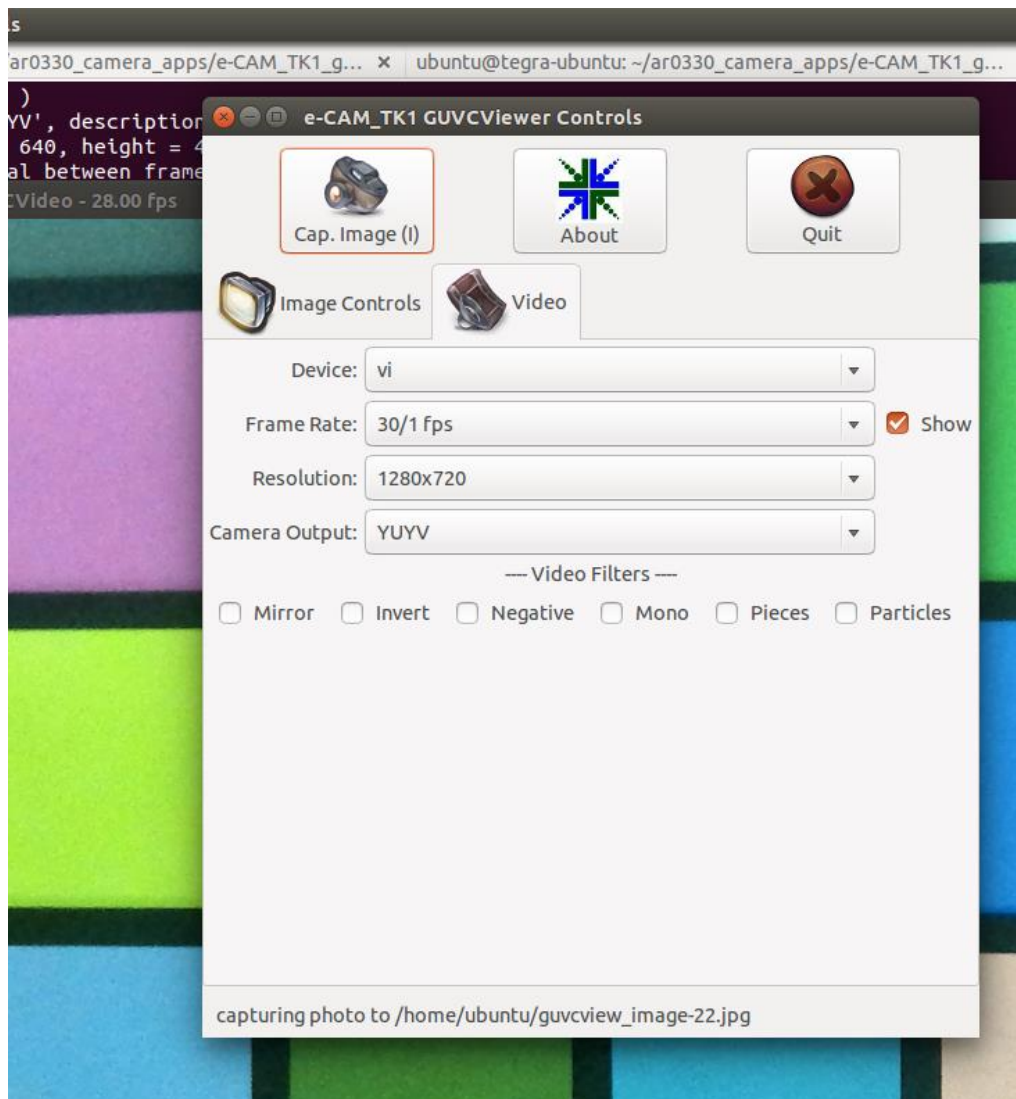
#### 11.2.3.1 Still Image Capture

The user can capture the still image by selecting Cap.Image button in the top of the control panel. The image will be saved in the home directory of the current user by default. The user can configure the folder where in to save the images. The default name for captured image file is guvcview\_image.jpg

**Figure 19: Capture still image**







**Figure 19: Capture still image**

**Note:**

To take an image of another resolution the user must first switch the preview to that resolution. Unlike Windows the Linux kernel does not support cross resolution images.

### 11.2.3.2 Still File Path

The user can set up the folder where the captured images will be saved using Photo -> File. This will open a save file dialog box. Here the user can select the file format for saving the image capture. The user can also browse to the required directory and set the file name so that in future, images captured will be saved in that folder.



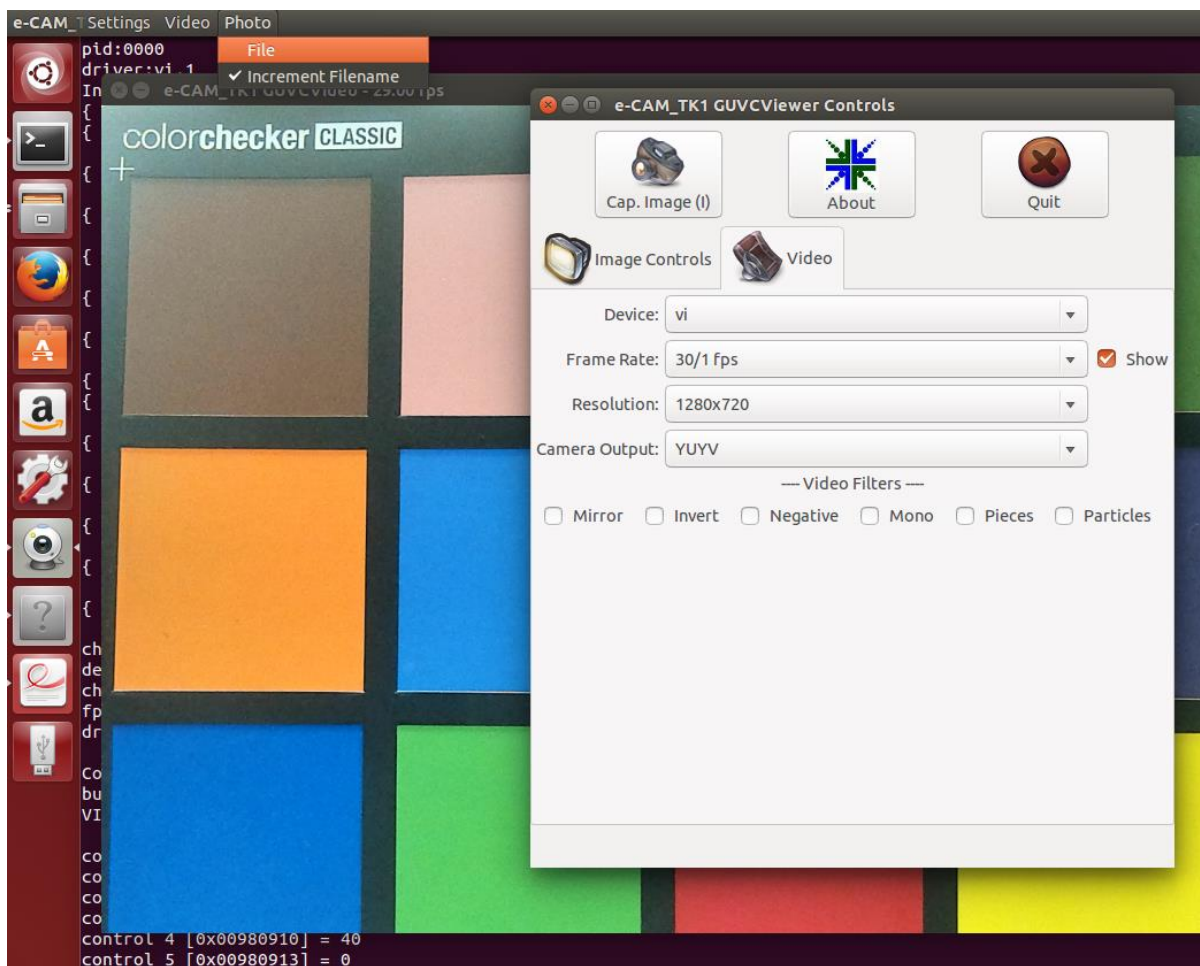


Figure 20: Save file dialog to set the Still Image Folder

## 11.3 Other options

### 11.3.1 About

The About button can be used to view the details of the ecam\_tk1\_guvview application and its current version.



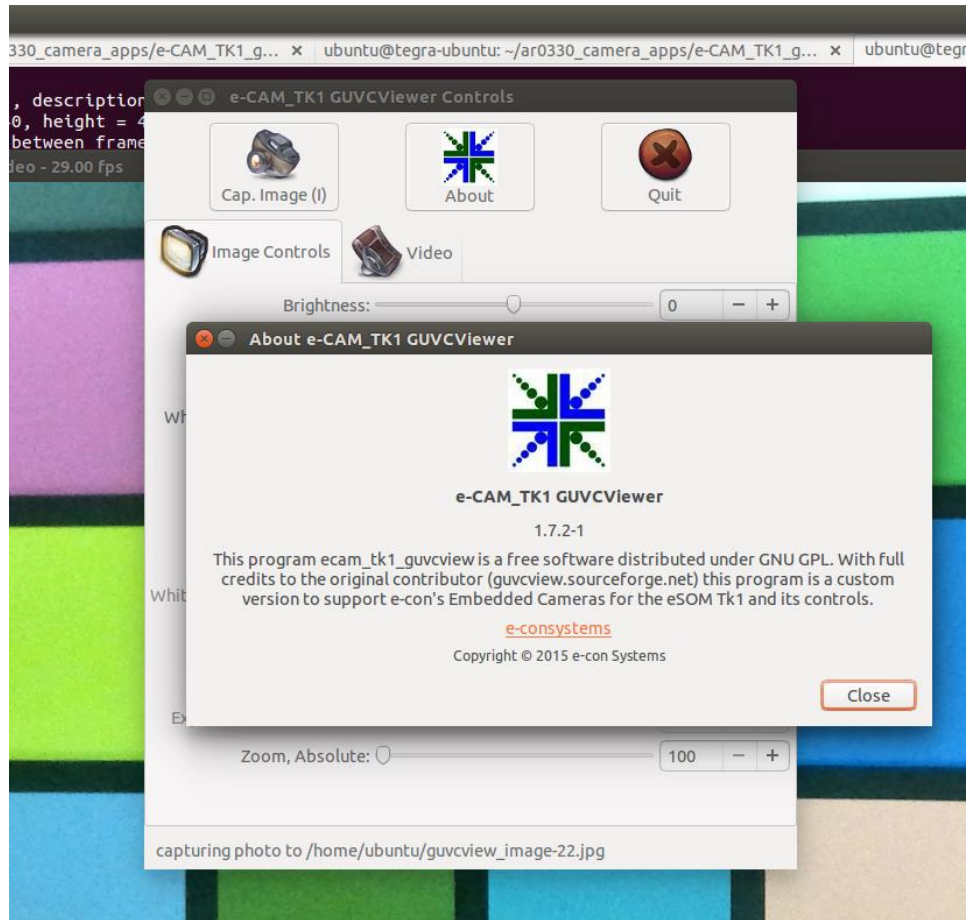


Figure 21: About dialog box

## 12 Known issues and Limitation

1. This ecamTk1\_guvview Application is tested in L4T\_R21.4 (armhf 32 bit) Linux Distribution only.
2. Audio and Video Recording does not work and is disabled.
3. Increasing virtual memory is required If this error occurs.

vmap allocation for size <.....> failed: use vmalloc=<size> to increase size.

vmalloc: allocation failure: <.....> bytes

4. Application may crash on using two instances of this application to stream two cameras at same time

## 13 Conclusion

This document describes how to connect ACC-TK1-CUMI0330CAM Camera board to Propus Board and various features and options available in ecamTk1\_guvview application. For more information, please contact [sales@e-consystems.com](mailto:sales@e-consystems.com)

