The R-Car ADAS View Solution manual

OEM Ethernet Proof of Concept (PoC) Project. Design and Performance Evaluation Report

1. Contacts

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2. Initial setup of H3/M3 board

For initial setup of H3 or M3 use instruction from the https://elinux.org/R-Car/Boards/H3SK https://elinux.org/R-Car/Boards/M3SK. To build root filesystem with ADAS applications support see the http://elinux.org/R-Car/Boards/ADAS-View-Solution-Kit

3. SurroundView start settings and updating parts

Note that you need to sync SD card after any changings: “sync” command.

Use vi to edit files on board or mount SD card to the host PC/laptop

As an example, assumed that working directory of SurroundView with necessary resources is **/home/root/sv**

3.1 Building

See the https://github.com/CogentEmbedded/sv-utest#build for building instructions.

3.2 Options/parameters of the SurroundView application

Full list of the options (the main options are highlighted):

Usage: sv-utest [options]

Available options:

-d|--debug - set debug level 0-6
-f|--format - video format, must be first in command line (available options: uyvy, nv12,i420)
-i|--iface - for MJPEG cameras only, network interface
-m|--mac - for MJPEG cameras only, cameras MAC list: mac1,mac2,mac3,mac4
where mac is in form AA:BB:CC:DD:EE:FF
-v|--vin - V4L2 camera devices list: cam1,cam2,cam3,cam4
where cam is in form /dev/videoX
-c|--cfg - playback tracks configuration to load
-o|--output - desired Weston display output number 0, 1,.., N
-w|--js - joystick device name
-h|--help - this help
-V|--version - print version
--view - orientation of window 0 - portrait, 1 - landscape
--resolution - window size as WidthxHeight
--camres - camera output size as WIDTHxHEIGHT, default is 1280x800

Auxiliary calibration options:

--intrinsicframes <mask1>,<mask2>,<mask3>,<mask4> - specify comma-separated

list of file masks which can be loaded in calibration UI
in place of grabbed frames

--extrinsicframes <mask>,<mask2>,<mask3>,<mask4> - specify file masks
which can be loaded in extrinsic calibration UI
in place of grabbed frames

--intrinsicoutput <directory> - specify directory where grabbed
intrinsic calibration frames are stored
with camera%d_frame%d.png file names

--extrinsicoutput <directory> - specify directory where grabbed
extrinsic calibration frames are stored
with extrinsic_frame%d.png file names

Calibration options:

--intrinsics-cell-width <value> - width of the cell on the chess pattern board in mm, default 50

--intrinsics-cell-height <value> - height of the cell on the chess pattern board in mm, default 50

--intrinsics-board-width <value> - width of the chess pattern board in terms of cross between cells, default 9

--intrinsics-board-height <value> - height of the chess pattern board in terms of cross between cells, default 6

--intrinsics-grab-interval <value> - time interval between frame capture attempts
in timer mode in seconds, default 10 seconds

--intrinsics-num-frames <value> - number of frames to grab for intrinsics calculation,
default 15 frames

--extrinsics-num-circles <value> - number of circles on pattern (2 or 3), default 3

--extrinsics-circles-param <value> - circles pattern parameter: radius for 2-circles pattern, length between circles centers for 3-circles pattern, default 55 mm

3.3 Camera order/changing intrinsics

The camera named in Linux in the next order:

CN4 -- /dev/video0, CN5 -- /dev/video1, CN6 -- /dev/video2, CN7 -- /dev/video3

It will be 3, 2, 1, 4 facra connectors if you look at the camera board from the connectors side (point of view).

The meaning of the cameras in SurroundView:

/dev/video0 (CN4) – right mirror camera

/dev/video1 (CN5) – left mirror camera

/dev/video2 (CN6) – front camera

/dev/video3 (CN7) – rear camera

Intrinsics are stored in the /home/root/sv/calib directory, their name are:

_dev_video0.yaml – right camera

_dev_video1.yaml – left camera

_dev_video2.yaml – front camera

_dev_video3.yaml – rear camera

Each camera has a respective “map” file, which is stored in /home/root/sv:

_dev_video0.map, _dev_video1.map, _dev_video2.map, _dev_video3.map

To change intrinsic, do the following steps:

1) Take the camera intrinsic file (i.e. 5101.yaml for camera numbered 5101)
2) Copy the intrinsic file to the appropriate file on the SD card, i.e. if you changing intrinsics for the front camera:

   cp 5101.yaml <mountpoint>/home/root/sv/calib/_dev_video2.yaml

   Then just remove old map file (it will be regenerated at the start of SurroundView):

   rm <mountpoint>/home/root/sv/_dev_video2.map

3.4 Changing car model

The car model are stored in SurroundView home directory as two files:

/home/root/sv/Car.obj and /home/root/sv/Car.mtl .

To change car model just copy your files (object and material) to this files:

cp NewCar.obj /home/root/sv/Car.obj

cp NewCar.mtl /home/root/sv/Car.mtl

Not that material format parameters order must be the same as in the default SurroundView material file:

<part of the Car.mtl>

newmtl BMW_Glass

Ns 1.4710

Ni 1.5000

d 0.8000

Tr 0.1500

Tf 0.8500 0.8500 0.8500

illum 2

Ka 0.0000 0.0000 0.0000

Kd 0.0766 0.0924 0.0956

Ks 0.1000 0.1000 0.1000

Ke 0.0000 0.0000 0.0000

4. SurroundView intrinsics calibration

First, you need to be sure that the SurroundView is running with your chess board pattern parameters.

Note that the cell dimensions are measured in mm, the board dimensions are measured in number of cross between cells. The default settings are 50 mm cell width and height, board width 9 crossings, height – 6.

1) At the main 3d SurroundView screen press “I” key on keyboard to get to “Intrinsics menu”.
   Here you can see split camera view of 4 cameras. Press “space” to switch in undistorted view.
2) Choose the camera with keys 1,2,3,4 – right, left, front, rear cameras.
3) Then you can choose how to calibrate: in manual mode (key M) or by timer (key T).
4) In Manual mode you need to press Enter to capture frame, in Timer it will be automatically each 10 seconds.
5) Fill the screen of the application with the chess board patterns: the pattern on the screen must be hold without any inclines, fill not less than 1/3 of screen by the height.
6) After necessary number of frames (15) captured you will be able to start calculation by pressing Enter key.
7) After calculation ended you need to save the results with S key.

To go back from the menu, use ESC key. Also, it’s possible to close the application by ESC.

Below you can see an example of proper and invalid chess board positions.

Valid chess board positions

Invalid positions

5. SurroundView extrinsics calibration

Check that the application is running with your pattern parameter **--extrinsics-circles-param.**

This parameter means the distance between circles centres at one pattern in mm. The default value is 55 mm.

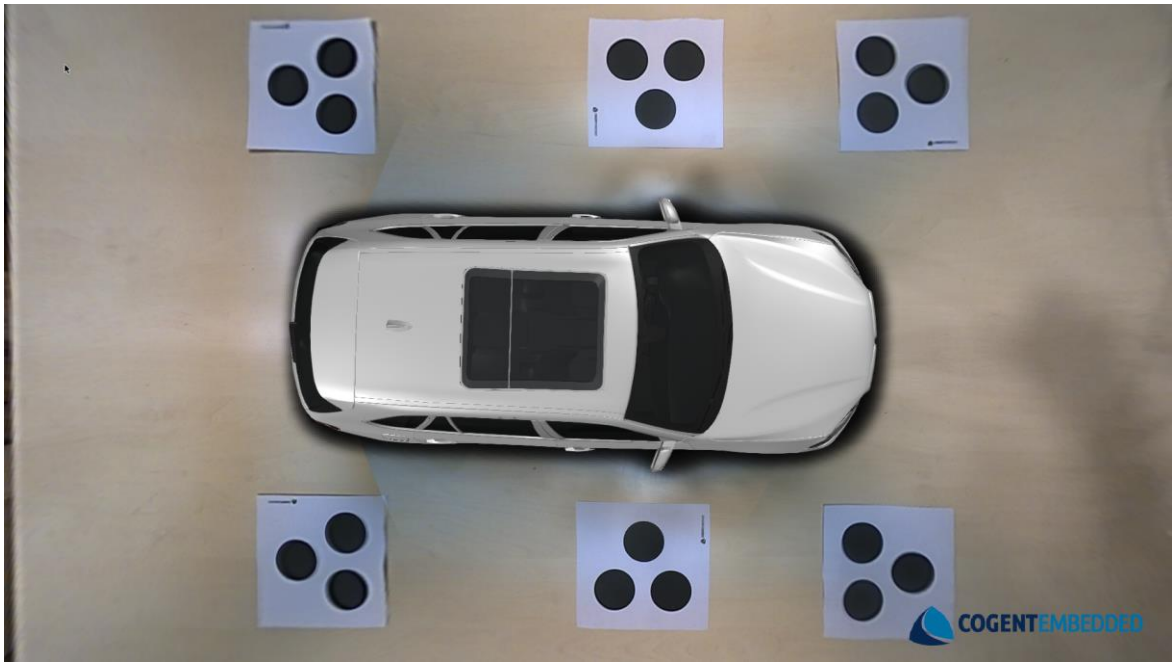
Place the patterns around the car as it's showed on a picture

1) At the main 3d view press "E" key on keyboard to go to "Extrinsics" calibration menu.
2) Each time you are going into this menu, application captures last frame from each camera. These frames are using to calculate extrinsics.
3) To adjust scale of the image, go to the camera menu with the one of the key 1,2,3,4.
4) Be sure that each camera "sees" the circles as it's showed on the picture: right and left camera must see 9 circles without any reflections/light patches, front and rear 6 circles – also without any "noise".

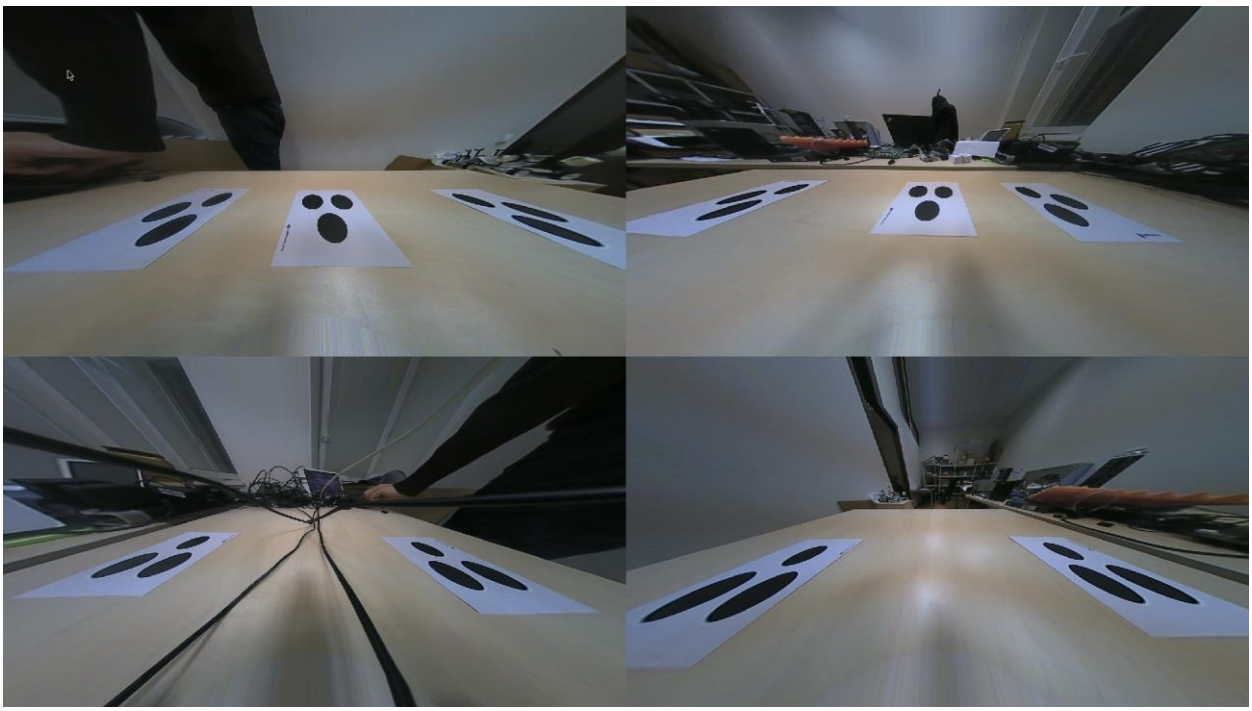
   You can adjust the scale of the image with the left/right arrows on keyboard. After you have adjusted scale, you need to save results with S key.
5) After all cameras positions and scales are set, go back to the main view and then again to the extrinsics menu by E key to recapture frames.
6) Press Enter to start calibration.
7) To succeed application must find all of the circles, after that it starts optimization process.
8) When optimization has been ended, application writes error result. This result represents average offset between the positions on adjacent camera views of one circle that visible on both of them. The bigger result could be caused by not flat surfaces of the circles patterns or bad intrinsics.
9) Go back to the main 3d view with ESC key to see the result.

The extrinsics are stored in the /home/root/sv/extrinsics.yaml .

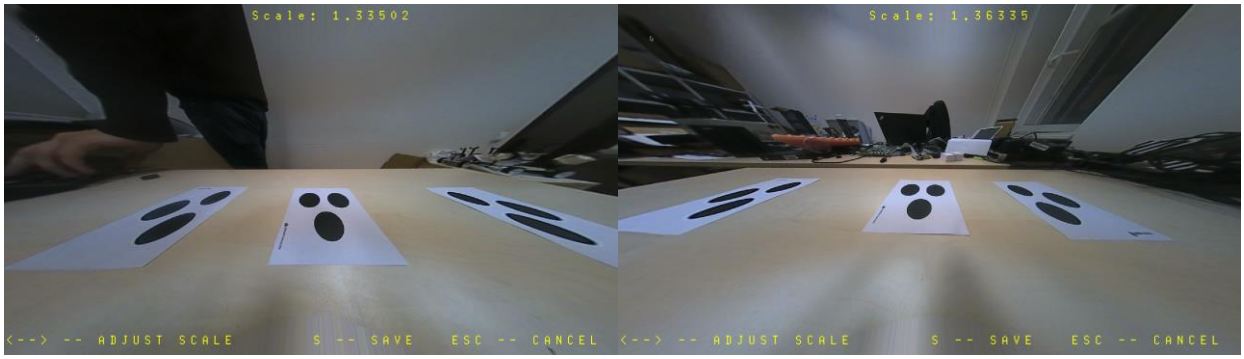
Reference pictures:



Top view. Patterns position.

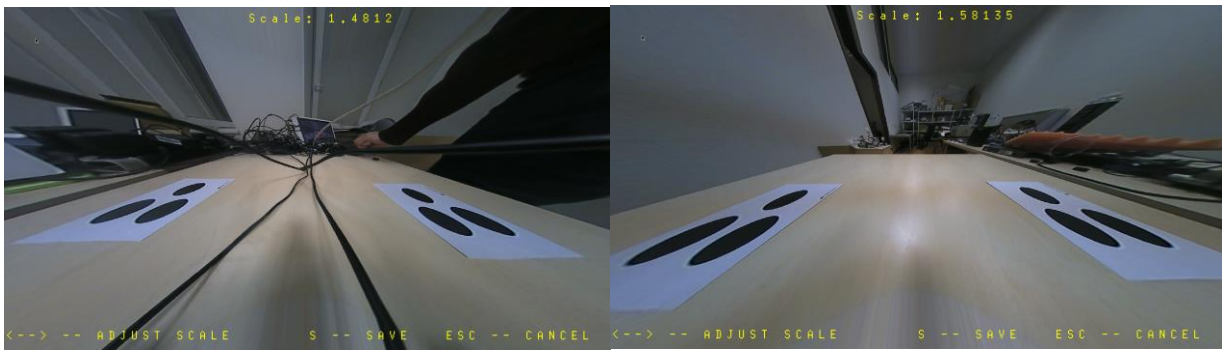


Right, left, front, rear camera views.



Right camera (key 1 in extrinsics menu)

Left camera (key 2 in extrinsics menu)



Front camera (key 3 in extrinsics menu)

Rear camera (key 4 in extrinsics menu)

6. SurroundView sphere adjusting

After extrinsic calibration succeeded you may need to fix sphere view. The fastest way to do that is to press keys **F10** – auto zoom sphere by car width or **F11** – auto zoom sphere by car length. The result will be the same for a car if it has proper Car.obj -- the difference will be only if model car dimensions ratio (width/height) is different from the actual car (camera position). Press **F12** key to centre a car properly.

If you are not satisfied by the result, you can use **F8** to adjust car position with left/right arrows, **F9** to change zoom with the arrows.

Also, you can adjust cameras zones overlapping by pressing **F7** and changing the overlap width with the arrows.

It's possible to remove the artefacts on the sphere, related with the appearance of the objects in the camera bottom view like bumpers/wheels. Press **F1, F2, F3** or **F4** to choose camera, then **F5,** then use arrows left to cut off bottom of the choosed camera view **,** right – to add more view on the bottom.

At the end, you must save the result with **S** key.

The sphere settings are stored in /home/root/sv/config.yaml

7. Known issues, what to do in case of errors.

7.1 SurroundView doesn't start

1) You need to check that cameras are booted properly, use next commands:

dmesg | grep ov

You must see 4 lines like that (note the resolution):

[7.185587] ov106xx 4-0060: ov490/ov10640 Product ID 4 Manufacturer ID 90, rev 1b, res 1280x800, OTP_ID 5c:40:00:43:f6:00

[7.257830] ov106xx 4-0061: ov490/ov10640 Product ID 4 Manufacturer ID 90, rev 1b, res 1280x800, OTP_ID 18:44:00:43:f5:00

[7.330031] ov106xx 4-0062: ov490/ov10640 Product ID 4 Manufacturer ID 90, rev 1b, res 1280x800, OTP_ID 28:28:00:43:f8:00

[7.401685] ov106xx 4-0063: ov490/ov10640 Product ID 4 Manufacturer ID 90, rev 1b, res 1280x800, OTP_ID 20:4c:00:43:f8:00

If not, then power off/power on the camera board and the H3 board.

2) If you are sure that cameras are ok, provide surroundview log

7.2 SurroundView extrinsics calibration errors

If you can't calibrate extrinsics and you don't have idea what is wrong, take the pictures of the camera position and send them to technical support. You need to do next steps for that:

1) Go to the extrinsics menu (with E key) and take the screenshot of Weston with the "WinKey + S": screenshot will appear in /wayland-screenshot.png file (not the "/" – it's in the root directory, yes). Copy screenshot to some file, i.e.:

   cp /wayland-screenshot.png /home/root/extrinsics.png

2) Go to intrinsics menu (I key), press space to see undistortion view, then take screenshot again with "WinKey + S", it will appear in the same /wayland-screenshot.png file.

   Copy file: cp /wayland-screenshot.png /home/root/undistortion.png

3) Sync the SD card with "sync" command ad provide the png files to support team.