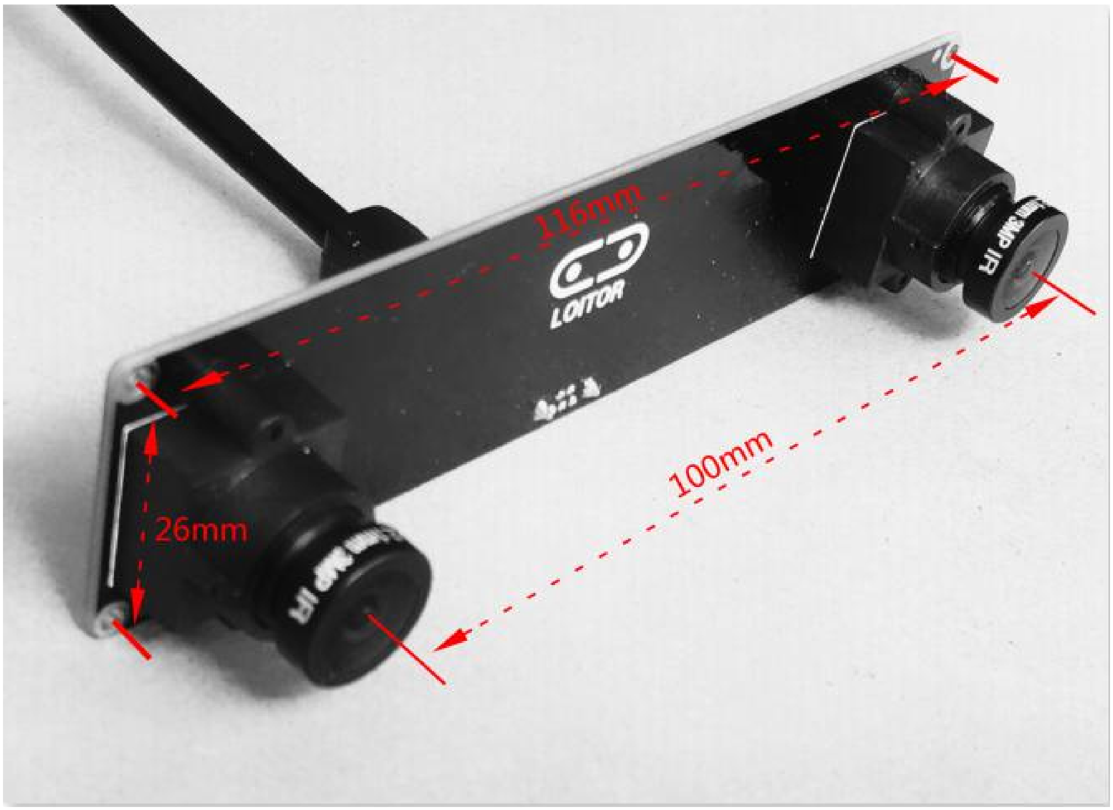
LOITOR Visual-Inertial Camera

Instruction manual V0.6

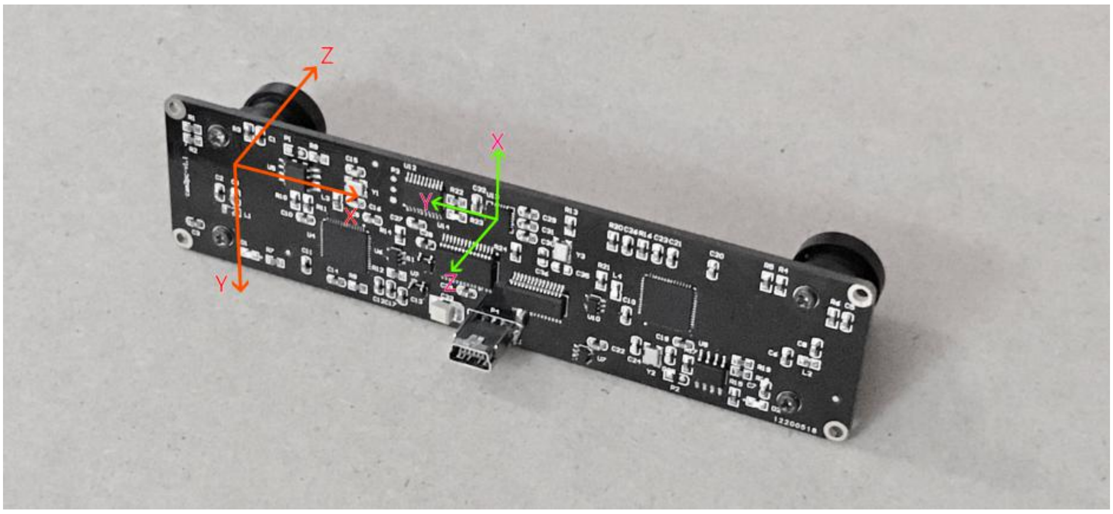
Loitor Visual Inertial Camera is a general vision sensor designed for visual algorithm developers. Providing abundant hardware control interface and data interface aimed to reduce development threshold with reliable image and inertial data.

1. Hardware Specifications

1.1 Physical Dimensions



1.2 Camera Coordinate System between Left camera and IMU

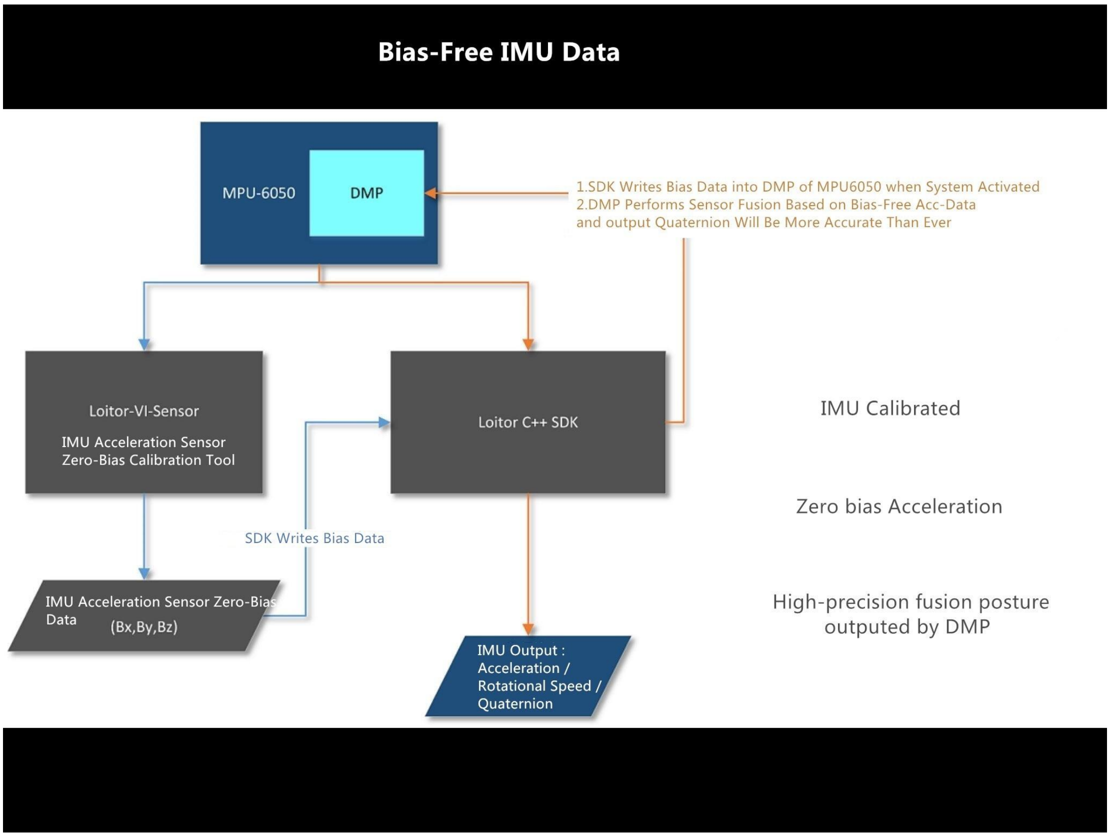


1.3 Hardware Performance and Specifications

	CMOS	IMU
Type	MT9V034	MPV-6050
Exposure Mode	Global shutter	-
Controller IC	CY68013	STM-32
FPS	24-65fps	200fps
Supported Resolution	320*240/640*480/752*480	-
Firmware Update	Firmware Update Supported By Windows Software	-
Baseline	10cm	-
Lens physical interface	M12 Lens interface	-
Lens Specifications	2.1mm/150º+6mm/60º	-
Data interface	Usb 2.0	
Data Delay	(1/Current_FPS)s	100us
Frame Synchronization	Stereo Synchronization Triggered By Camera Driver	-

2. Product Feature

2.1 IMU zero bias calibration program, Zero bias initialization algorithm of DMP, High precision 6-DOF data, Minimum attitude drift.



Bias-Free IMU Data

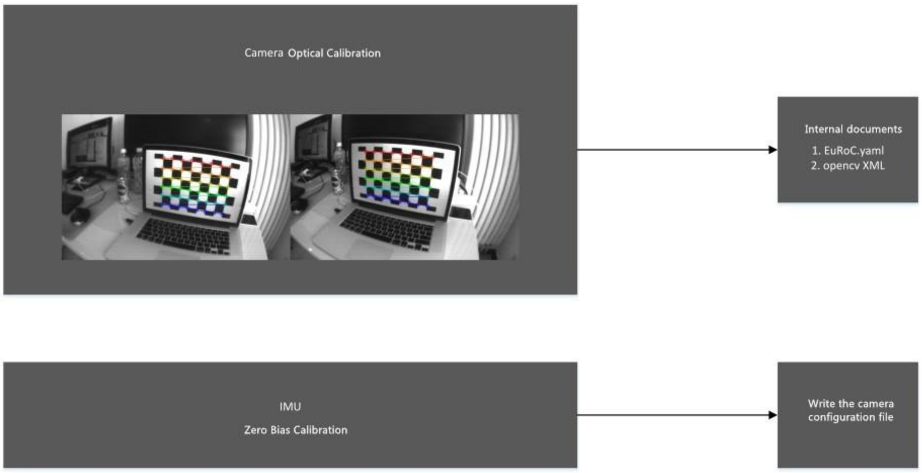
MPU-6050
DMP
1.SDK Writes Bias Data into DMP of MPU6050 when System Activated
2.DMP Performs Sensor Fusion Based on Bias-Free Acc-Data
and output Quaternion Will Be More Accurate Than Ever
Loitor-VI-Sensor
IMU Acceleration Sensor
Zero-Bias Calibration Tool
Loitor C++ SDK
SDK Writes Bias Data
IMU Acceleration Sensor Zero-Bias
Data (Bx,By,Bz)
IMU Output :
Acceleration /
Rotational Speed /
Quaternion

IMU Calibrated

Zero bias Acceleration

High-precision fusion posture
outputed by DMP

2.2 Stereo optical parameters already accurately calibrated



2.3 The lens seat rifled through special processing, to ensure the camera would not loosen in the long-term delivery and the lens can be replaced.

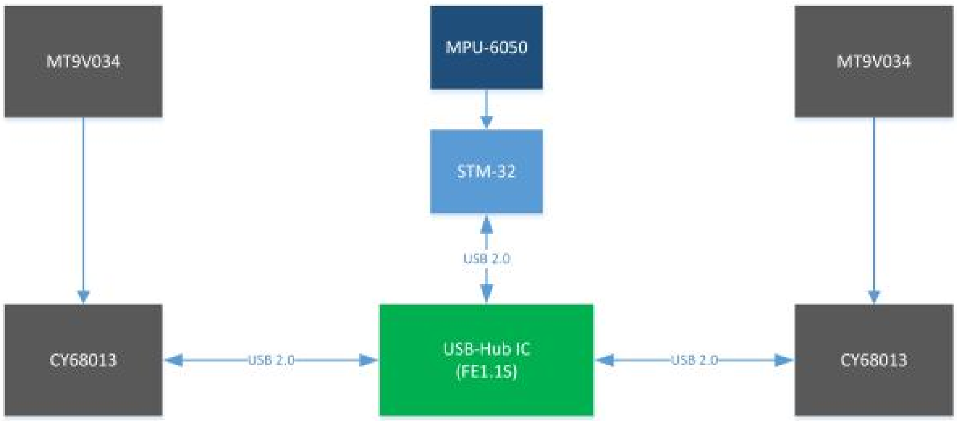
2.4 SDK needs no compilation, no special dependency libraries(only relay on libusb)

2.5 stable and reliable ROS driver

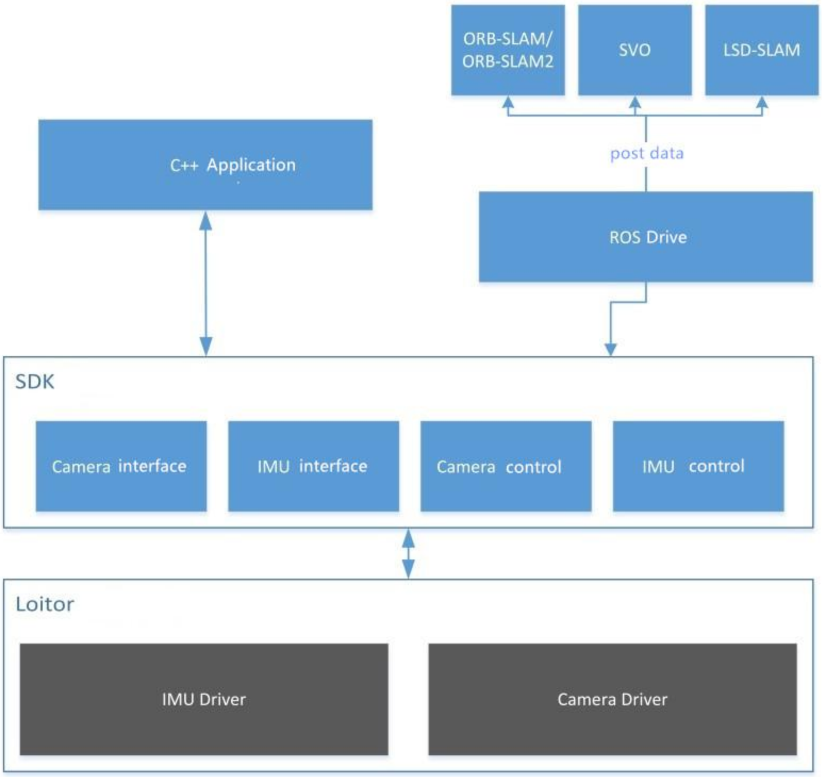
2.6 Ubuntu 16/14 supported

3. Hardware&Software Architecture

3.1 Hardware Architecture

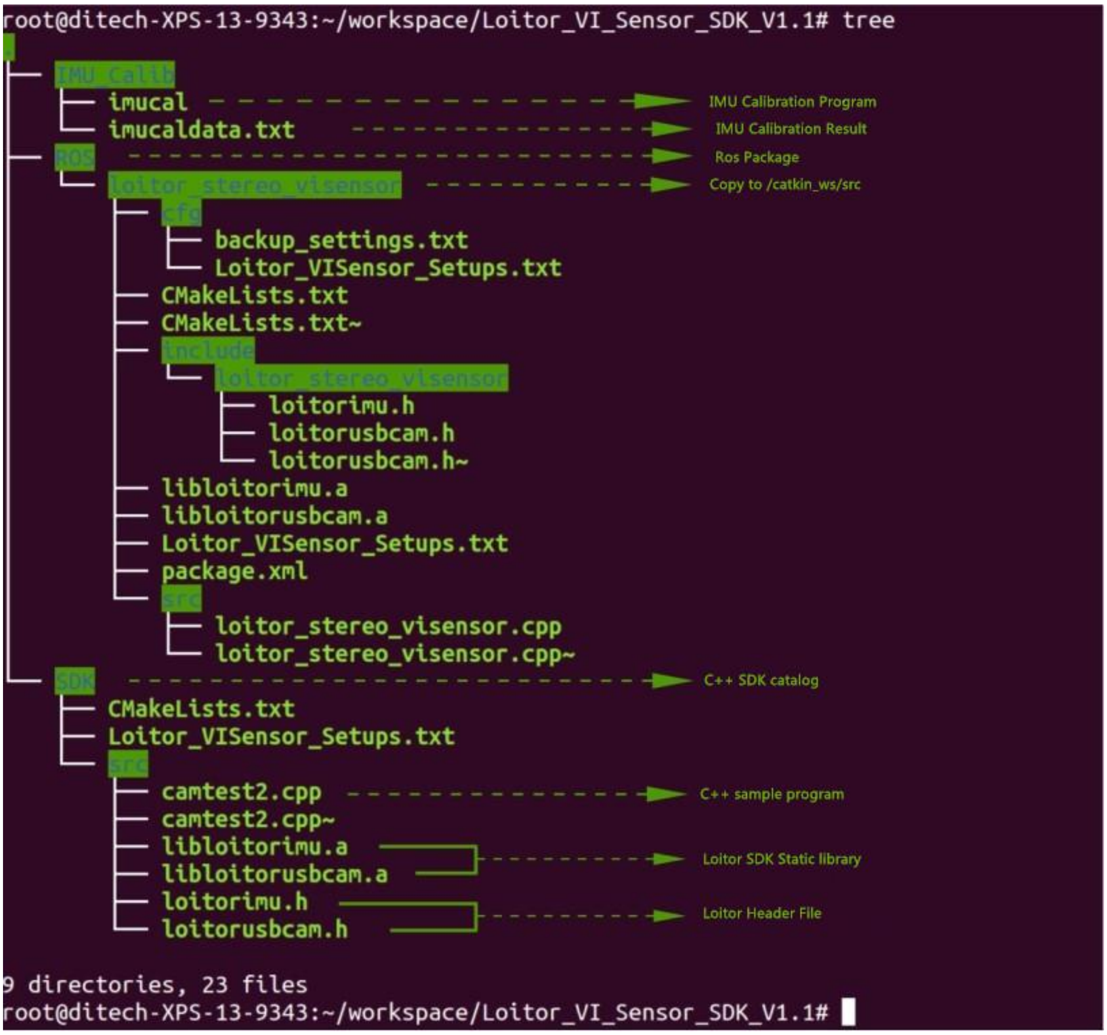


3.2 SDK Architecture



4. SDK directory structure and Demo compilation step by step

4.1 SDK directory structure



```
root@ditech-XPS-13-9343:~/workspace/Loitor_VI_Sensor_SDK_V1.1# tree
.
├── IMU_Calib
│   ├── imucal
│   └── imucaldata.txt
├── ROS
│   └── loitor_stereo_visensor
│       ├── cfg
│       │   ├── backup_settings.txt
│       │   └── Loitor_VISensor_Setups.txt
│       ├── CMakeLists.txt
│       ├── CMakeLists.txt~
│       ├── include
│       │   └── loitor_stereo_visensor
│       │       ├── loitorimu.h
│       │       ├── loitorusbcam.h
│       │       └── loitorusbcam.h~
│       ├── libloitorimu.a
│       ├── libloitorusbcam.a
│       ├── Loitor_VISensor_Setups.txt
│       ├── package.xml
│       └── src
│           ├── loitor_stereo_visensor.cpp
│           └── loitor_stereo_visensor.cpp~
└── SDK
    ├── CMakeLists.txt
    ├── Loitor_VISensor_Setups.txt
    └── src
        ├── camtest2.cpp
        ├── camtest2.cpp~
        ├── libloitorimu.a
        ├── libloitorusbcam.a
        ├── loitorimu.h
        └── loitorusbcam.h

9 directories, 23 files
root@ditech-XPS-13-9343:~/workspace/Loitor_VI_Sensor_SDK_V1.1#
```

4.2 C++ sample program compilation

This program is the minimum demonstration of Loitor SDK, please make sure OPENCV has been successfully installed on your computer.

If not installed, the latest version of OPENCV can be downloaded in official website.

1.choose your work space, such as /home/workspace/

2.Copy /Loitor_VI_Sensor_SDK_V1.1/SDK to /home/workspace/

3.start command line, enter the ROOT

```
cudo -s
```

4.Enter SDK catalog

```
cd/home/workspace/Loitor_VI_Sensor_SDK_V1.1/SDK
```

5.Execute CMake

```
cmake .
```

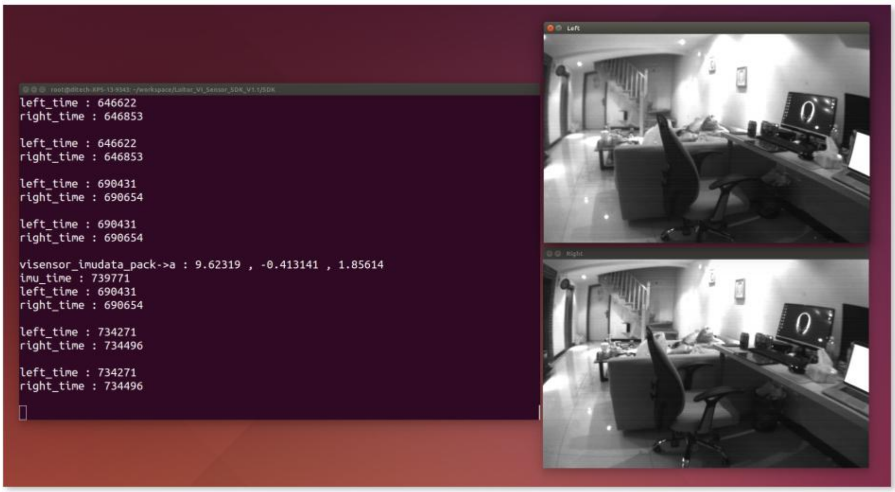
6. Compile the sample program

```
make
```

7. Execute Demo program

```
./camtest2
```

8. Applications results



root@ditech-XPS-13-9343: ~/workspace/Loitor_VI_Sensor_SDK_V1.1/SDK
Left
Right

```
left_time : 646622
right_time : 646853

left_time : 646622
right_time : 646853

left_time : 690431
right_time : 690654

left_time : 690431
right_time : 690654

visensor_imudata_pack->a : 9.62319 , -0.413141 , 1.85614
imu_time : 739771
left_time : 690431
right_time : 690654

left_time : 734271
right_time : 734496

left_time : 734271
right_time : 734496
```

9. If program failed, please see 11.1 for solution.

4.3 ROS Package

~~ROS Package~~ this Package rely on

cv_bridge

image_transport

opencv2

roscpp

rospy

sensor_msgs

std_msgs

1. find your catkin workspace and enter /src catalog

```
cd/home/workspace/catkin_ws/src
```

2. Copy /Loitor_VI_Sensor_SDK_V1.1/ROS/loitor_stereo_visensor to catkin_ws/src

3. Enter catkin workspace

```
cd/home/workspace/catkin_ws
```

4.Compile

```
catkin_make
```

5.If compilation successful, the ROS Node can run normally; Otherwise you need to check whether Loitor ROS Package has been successfully installed in ROS system.

4.4 ROS Package:How to start

1.Before running, update the ROS environment variables

```
Source/devel/setup.bash
```

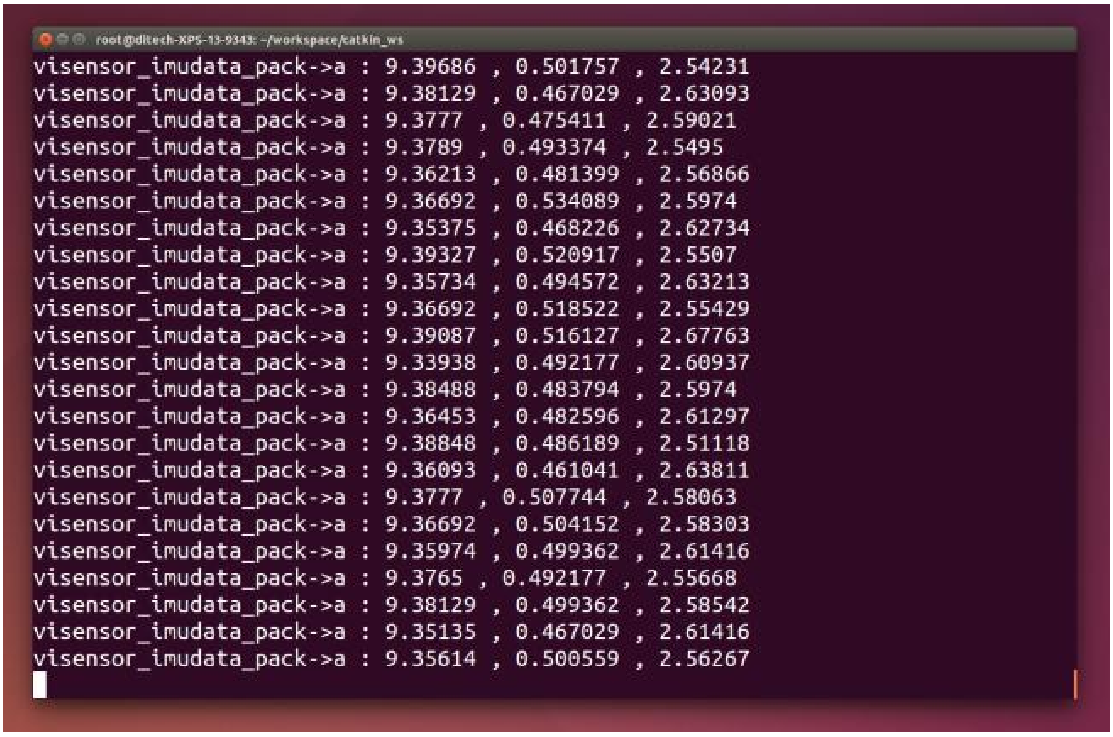
2.Once step 4.3 is successful, you can start the ROS node, the command is:

```
Rosrun loitor_stereo_visensor loitor_stereo_visensor
SETTINGS_FILE_PATH
```

You need replace SETTINGS_FILE_PATH with the actual path of "Loitor_VISensor_Setups.txt", such as:

/home/di-tech/workspace/Loitor_VI_Sensor_SDK_V1.1/SDK/Loitor_VISensor_Setups.txt

3.expected output:



```
visensor_imudata_pack->a : 9.39686 , 0.501757 , 2.54231
visensor_imudata_pack->a : 9.38129 , 0.467029 , 2.63093
visensor_imudata_pack->a : 9.3777 , 0.475411 , 2.59021
visensor_imudata_pack->a : 9.3789 , 0.493374 , 2.5495
visensor_imudata_pack->a : 9.36213 , 0.481399 , 2.56866
visensor_imudata_pack->a : 9.36692 , 0.534089 , 2.5974
visensor_imudata_pack->a : 9.35375 , 0.468226 , 2.62734
visensor_imudata_pack->a : 9.39327 , 0.520917 , 2.5507
visensor_imudata_pack->a : 9.35734 , 0.494572 , 2.63213
visensor_imudata_pack->a : 9.36692 , 0.518522 , 2.55429
visensor_imudata_pack->a : 9.39087 , 0.516127 , 2.67763
visensor_imudata_pack->a : 9.33938 , 0.492177 , 2.60937
visensor_imudata_pack->a : 9.38488 , 0.483794 , 2.5974
visensor_imudata_pack->a : 9.36453 , 0.482596 , 2.61297
visensor_imudata_pack->a : 9.38848 , 0.486189 , 2.51118
visensor_imudata_pack->a : 9.36093 , 0.461041 , 2.63811
visensor_imudata_pack->a : 9.3777 , 0.507744 , 2.58063
visensor_imudata_pack->a : 9.36692 , 0.504152 , 2.58303
visensor_imudata_pack->a : 9.35974 , 0.499362 , 2.61416
visensor_imudata_pack->a : 9.3765 , 0.492177 , 2.55668
visensor_imudata_pack->a : 9.38129 , 0.499362 , 2.58542
visensor_imudata_pack->a : 9.35135 , 0.467029 , 2.61416
visensor_imudata_pack->a : 9.35614 , 0.500559 , 2.56267
```

4. If your ROS operation permission is not the root but the average user, it may lead to the problem that ROS driver quit automatically. You can solve the problem following 11.1.

4.5 Get the Timestamp Data

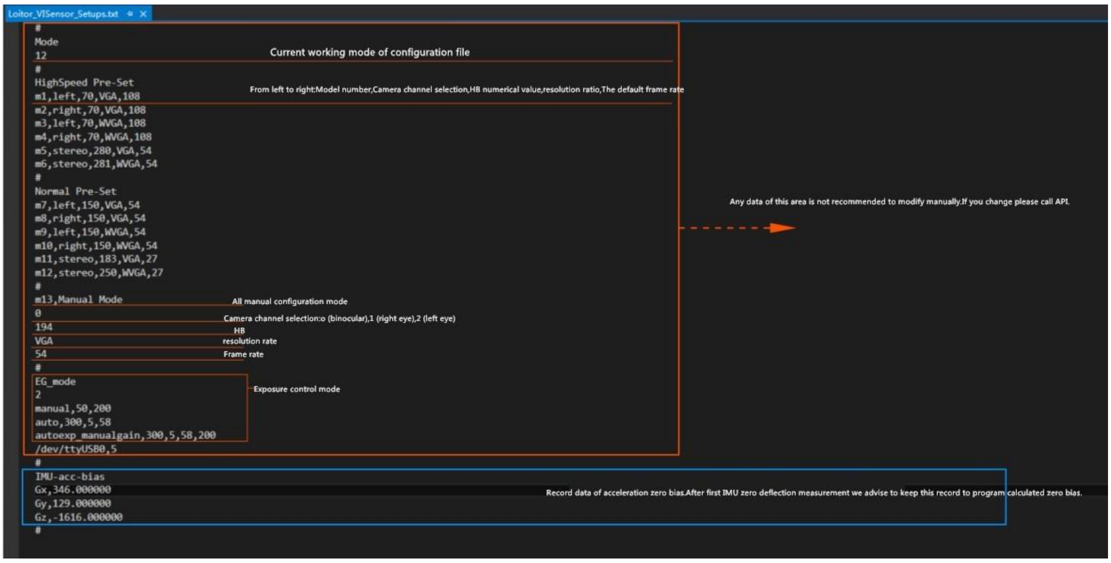
Image data and IMU data have been added precise timestamp by Loitor ROS Drive, you can get them in msg.header.Stamp.

5. Camera Configuration File

If you look at the usage of main() in camtest2.CPP file, you will find the use of SDK is very simple:

1. visensor_load_settings(“Loitor_VISensor_Setups.txt”);//Load the camera configuration file
2. Visensor_Start_Cameras();//Start the camera
3. Visensor_Start_IMU();//Start IMU

first, we require the system load the camera configuration file, since the file contains several parameters for camera and IMU.Follow the picture:



```
#
Mode
12
#
HighSpeed Pre-Set
m1,left,70,VGA,108
m2,right,70,VGA,108
m3,left,70,WVGA,108
m4,right,70,WVGA,108
m5,stereo,280,VGA,54
m6,stereo,281,WVGA,54
#
Normal Pre-Set
m7,left,150,VGA,54
m8,right,150,VGA,54
m9,left,150,WVGA,54
m10,right,150,WVGA,54
m11,stereo,183,VGA,27
m12,stereo,250,WVGA,27
#
m13,Manual Mode
0
194
VGA
54
#
EG_mode
2
manual,50,200
auto,300,5,58
autoexp_manualgain,300,5,58,200
/dev/ttyUSB0,5
#
IMU-acc-bias
Gx,346.000000
Gy,129.000000
Gz,-1616.000000
#
```

Current working mode of configuration file

From left to right:Model number,Camera channel selection,HB numerical value,resolution ratio,The default frame rate

All manual configuration mode

Camera channel selection:o (binocular),1 (right eye),2 (left eye)

HB

resolution rate

Frame rate

Exposure control mode

Any data of this area is not recommended to modify manually.If you change please call API.

Record data of acceleration zero bias.After first IMU zero deflection measurement we advise to keep this record to program calculated zero bias.

Blue area is used to record imu zero bias, and specific set method will be given in step 8.

6. visensor_API Instructions

6.1 Camera Controls

1.void visensor_set_auto_EG(int E_AG);

Set the exposure mode:

E_AG=0 means manual mode, you need to set the exposure value manually;

E_AG=1 means automatic mode (Limit of 0-255);

E_AG=2 means automatic&manual mode(setting the gain value):

visensor_set_gain()

E_AG=3 means automatic gain&exposure mode

2.void visensor_set_exposure(int_man_exp);

Set manual exposure value (Limit of 0-255)

3.void visensor_set_gain(int_man_gain);

Set the manual gain value

4.void visensor_set_max_autoExp(int max_exp);

Set maximum on automatic exposure mode (limit of 0-255)

5.void visensor_set_max_autoEXP(int max_exp);

Set minimum of automatic exposure mode (limit of 0-255)

6.void visensor_set_resolution(bool set_wvga);

Set the resolution,set_wvga=ture means 752*480 otherwise 640*480;

7.void visensor_set_fps_mode(bool fps_mode);

Set the frame rate:

Fps_mode=ture means High frame rate:

According to HB under WVGA, range from 40fps-50fps;

According to HB under VGA, range from 50fps-65fps;

Fps_mode=ture means Low frame rate:

According to HB under WVGA, range from 22fps-27fps;

According to HB under VGA, range from 22fps-25fps;

8.void visensor_set_current_HB(int HB);

Set current HB .range from 70-255;

9.void visensor_set_desired_bin(int db);

Set up automatic exposure to “Achieve brightness”, CMOS will adjust exposure automatically according to the numerical. The higher the db, the brighter the image ranging from 0 to 48.

10.void visensor_set_cam_selection_mode(int_visensor_cam_selection);

You can choose different mode of “left eye”,” right eye” and “binocular” through Camera.

_visensor_cam_selection=0 means “binocular”;

_visensor_cam_selection=1 means “right eye”;

_visensor_cam_selection=2 means “left eye”;

11.void visensor_set_current_mode(int_mode);

Change the current camera work mode manually.

12.int visensor_Start_Cameras();|void visensor_Close_Cameras();

Start and turn off the camera safely.

Function Visensor_Start_Cameras() should be called after calling function 1-11 which means if you need to change the camera settings through API it should be acted before visensor_Start_Cameras.

13.void visensor_save_current_settings();

To save the current mode settings in the configuration file should be acted after function 1-11.

6.2 Image data read interface

1.void visensor_get_stereoImg(char*left_img,char*right_img);

Fetch current left-eye&right-eye images(single channel)

2.void visensor_get_stereoImg(char*left_img,char*right_img,timeval&left_stamp,timeval*right_stamp);

Fetch current left-eye&right-eye images(single channel) and return the timestamp of shooting time.

3.visensor_get_leftImg(char*left_img);

Only fetch the left-eye image.

4.void visensor_get_leftImg(char*left_img,timeval*left_stamp);

Only fetch the left-eye image and return the timestamp of shooting time.

5.visensor_get_rightImg(char*right_img);

Only fetch the right-eye image.

6.void visensor_get_rightImg(char*right_img,timeval*right_stamp);

Only fetch the right-eye image and return the timestamp of shooting time.

6.3 IMU Control

1.visensor_Start_IMU();

Open the serial port and start IMU.

2.void visensor_Close_IMU();

Turn off IMU safely.

3.void visensor_set_imu_portname(chat*input_name);

Set the serial port name manually.

6.4 IMU Data

1.void visensor_set_imu_bias(float bx,float by,float bz);

Setting IMU zero bias manually.

2.visensor_imudata visensor_imudata_pack

The variables are set as globle variables to record current IMU data(timestamp included) and it can be referenced as loitorimu.h

7. Setting HB parameters manually

HB (Horizontal Blanking) line of Blanking, a CMOS MT9V034 register which is an important parameter, it can affect the size of the frame rate, if the setting is not appropriate (too big or too small) also can result in images caton, frame lost even USB connection failure.

The greater the HB, each frame transmission time is longer, the lower frame rate; If your USB bus capacity is limited, we suggest set the HB to around 250.

HB is smaller, the higher acquisition frame rate, but the greater the pressure for USB transmission. Smaller HB values (such as 120-194) is more suitable for PC with strong USB transmission ability.

If you find the camera there lost frames and caton, modify HB values through the API, and then call visensor_save_current_settings () to save the Settings.

8. IMU accelerometer zero calibration procedure

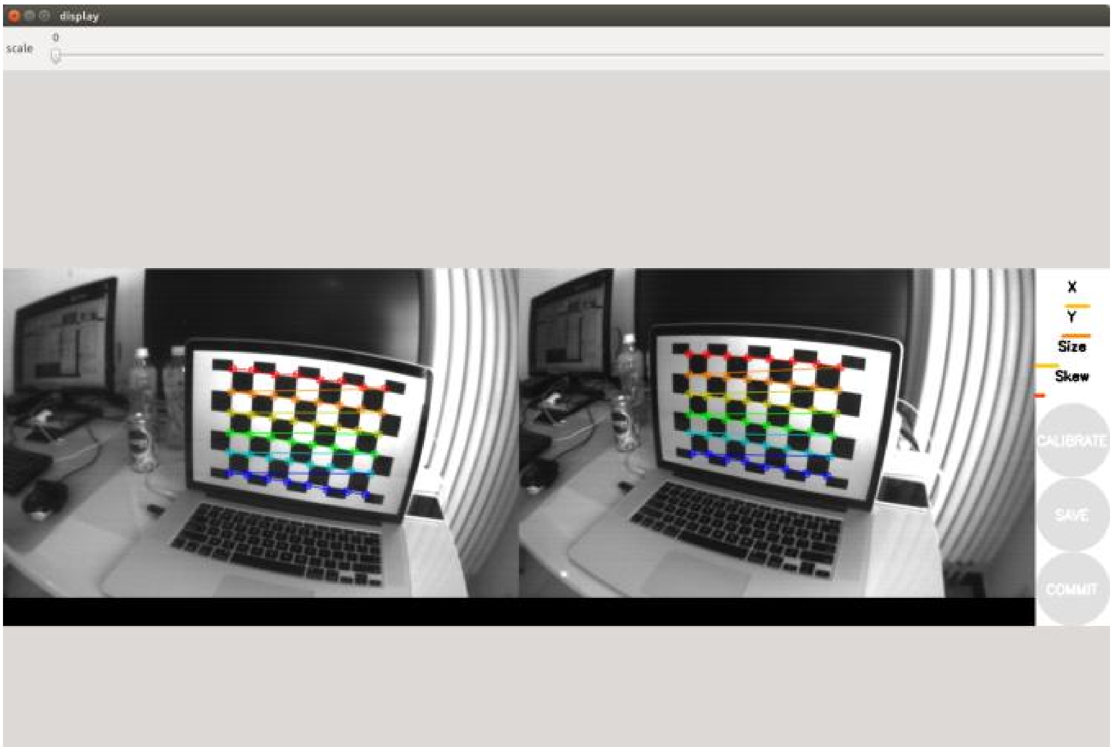
1. Follow the command line to enter IMU_Calib folder, start . / imucalib to set zero calibration according to clew .

2. After calibration completed it will automatically write into the configuration file: imucaldata. TXT , then you need to manually copy the three parameters in the configuration file to Loitor_VISensor_Setups. TXT in the blue area.

9. Optical calibration

We use the ROS camera_calibration factory for camera calibration, its parameters has been written to the file:

/ ORB_SLAM2 / Examples/Stereo/EuRoC. yaml



10. Compile the ORB - SLAM2 and use Loitor camera for testing

1. Following the ORB - SLAM2 official guidance for ORB - SLAM2 compilation and configuration.

2. Since the optical calibration has been completed, first run Loitor ROS Node after compilation, then run the ORB - SLAM2 following default

configuration.

11. Several Problems you may meet

11.1 serial file cannot be opened

1. The serial port name is wrong; You need to check the USB device serial path, and write the paths in the corresponding part in Loitor_VISensor_Setups. TXT

2. Ordinary users can't open the serial port under file (access problem) : Under Linux device you need to use sudo or the root user and in order to make ordinary users also can use a serial port you can increase the udev rules to implement, the specific method is as follows:

Sudo vim/etc/udev/rules. D / 70 - ttyusb. Rules

Add the following contents:

KERNEL = = "ttyUSB [0-9] *", the MODE = "0666", save and insert the USB to turn over serial port, it can be solved.

11.2 When IMU is on electricity you need to wait for 8 to 10 seconds and initialize the gyroscope to zero bias, remain the camera still, otherwise will result in attitude drift obviously.

For more information please visit
https://github.com/loitor-vis