Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 4, April -2017

Development of Heterogeneous Camera Monitoring System and Evaluation of Performance Parameters

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Abstract
Machine Vision is widely used in Remote handling and robotics area for development of vision based robotic application, Inspection in Hazardous area etc. Industrial Network cameras provide precise results of Real time frame grabbing from remote locations. Cameras like GigE cameras, IP network Cameras etc. are being used globally but each camera can only be controlled with its proprietary software. So if we want to control different make multiple cameras from a single platform than latency and heterogeneity issues becomes prominent. In this paper, using C++ based libraries like Pylon, OpenCV, heterogeneous Cameras on a single platform have been integrated. For comparison, LabVIEW is also used here for heterogeneous camera frame grabbing. The final goal is to achieve a low latency vision system for remote handling and monitoring work cell environment using heterogeneous machine vision technology.

Key words: *GigE camera, Axis Cameras, heterogeneous Cameras, Machine Vision, Virtual Reality, Virtual Path Planning.*

I. Introduction

Machine vision and image processing are key points for building intelligent robotic systems. Machine vision is used to obtain relevant information of the working environment of the robot by capturing, processing, and analyzing images. It is crucial when the remote handling operations are performed in inaccessible locations not directly visible to the operator. The work has been carried out towards the initial developments of machine vision based monitoring system for remote handling vision requirements.

Remote Handling System

Remote handling is a combination of technology and engineering management systems to enable operators to safely, reliably and repeatedly perform manipulation of items without being in personal contact with those items. All maintenance and inspection operation to operated distance place from working cell. Handle many and large components inside the machine. Remote handling in remote place is challenge task to develop In-vessel inspection system. Here, we are proposing a generalized machine vision system for heterogeneous cameras on single place with high frame grabbing rate.

Monitoring system

Cameras provide the way of development a monitoring system so we can use vision standards (IP camera, Network camera, GigE and USB cameras) to make a vision or surveillance system. Monitoring of working environment must provide useful information about remote location, so you can control your system from the remotely located system. Monitoring system should be designed in such away that all work cell areas can to be monitored using different type of machine vision cameras and we should get nearly live real time stream from cameras. Cameras of different type and different vendor are attached to the work cell. Monitoring system should also take into account the specific configured system at handling area (viewer system). Need of monitoring system can be described as we need to monitor the work cell, robot position, and environment of controlling area using heterogeneous cameras system etc.[3][4]

Objective and Challenges

Development of Multi-type network cameras based monitoring system using different approaches. Various cameras should be interfaced using different platforms with generalizedand respective libraries. Main Challenge of this system is integrate heterogeneouscameras in a single application, then it should be analyzed on how to improve the performance by upgrading the platform and dependencies for frame grabbing speed of recently developed system to reach goals of a real time surveillance system.

II. Implementation of System

Monitoring system has been implemented using different machine vision standard camera to retrieve viewsof the work cell. In our experimental work we are using a network camera (Axis P5512), two GigE cameras (Basler Area scan camera) and USB web cameras (Logitech 2.0) for the analysis of frame grabbing time. Here main focus of work is to integrate multiple and multi-type camera with any open platform for the generalization and further image processing or to develop any custom image analyzer application.

Basically here we have to start with grabbing of images from camera then send it to our VC++ application toprogram further operations. Below figure shows an architecture of monitoring system for miscellaneous camera.

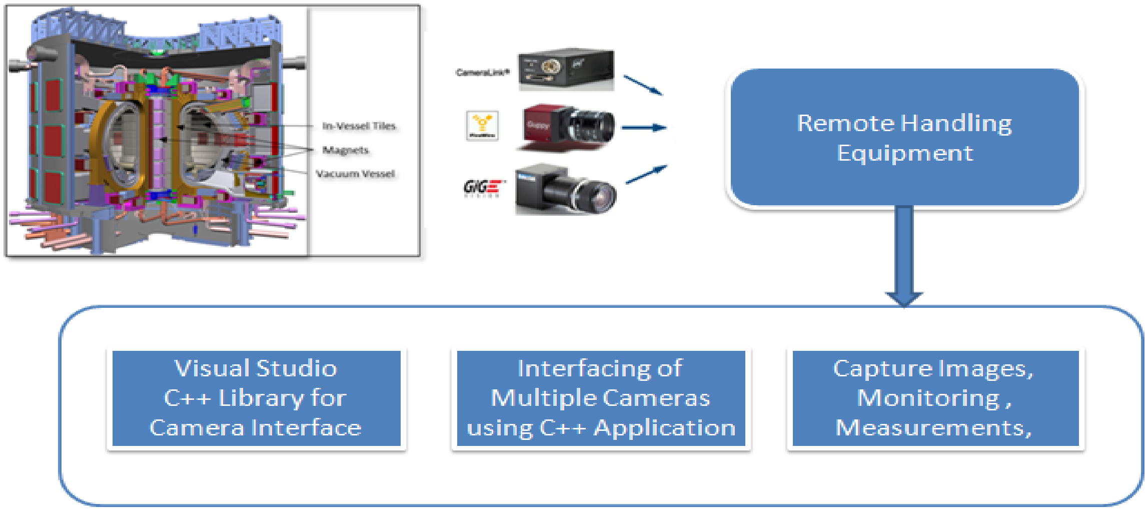
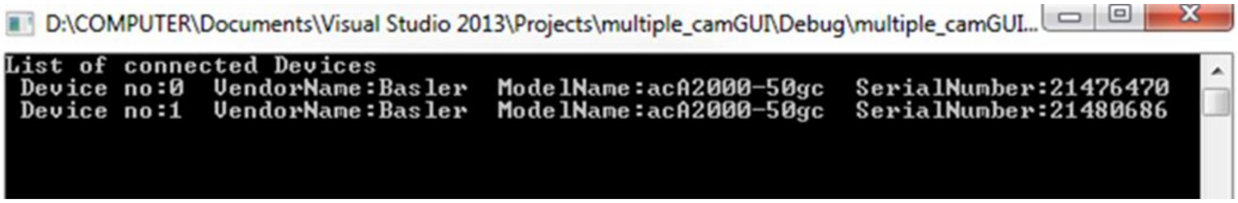

In-Vessel Tiles
Magnets
Vacuum Vessel
CameraLink®
GigE
Remote Handling Equipment
Visual Studio C++ Library for Camera Interface
Interfacing of Multiple Cameras using C++ Application
Capture Images, Monitoring , Measurements,

Figure 1 Architecture of monitoring system

Here we have developed different type of applications using various approaches for measurement of frame grabbing rate of heterogeneous camera system. In this paper we are using four approaches for practical implementation which can described as below.

A. Multiple GigE camera with Pylon SDK

In first method, two Basler GigE (Gigabit Ethernet) cameras are used to make multiple camera system. Most of IP camera manufacturers develop their own dedicated library. So here we are using Basler's dedicated library and SDK known as PYLON for building the system. We can connect multiple GigE cameras for themonitoring system. User can create hisown application for accessing the IP camera. Also, create some interesting and simple control GUI for any non-technical user. GUI can be created in supported platforms like visual studio, Qt etc. All these platforms support C++ language.


D:\COMPUTER\Documents\Visual Studio 2013\Projects\multiple_camGUI\Debug\multiple_camGUI...

```
List of connected Devices
 Device no:0  VendorName:Basler   ModelName:acA2000-50gc   SerialNumber:21476470
 Device no:1  VendorName:Basler   ModelName:acA2000-50gc   SerialNumber:21480686
```

Figure 2 Scan network IP camera

First function of application is to scan all network cameras from our dedicated network. Listed out all device which attach with our system for monitoring system. Also, list out all IP address and device ID address, device info which containing the full name, model name, serial number etc. It creates device buffer array of scan camera with all of device information which is as shows in above figure.

B. Multi-Type camera with OpenCV

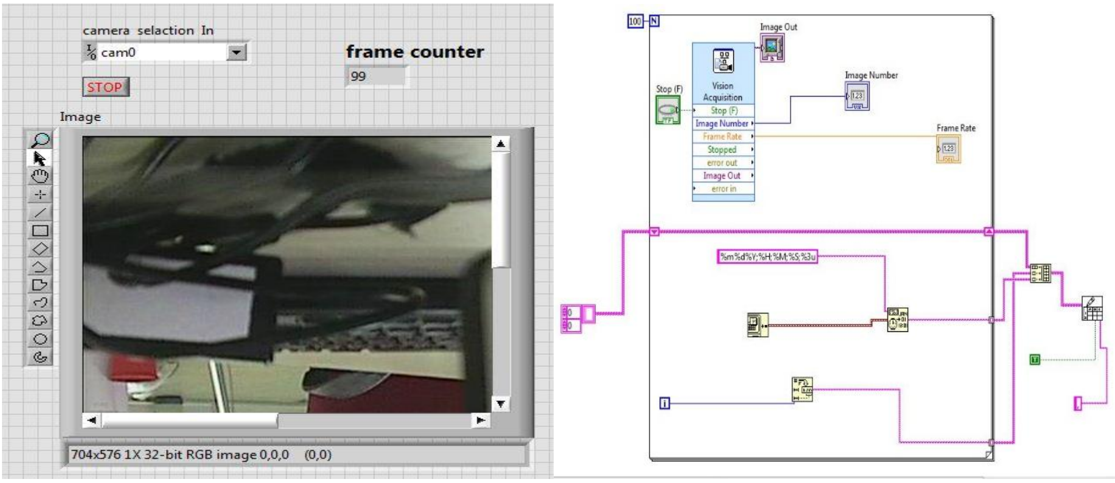
Second method is heterogeneous camera grabbing application build using OpenCV package, which is a generalized platform for developing camera viewing application. Here we are using a GigE camera, a network camera and a USB web camera for the heterogeneous platform.OpenCV initializes each camera using different commanding method like Axis network camera by HTTP connection,IP camera directly scan from network.But OpenCV cannot identify the hardware configuration so, user can't differentiate betweenthe cameras.

C. Multi-Type camera with LabVIEW

LabVIEW development software which support different kind of camera and image acquisition module help to improve image acquisition method and video processing. Acquisition module set different parameters like resolution, gain, and brightness for set viewing output. Basler IP camera and axis network camera interface using PoE (power on Ethernet switch) through direct connection with system Ethernet port. Image acquisition module initialize camera, set time stamp for each grabbing frame and store in excel sheet with number of frames and time stamp to analyze the performance with frame grabbing rate.

D. Multi-Type camera with Frame Grabber (NI-8234)

External hardware support for frame grabbing are used for better results. Frame grabber help to improve camera internal working process. It helps to improve frame grabbing of camera and system interface speed. The PXIe-8234 grabber module with Vision Acquisition Software can acquire images frame from the GigE Vision cameras. It transfers images at full Gigabit Ethernet bandwidth on ports simultaneously, and it is optimized CPU load power up processing of frame on video card'sboard. [5]



camera selaction In: cam0

frame counter: 99

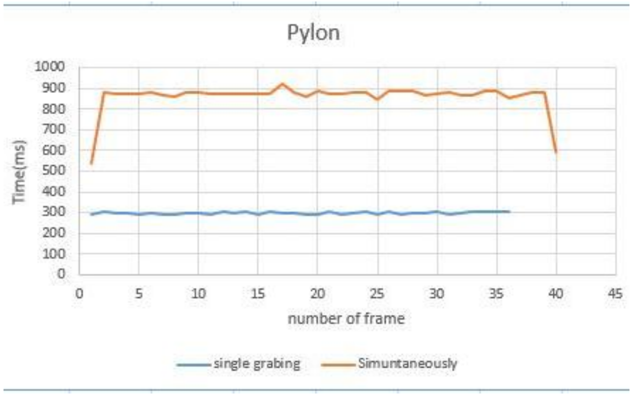
704x576 1X 32-bit RGB image 0,0,0 (0,0)

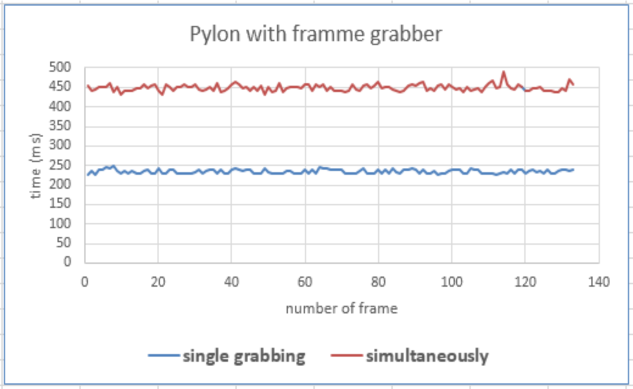
III. Results

Here we are analyzing the performance of multiple and multi-type cameras for grabbing the images. Now as per frame rate measurements, we can create graphs for grabbing ratio. We are using same camera for each platform, but getting different frame grabbing rates for every experiment. We presentthe graphs for each experiment as per below.

A. Frame Grabbing Rate inMultiple GigE camera with Pylon

First graph shows the result for frame rate in the range of milliseconds. We can see that time required for each frame grabbing time frame is nearly equal to 300 to 350 milliseconds. Second graph show the results for simultaneous frame grabbing with multiple cameras.

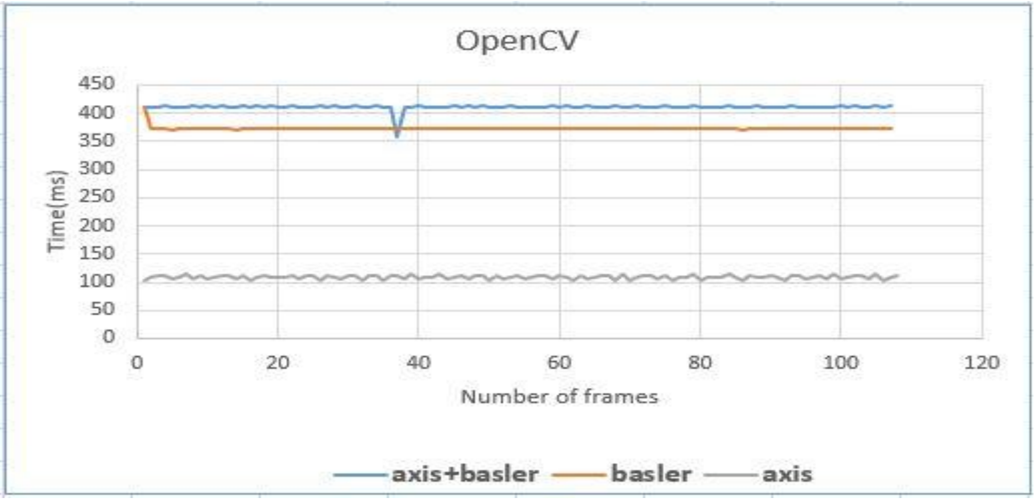




Now as shown in figure that blue line in graph shows the frame grabbing time of single camera and orange line shows the grabbing time of a camera when both the cameras run simultaneously. We can see that grabbing time is now between 850 to 900 milliseconds approximately. So graph describe that camera frame rate decreases because of simultaneous grabbing of images from the network camera.

B. Frame Grabbing Rate inMulti-Type camera with OpenCV

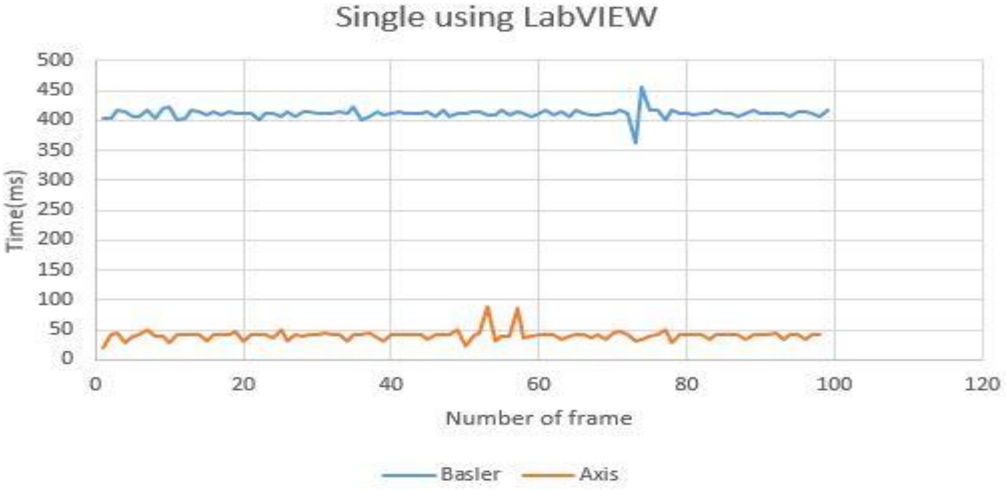
The Multi-type Network Cameras are accessedsimultaneously using OpenCV. below graph shows individual camera's frame grabbing characteristics. First we grab images from single camera (GigE/ Axis) at a time and measure frame rate for each camera. It also shows measurement of framerate for multi cameras (axis and GigE) accessed simultaneously.

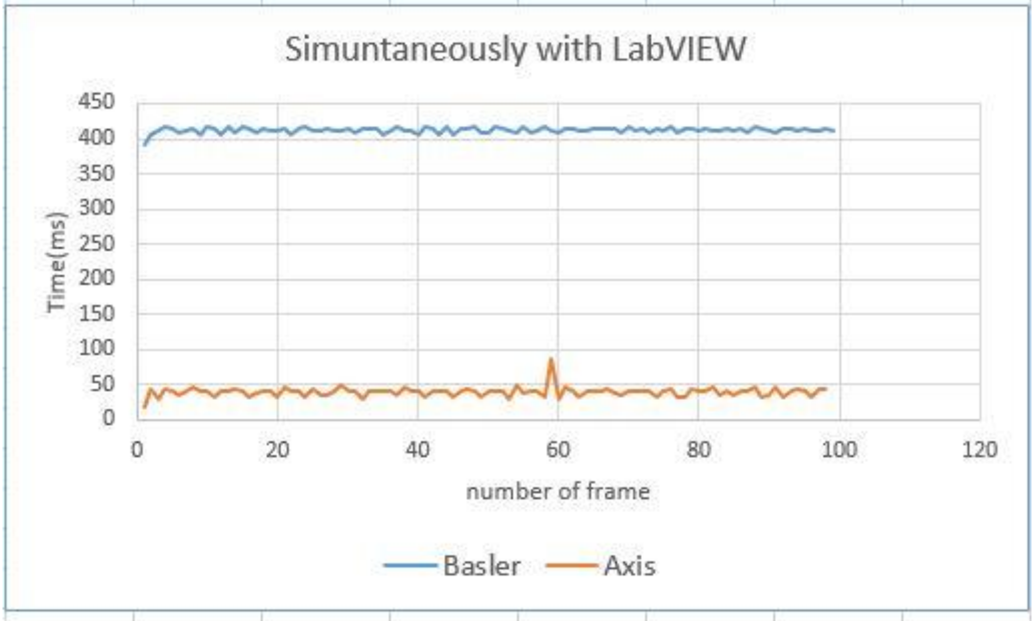


We can see that the results are lower than single grabbing and time required for every corresponding grabbing is nearly equal to 300 to 350 milliseconds for GigE camera which is 300 milliseconds in first case. Similar vales of 300 to 350 milliseconds for network camera which is 300 milliseconds and 300 to 350 milliseconds for web camera which is 300 milliseconds in first case respectively. So, after this experiment, we can conclude that camera latency is affected by another camera used in network.

C. Frame Grabbing Rate inMulti-Type camera with LabVIEW

Similar to previous experiments, we can compare results of time period for frame grabbing using multiple cameras and multi-type cameras using c++ application. Now it is measured using LabVIEW Platform. For this approach, both cameras are directly accessed using LabVIEW IMAQ (Image acquisition Module).

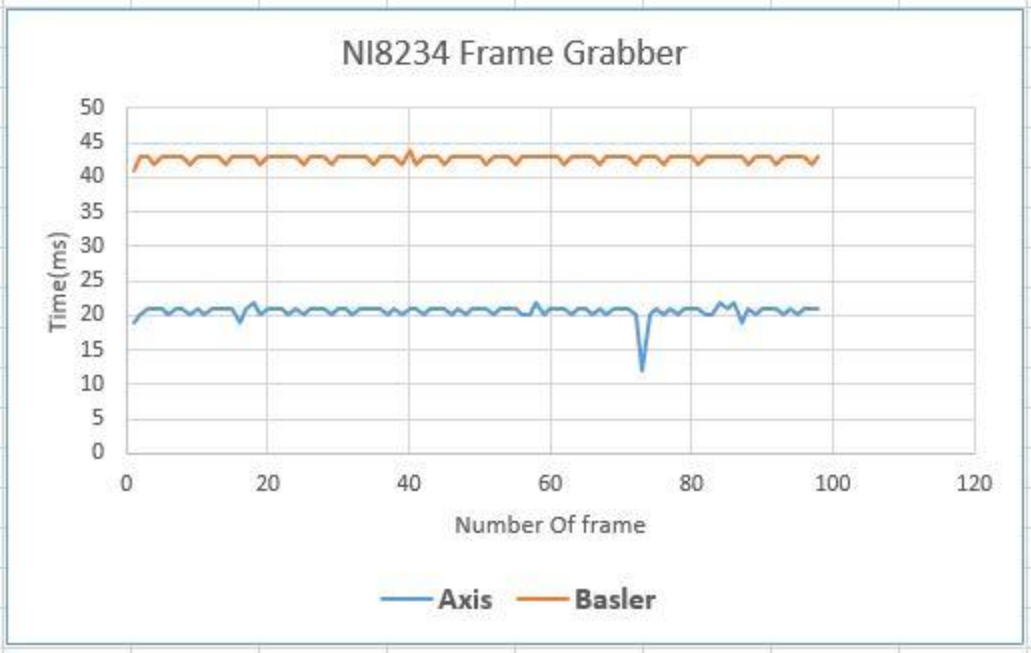




From this approach it retrieves that latency is decreased but fluctuation of frame grabbing remains high. But here we can overcome pervious latency problem because of other camera in network.

D. Frame Grabbing Rate in Multi-Type camera with Frame Grabber (NI-8234)

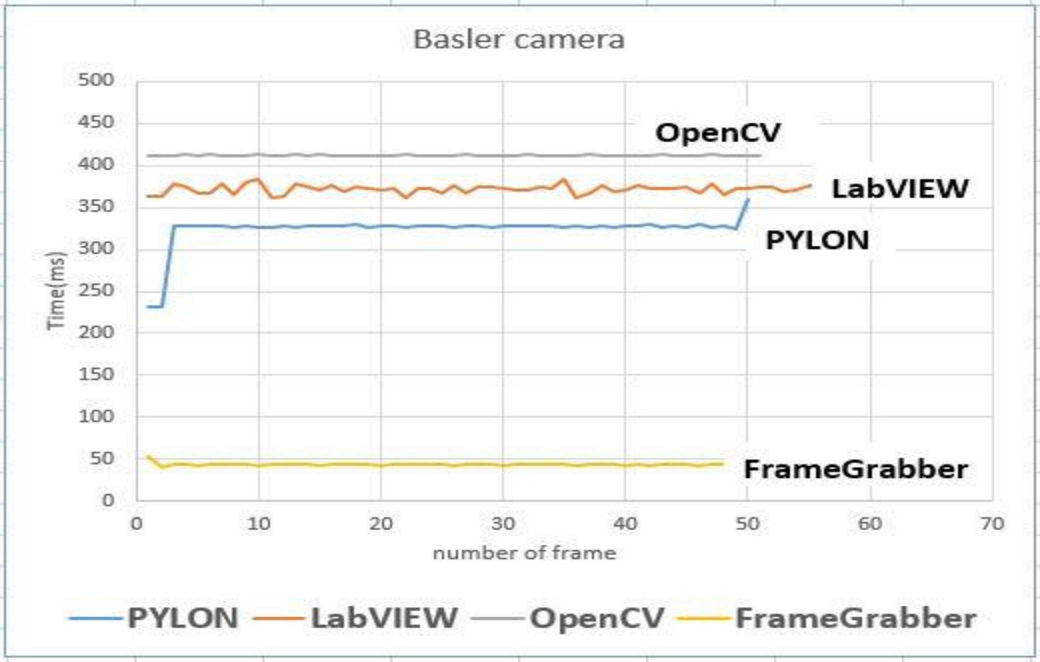
For solution of the problem in the above approach, we can use Frame grabber module with NI PXI Module. It provides Ethernet based Frame Grabber Module of NI 8234. By using this module, we can observe better results than other two approaches. There are mainly two advantages of this approach. First is high frame grabbing rate than above mentioned approaches and second is less fluctuation in results. It shows grabbing time period remains nearly constant between two continuous frames.

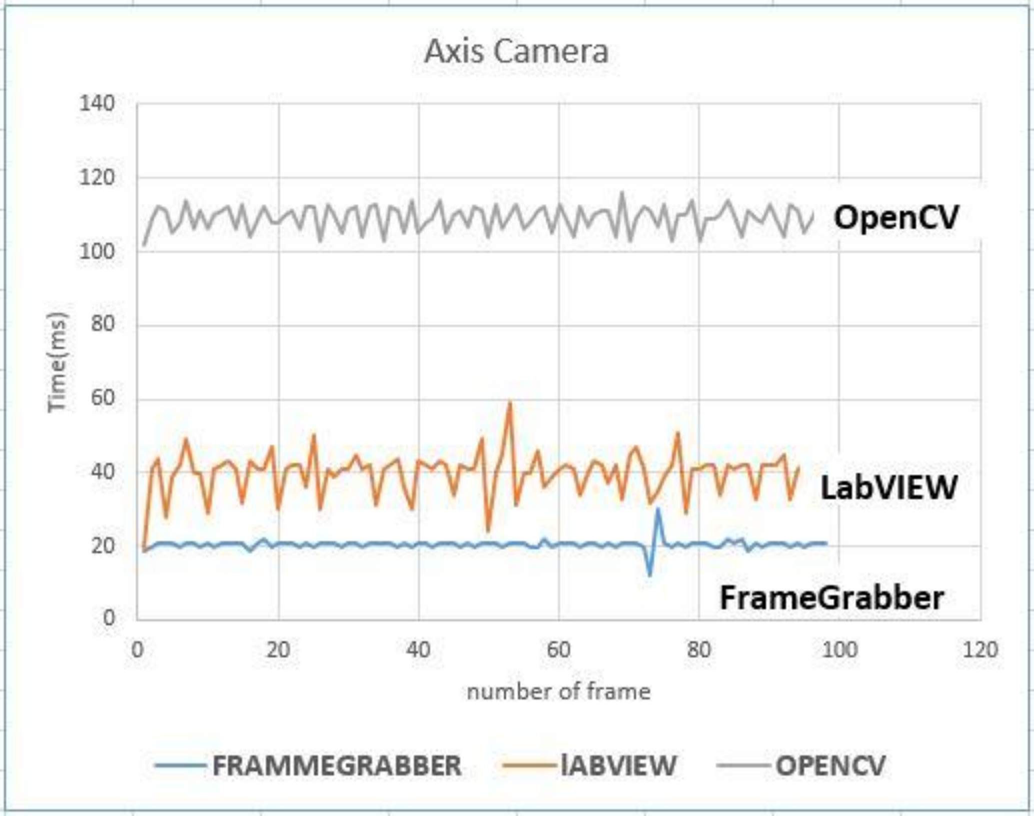


IV. Conclusion

First method developed using open source lib (OpenCV) for grabbing frame. But in this method we are facing an issue of slow grabbing frame rate from camera. OpenCV library is not sufficient to be used with multiple cameras simultaneously. Also it is is not able to read camera basic info like hardware address, serial number, vender name etc. So, it's not more useful for heterogeneous monitoring system.

We can compare the results of the experiments conducted to find the latencies in different scenarios are as following:





Another approach for built heterogeneous system is using LabVIEW. LabVIEW is more effective approach than OpenCV or pylon for variant and multi-type camera integration. Even we found that frame grabbing rate is too high than both of them. But some hardware latency is present which can not be overcome by software only, so using different software is not only the possible way to improve latency of frame grabbing. Now as a second method for improvement in latency and Power up camera hardware, we are using external frame grabber. External frame grabber improves power, hardware trigger, and processing period for grab and transmit analog signal. It's make cameras faster and much near to real time grabbing and monitoring.

Reference

[1] M. Huguet, "Remote handling maintenance of ITER R . Haange , ITER Joint Central Team , ITER Home Teams."

[2] P. Dutta, N. Rastogi, S. Joshi, A. Patel, M. Trivedi, and K. K. Gotewal, "Development and Testing of Visual Inspection Applications for Tokamak Maintenance," no. August, 2016.

[3] P. Rai, K. Tiwari, P. Guha, and A. Mukerjee, "A Cost-effective Multiple Camera Vision System using FireWire Cameras and Software Synchronization," 2011.

[4] D. Thiel, M. Goulart, S. Botelho, and R. De Bem, "Hardware and Software Infrastructure to Image Acquisition using Multiple Cameras," *Ucsp.Edu.Pe*, 1998.

[5] "PXIe-8234 - National Instruments." [Online]. Available: http://www.ni.com/en-in/support/model.pxie-8234.html. [Accessed: 09-Mar-2017].