

Automatic Camera Adjustment in XYZ Direction in a Vision System by Using NI LabVIEW and FPGA Programming

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Abstract— Vision system is manufacturer primary consideration to automate production or to improve quality. Vision system can complete the complex task at very high speed with high accuracy and consistency. One of the companies which provide industrial vision testing solution is GOEPEL Electronics India Pvt Ltd. The company's focus is on solutions and products for testing car seats, ECU's and electronic assemblies. In this company automobile clusters are tested by using TOM Line vision system. In this TOM Line setup industrial camera is part of it which is fixed in its position. If the camera is fixed then we can test only half part of the cluster at a time. Full part of the cluster is tested by moving the camera in XYZ direction which is explained in this paper. Stepper motor is used to move the camera in XYZ direction and the steps to reach the expected position is saved. In this paper stepper motor is interfaced with labVIEW using Altera FPGA.

Keywords— Vision System, LabVIEW, Stepper Motor, Altera FPGA, Automobile Clusters.

I. INTRODUCTION

One of the Automobile parts testing company is the Goepel Electronics India Pvt Ltd. Goepel's headquarter is in Jena, Germany. In Goepel, to test the any type of vehicle clusters TOM-Combi Line Vision Sytem is used. TOM Line is a mechanical vision programming. The TOM product offering incorporates customisable optical examination frameworks to be connected in estimation designing and mechanical quality affirmation. Composed hard and programming segments ensure most elevated usefulness and unwavering quality. TOM Combi-Line, the new optical investigation framework for cost-productive model and assessment trial of instrument bunches of any vehicle sorts. Notwithstanding the general product offering we offer extraordinary answers for the review of gatherings in cars e.g. instruments assessment of electronic modules. The reduced desktop framework can be prepared relying upon the application with up to three 5 Megapixel cameras.

Pictures of the instrument groups are not seen straightforwardly but rather through an incorporated mirror framework. A unique component is the adaptable UUT apparatus, empowering the optical examination of combinational instruments of any sort.

On the off chance that the computerized clusters are tried or set physically, then the outcomes won't be exact. To beat this issue, clusters should be placed or tried consequently by utilizing calculations. At present, in the TOM combi Line, groups are all the time replaces. Henceforth there will be a position change in the district of intrigue. To get the district of intrigue camera ought to be balanced physically. So the outcome will be less exact. In this venture, we are changing the camera consequently by utilizing a few algorithms to get more exact outcome. With the goal that camera will move in XYZ heading.

II. REVIEW OF THE LITERATURE

In the paper [11], they have explained how to make connections with Cyclone II series of FPGA. From this paper we learned to make connections with Cyclone V series of FPGA. Because setup guide is similar to the higher generation series.

In the paper [13], they have explained the interfacing of labVIEW with NI myRIO. From this paper we have learned how to control the stepper motor using LabVIEW.

In the paper [12], explained how to move the object in XY direction. They also used stepper motors which are controlled using Arduino Mega 2560. In our paper, we have implemented to one more direction, i.e in Z direction and controlled using Altera FPGA board.

III. METHODOLOGY

In this proposed system the industrial camera which is placed in the TOM-Combi line setup is moved in X, Y and Z direction. So that automotive cluster can be tested full at a time. No need to remove the camera to test only the left part or right part of the cluster. The movement of the camera is done by using three stepper motors M1, M2, and M3 in XYZ direction respectively. To drive the stepper motors three separate A4988 driver circuit is used. The driver circuit is controlled by Altera FPGA. FPGA is controlled by NI LabVIEW.

The camera is placed in the default position, P1 when the program has been started. The camera is moved to the position, P2 by using trial and error method. The number of steps needed by the motor to move the camera from the position P1 to P2 is stored in the file. The direction in which stepper motor should move is given in Lab VIEW Graphical User Interface.

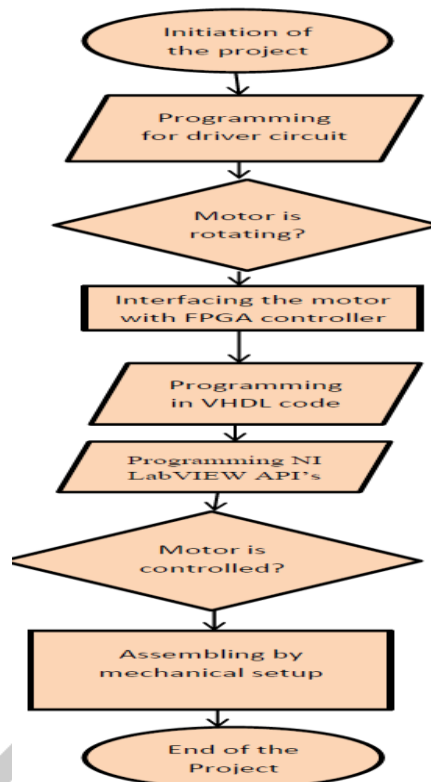


Fig. a Flow chart for the proposed system

A. Block Diagram

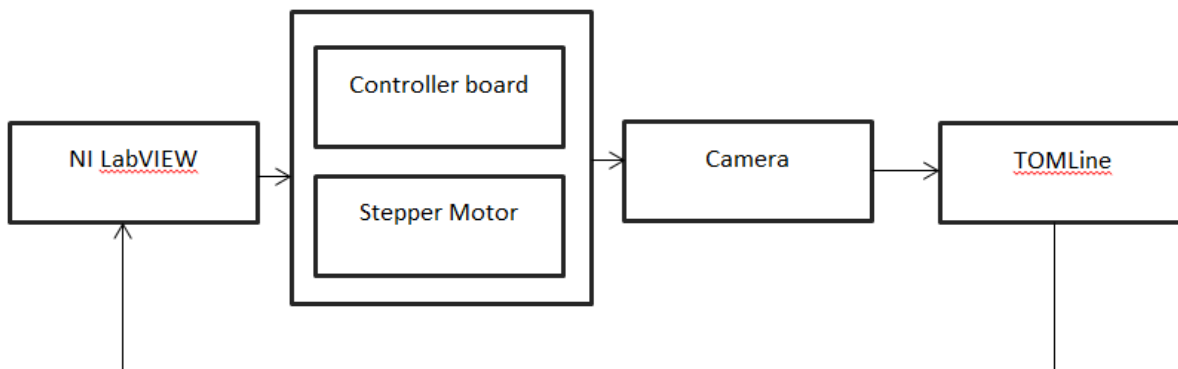


Fig. A Block diagram of the proposed system

NI labVIEW will control the controller circuit and drive the driver circuit. Altera FPGA is the controller circuit and A4988 is the driver circuit. FPGA will control the driver circuit and driver will drive the stepper motor. So that the camera which is placed in the setup consisting of three motors will move according to the command given by the labVIEW. TOM Line will send the signal whether the camera has to move in any direction or not.

1) National Instruments: LabVIEW: NI is abbreviated as National Instruments. LabVIEW is an acronym of Laboratory Virtual Instrumentation Engineering Workbench. It is a software which has wide variety of applications in industries, colleges etc. LabVIEW is highly productive and it provides development environment for creating customized applications. LabVIEW interacts with real-time data or signals in fields like science and engineering. Vast variety of tools are available in LABVIEW environment. Hence LABVIEW is very unique software. The complex programs can be very easily completed using LabVIEW tools. LabVIEW is a Graphical programming language. No need to write lengthier codes in LabVIEW. For this project we used NI Lab VIEW of version 17, 32 bit software.

LabVIEW is a visual programming which is widely used because it is interlinked to data acquisition, analysis of data and logical operations. Graphical programming language also supports external hardware. Instead of writing lengthier code, complex programs can be done in a very understanding way. Programming can be done in two panels. They are:

- Front Panel

Front panel is the display in which user is capable of placing functional modules in his own line of thought of algorithm. Front panel can be designed in more understanding way to the user and can also make it more attractive to the user. Hence it is called as

user friendly software. In the front panel control module or indicator modules can be placed. The front panel of the proposed system is shown below.

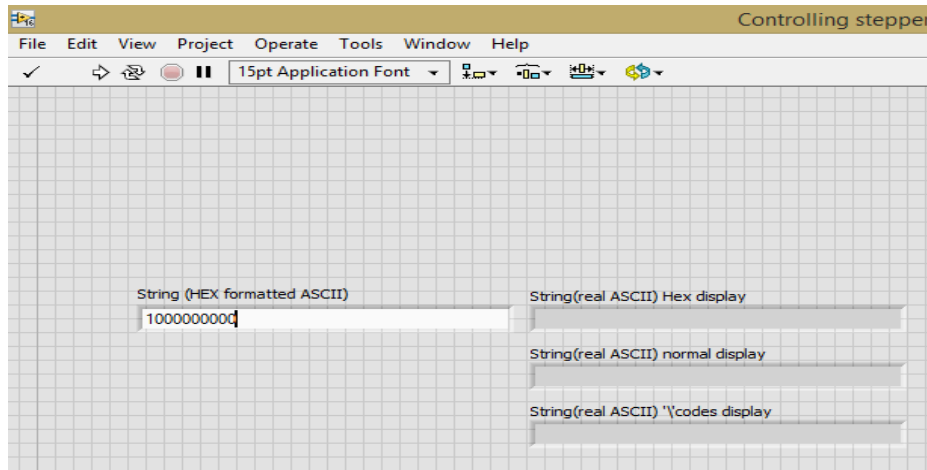


Fig. 1(a) Front panel of the proposed system

• Block diagram

Main algorithm of the program is designed using functional blocks in block diagram panel. Functional block are connected one another using wires. Running a program is easy and also easy to detect errors. The block diagram window of the proposed project is shown below.

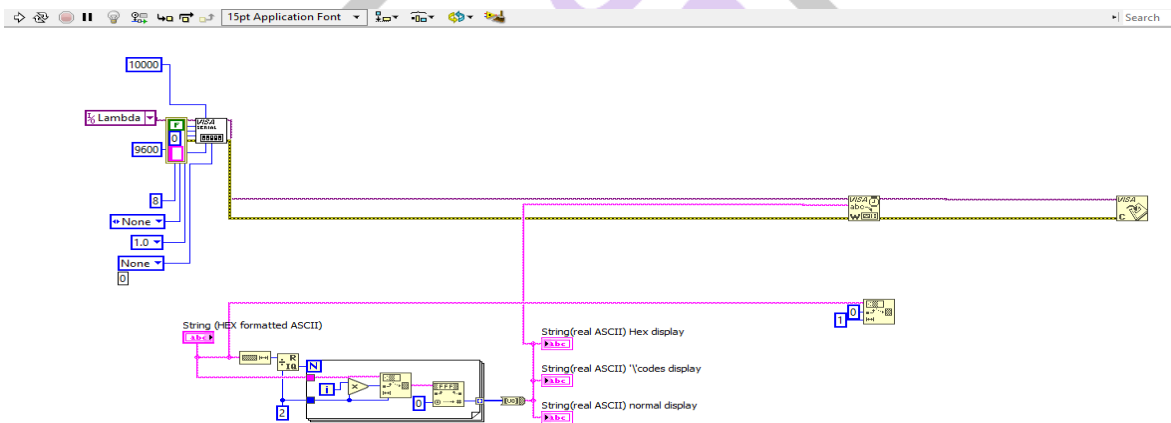


Fig. 1(b) Block diagram panel of the proposed system

2) Altera FPGA: Altera FPGA is owned by Intel. Altera manufactures reconfigurable complex digital circuits and Programmable Logic Devices(PLDs). FPGA stands for Field Programmable Gate Arrays. In this project we are using Cyclone V series which was introduced in 2011. Deo-Nano-SOC Cyclone FPGA with an ARM based hard processor system (HPS). FPGAs can be used for high-volume applications. It is low power, cost sensitive device which has configurable embedded SRAM, high-speed I/Os, high-speed transceivers and logic blocks. Cyclone V 5CSEMA4U23C6N device consists of Dual Core ARM Cortex-A9, 40K programmable logic elements, 2 hard memory controllers, 5 fractional PLLs, 2460K embedded memory, micro SD card socket, arduino expansion headers and two 40 pin expansion headers. To drive the stepper motor, signal is given to the A4988 driver IC by the altera FPGA. The program is written in VHDL Code and simulated using Quartus Prime software. Compiling steps are shown below using block diagram. We used quartus prime lite edition software of version 15.1.

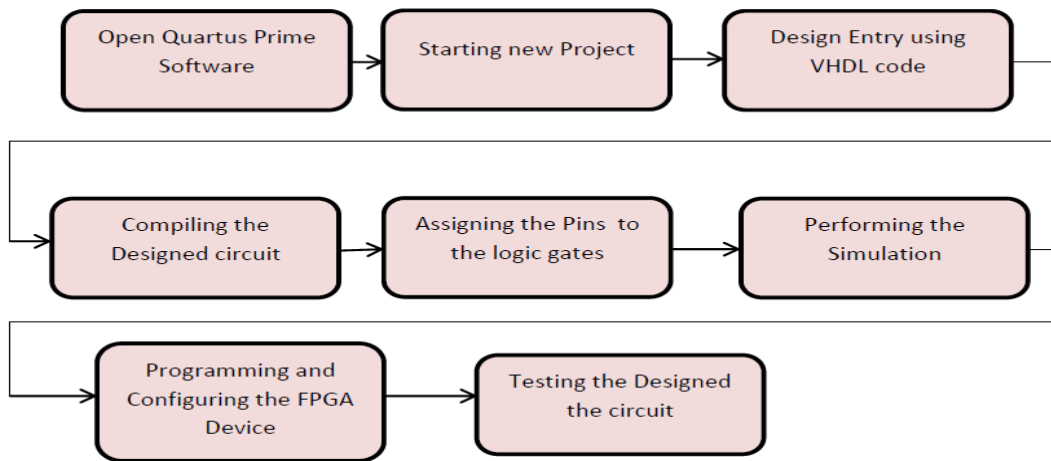


Fig. 2 Simulation flow of Quartus prime Software

RS-232 cable is connected from computer terminal to the MAX 232. RS-232 is used for serial communication which is DB-25 connector. RS 232 is a full duplex component which transmits and receives at the same time. In this project, transmission of command signals and information from the FPGA device can be received through this RS232 cable.

MAX232 is an integrated IC TTL logic which converts the required signal from the RS 232 to the proper signal which is used in the TTL logic circuits. TTL logic is connected to the Altera Cyclone V FPGA device. For FPGA code is written in VHDL code and debugged through Quartus Prime software. NI LabVIEW GUI sends signal to the FPGA. FPGA creates VHDL code and command from the programming sends signal to the motor to work.

3) Stepper Motor: In this paper, we are using Nema 17 stepper motor linear actuator. Linear actuator means it converts rotatory motion in to linear movement which has built-in threaded shaft. Linear actuator is capable to lift, push, tilt, adjust or pull heavy bodies. No need to do any assemble work and additional support bearing or coupling. Stepper motor linear actuator costs very less and requires less space. Nema 17 stepper motor is a bipolar, two phase, four wire, permanent linear actuator. Step angle is 1.8° for full stepping mode and 0.9° for half stepping mode linear actuator. It is a class hybrid stepper motor.

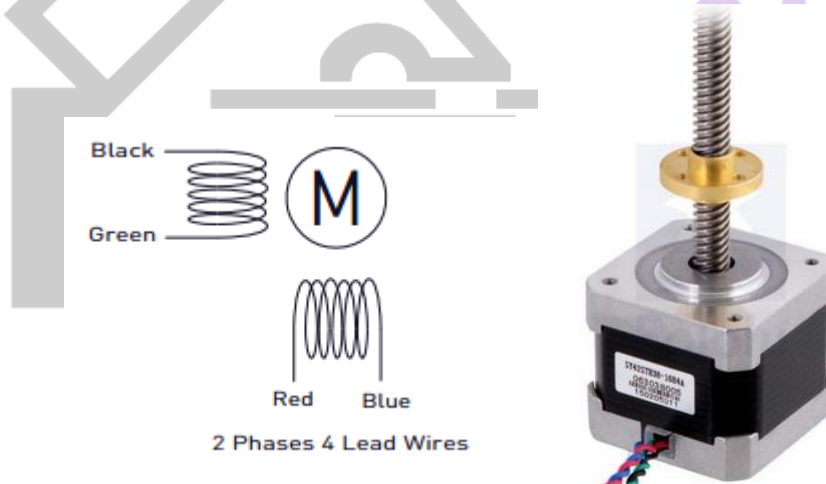


Fig.3 Nema17 stepper motor linear actuator

4) A4988 Driver: A4988 stepper motor driver can control one bipolar stepper motor and not unipolar stepper motor. It can be used to drive the motor in five modes of stepping mode resolutions. They are full-step, half-step, quarter-step, eighth-step and sixteenth step. A4988 driver can be connected to the four wire, six wire and eight wire stepper motors. It is adjustable to the current control. It is easy to interface the motor with the direction and step pin of the driver A4988.

Table. IV Stepping Mode resolution

| MS1 | MS2 | MS3 | Resolution |
|------|------|------|--------------|
| Low | Low | Low | Full step |
| High | Low | Low | Half step |
| Low | High | Low | Quarter step |
| High | High | Low | Eighth step |
| High | High | High | Sixteen step |

5) Industrial Camera: It is an industrial camera of 3 to 5 megapixel resolution. It is connected through digital USB. The high performance industrial cameras with GigE interfaces or USB are manufactured by the leading manufacturer IDS Imaging Development Systems GmbH. through the Ethernet network it transmits video and other related data in high speed. It transmits high speed video and other related data over the Ethernet networks. Along with the 5 megapixel CMOS sensor (MT9P031STM/MT9P031STC), the UI-5480SE is fitted. The CMOS sensor is extremely sensitive and is a real megapixel CCD spare. For all IDS cameras the IDS Software Suite is an identical software package.



The UI-5480SE camera has many applications in various fields. It has its application in industrial image processing or machine vision. It is used for the inspection of solar cells. Also used in microscopy and medical technology.

6) TOM-Combi Line: TOM Combi-Line means it is the new visual inspection system for cost-effective prototype and evaluation test of instrument clusters of any automobile vehicles. In addition to the regular product-line we offer superior solutions for the inspection of rallies in automobiles e.g. mechanisms inspection of electronic modules. The compact desktop system can be furnished depending on the application with up to three 5 Megapixel cameras.

TOMLine is a vision software of Goepel Electronics which has numerous functionalities that identifies the position and brightness of the indicator of the automobile clusters. For industrial applications, the TOMLine software is easy to handle image processing software.



Fig.5 TOM-Combi Line

B. Advantages

There are some advantages. They are

- More reliable
- Cost is less
- Number of cameras used in vision system can be reduced
- Testing speed can be increased

C. Result and analysis

When the camera has to move for a certain position, it should be rotated in a clockwise or counter clockwise direction. Steps should get saved in certain file. The outcome of the project is shown in the below figures.

When the clockwise button is pressed, direction pin is enabled. That means it is rotating in clockwise direction. And also reset and sleep pins are enabled and start pin is given with low signal. The waveform for the clockwise rotation is shown in the figure (a).

When the anticlockwise button is pressed, the direction pin will be disabled and reset and sleep pins are enabled. Stepper motor will rotate in anticlockwise rotation. Real time waveform for the counter clockwise rotation is shown in figure (b).

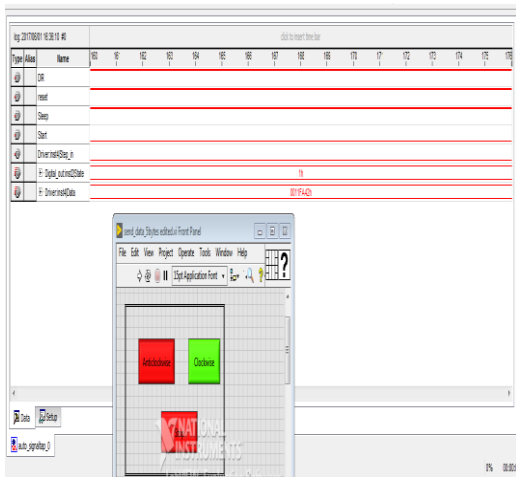


Fig. (a) Real time waveform for the clockwise rotation

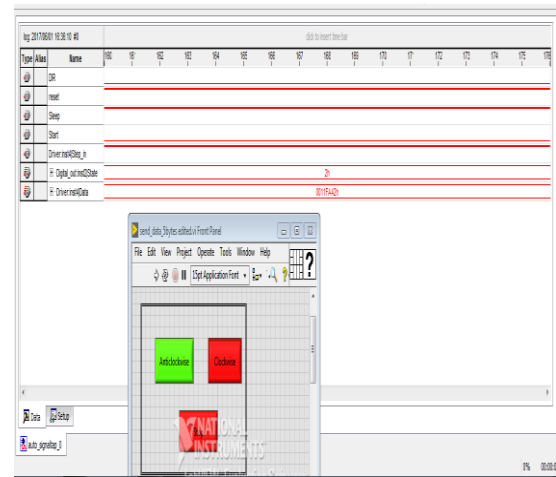


Fig. (b) Real time waveform for the counter clockwise rotation

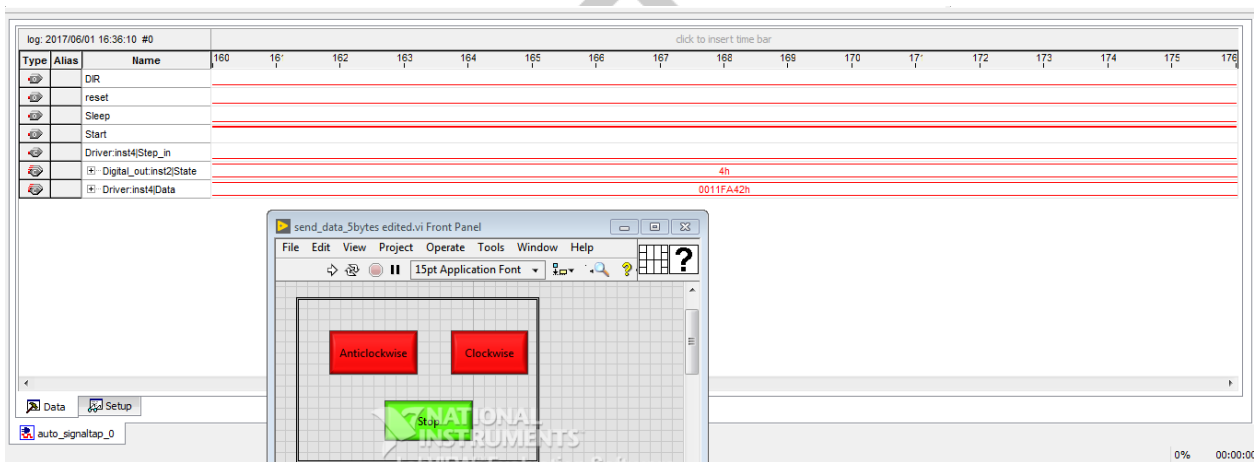


Fig. (c) waveform for the stop signal

When the stop button is pressed in the front panel of the labview, the reset and the sleep pins are provided with low signals. And hence disabled. And start pin is given with high signal. Therefore, the stepper motor gets stopped. The waveform is shown in the above figure (c).

IV. CONCLUSIONS

We can control the single motor very easily. But the combination of three linear actuator stepper motor will be difficult to control. By using three motors, we can test the full cluster and no need to unscrew the camera and fix for the desired position. We know that industrial camera is very costly. Number of camera usage can be reduced due to this project. In this project, we are not giving the number of step or number of revolutions to move the camera. The program for the Altera FPGA program itself receives the steps moved by the camera from the Deo nano SOC board.

In future it can be implemented by making the camera to adjust itself to the point of interest. Usage of the front panel of the LabVIEW can be reduced. The signals from the TOMLine software will directly control the motors to adjust it for accurate position.

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