Crankshaft Profiling & Gauging System

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Abstract— A Crankshaft is a mechanical part able to perform a conversion between reciprocating motion and rotational motion. It is located in the engine of a vehicle and converts the force created by the engine's pistons moving up and down into a force that moves the wheels in a circular motion so the car can go forward. Located inside the car's engine, it is connected to all the pistons in the engine and plays an important role in engine efficiency. Crankshafts are usually gauged using 2 methods, manual and automatic. Manual method includes usage of Vernier caliper and gauges. It also includes comparison of dimensional readings of crank with the hand drawn drawings. Thus the method becomes tedious, time consuming, less accurate and involves human interference. The currently used automated method includes gauging using completely automated machines like Coordinate measuring machine (CMM) and Virtual measuring machines(VMM) by virtue of image processing and laser technology which ultimately increases the cost. This project is motivated mainly by the need for inexpensive, more accurate and less complex gauging system. It also aims at providing the entire profile of the crank in the form of graphs, helping in analysis. Thus in this project we will develop a real time embedded and completely automated system for gauging the crankshaft.

Key words: Crankshaft, VMM, CMM

I. INTRODUCTION

Crankshafts find many applications in various branches of engineering. They are used whenever there is need to translate reciprocating linear motion into rotation and vice versa. In their more varied configurations, they are usually used in internal combustion engine and also in piston steam engines. Along with accurate dimensions, the axis of crank pin should be exactly parallel to the axis of journal. If not so, the engine's performance is hampered. The engine and fuel efficiency of an automobile is decreased. Thus profiling and gauging plays a very important role in manufacturing of crankshaft.

Our project is based on micro controller and windows embedded compactor (WinCE). Due to provision of graphical user interface, the system becomes more interactive in analyzing different dimensional parameters. The system will provide all dimensional readings of crankshaft which will be compared with the standard readings. This makes inspection easier as the entire profile is provided.

II. DESIGN CONCEPTS

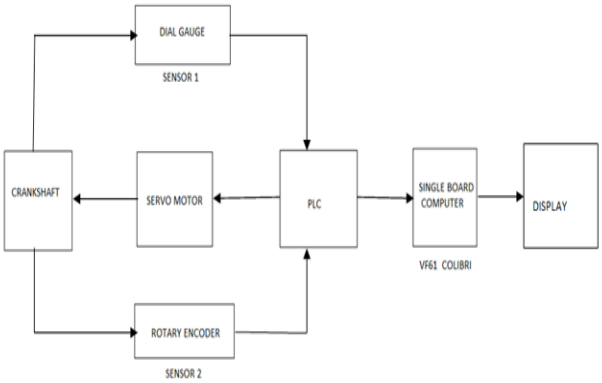

Fig. 1: Block diagram of system.

Quality of a crank shaft plays a very important role in industry. This quality can be maintained by proper manufacturing of a crank shaft. Currently used systems for profiling and gauging are Vision machine, CMM, VMM. All these systems use image processing and laser technology which makes them costlier. Also these systems are complex to use. CMM has drawback that it gets difficult to perfectly coordinate the job.

As this is an industrial system, industries carry their embedded work on SBC as their compact size makes them portable. We are going to develop GUI on SBC. The SBC module used is Colibri VF61 which requires a carrier board Orchid. We have chosen WinCE8 as an Operating System. The main purpose of using this OS is that it is latest [11]. For GUI development we are going to use Visual Studio Professional 2013, as WinCE8 supports only this version of Visual Studio. Main reason of choosing PLC is that, PLCs are easily programmed and have an easily understood programming language. Micro 850 is a series of Allen Bradley family, together with the Connected Components Workbench software, provides just enough control capability to match with our application requirement

A. Hardware design

Here, optocouplers are used as isolation circuit for the input side. In transistors H_{FE} is up to 100 but in optocouplers Current transfer ratio is 50%, for 10mA input we get 5mA output. Optocouplers provide isolation on controller side. It avoids unwanted switching, spikes in input side. A pull up resistor is applied to the input side which pulls the voltage levels up to 3.3V.

On the output side, optocouplers are cascaded with MOSFET.MOSFET will provide faster switching on the output side. A pull up resistor of 10kΩ is applied to the output of optocouplers. LED is used for indication. Input resistor circuitry is to provide extra load regulation on output side.

Unity Gain buffer Amplifier is used as isolation amplifier. It works without drawing any current from input terminal, it can give any amount of current that OPAMP can

supply. It can be used where we don't want to draw current from circuit i.e. load regulation. A resistor is connected to analog input which is pull down resistor.

For power supply, dc-dc buck converter is used which stepdown the input voltage known as switching regulator. This switching regulator converts 24V dc voltage to 5V dc voltage.

This regulator is further cascaded by low dropout voltage regulator for 5V and low dropout regulator for 3.3V.

B. Software design

VF61 is a SODIMM sized computer modules based on the Freescale Hybrid embedded System-On-Chip (SoC). It supports operating systems like Windows Embedded Compact and Linux. In our project we are going to use WinCE 8. The module VF61 needs to be booted with operating system's image on which you are going to work.

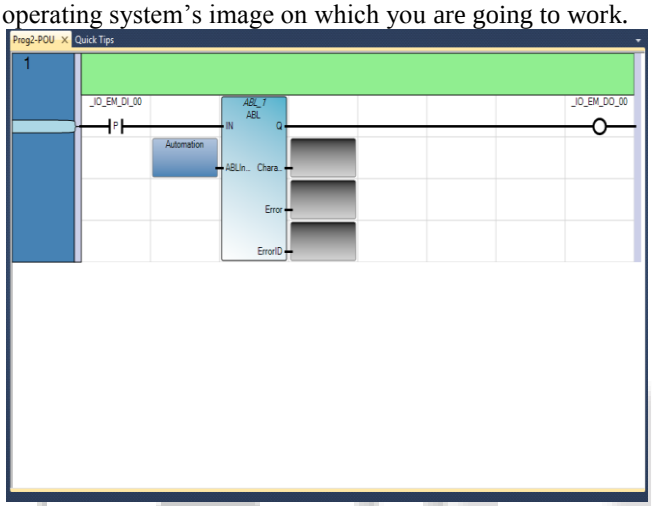

Fig. 2: Program for storing any input string length in the buffer of the plc

- DI_00 is the normally open contact of plc i.e. it is the input switch.
- DO_00 is the direct coil i.e. output coil.
- ABL block counts the total number of characters in the input buffer up to and including the end of line termination character.
- 'Automation' is the input string.
- Q is the final output.
- Error is the output. It tells whether the error is present or not. If error is present it gives TRUE and for no error, it gives FALSE.
- Error is the output which gives the error ID if error is present.
- Character is the output which tells the total number of characters in the input string. Here the output is 10 i.e. 10 characters of the input string 'Automation' are present in the buffer.

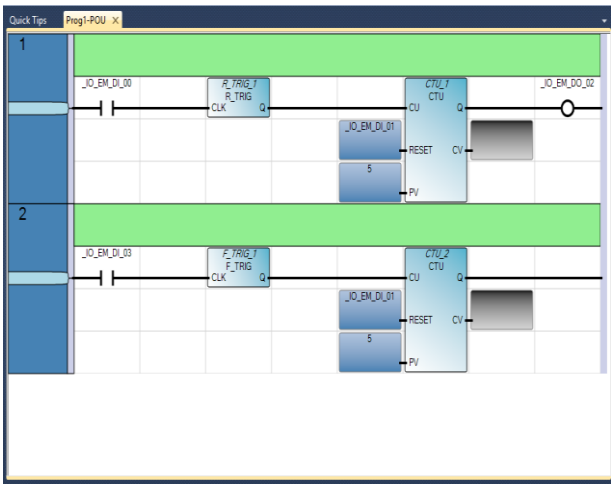

Fig. 3: Program for counting the number of pulses.

- DI_00 and DI_03 are the normally open contacts of plc i.e. it is the input switches.
- DO_02 is the direct coil i.e. output coil
- The block R_TRIG and F_TRIG are the blocks for detecting the rising edge and falling edge of the pulses respectively. The output of R_TRIG block goes high when a rising edge of the pulse is detected and output of F_TRIG block goes high when a falling edge of the pulse is detected.
- CTU is the up counter. In this program it is used to count the number of pulses.
- When the output of R_TRIG block goes high, CTU_1 counts for every rising edge.
- When the output of F_TRIG block goes high, CTU_2 counts for every falling edge.
- From this program we get the total number of pulses.

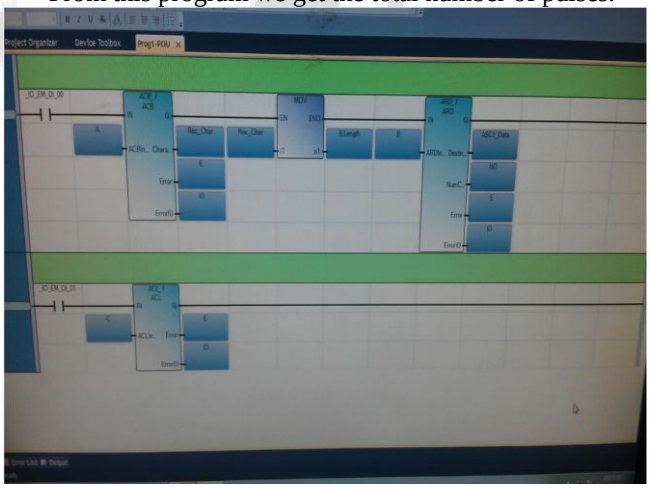

Fig. 4: Program for reading characters from plc to pc i.e. HyperTerminal

- For application development we have used Visual Studio Professional 2013.
- The application i.e. GUI is developed on Host computer and then its .exe file is deployed on Colibri module.[11]
- Before deploying a project on Colibri module, connect the Colibri to the host PC using a USB cable.
- Power up the board.
- The device will be shown as connected in Windows Mobile Device Centre. To deploy the project, in the Build menu, click Deploy solution.

III. EXPERIMENTAL RESULTS OF SYSTEM

Fig. 5. Experimental setup.

The figure shows the experimental set up of crankshaft.

WinCE8 is successfully installed on Colibri module VF61. After insertion of module on carrier board, the board is power up and it is connected to display through VGA cable. As soon as board is powered up it displays booting messages and after around 2 seconds the desktop will appear.

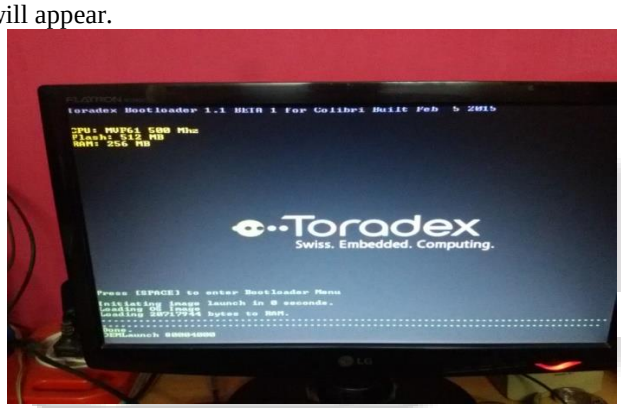

Fig. 6: Booting messages shown on screen.

While booting an image on Colibri module the error occurred was it was not able to read OS image from flash because the kernel had got corrupted. For troubleshooting this error, we used recovery mode and successfully booted an image.

We plotted the graphs of ovality of crankpin and degree reading from the rotary encoder and compared it with the standard. The ovality of crankpin affects the performance of engine. We also checked the cycle time of crankshaft for its balancing. For balanced crankshaft design cycle time should follow the repeatability

IV. CONCLUSION

Crankshafts have direct effect on the engine and fuel efficiency of an automobile. In recent years, with the requirements of more powerful engine in harsher working conditions, crankshaft quality issues have become even more important. Thus profiling and gauging plays a very important role in manufacturing of crankshaft. From the analysis we can see the dimensional readings of crankshaft. This system will provide a cost effective and less complex technology which will be applicable to various industries to improve the production quality, reduce the scrap product and easy profiling of crankshaft.

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