Design and Implementation of the Moving Work Piece Sorting System Based on LabVIEW

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ABSTRACT

Sorting is any process of arranging items systematically, arranging them in a sequence ordered by some criterion or grouping items with similar properties. In sensor based sorting the items are singularly detected by a sensor technique and separated by a mechanical process. The sorting techniques are generally applied in the three industries namely mining, recycling and food processing. Advances in sensing and quantifying material surface characteristics in connection with rapid growth in computing and software technology has made it possible to rely on sorting process more and more.

Keyword- *Conveyor, LabVIEW, PIC16F877A, ULN2003, Camera*

1. INTRODUCTION

The current sorting techniques use the sorting methods based on the parameters such as color, objects weight, shape and size. The proposed system will utilize a parameter Shape for identifying the various objects. By taking this parameters and using data processing the speed of the sorting process will be increased. Growing technological awareness and skills of the machine users as well as increasing the technical support by sorter manufacturers are the optimistic factors in growing the acceptance of sorting machine. However, lack of consistent, easy to be maintained and low cost sorting system are giving losses. Thus, there is a need to develop new machines based on reliable sensing and sorting techniques to promote sorting applications. The technology of sorting different work pieces has a higher demand in industrial production. Reduce the time of production by speeding the sorting technique of raw materials. Currently to automate the sorting process Robots are used which are very costly. Sorting manually is more time consuming, less accurate and costly. Hence, a moving work piece system which can sort different objects is required.

Sorting systems remain essential in numerous areas with diverse applications such as in manufacturing industry, libraries, factories, warehouses, pharmacies, supermarkets etc. The various types of Sorting Methods are as given below:

1. **Hand Sorting**--Impractical, Time Consuming and Less Efficient

2. Automated Sorting--Reliable, Efficient, Fast and Accurate

Hence an automated sorting technique is preferred over manual sorting process.

Various Parameters that are used to distinguish work pieces are as follows: 1. Color 2. Shape 3. Size 4. Weight

Fig-1 shows a sorting using conveyor and controller. In our system we will be using the shape as a distinguishing parameter to sort various work pieces. There are various techniques available in the market for sorting purpose namely optical sorting, magnetic sorting, sorting using air gun, electrostatic sorting, acoustic sorting, and sorting using conveyor belt. Of the available techniques we will be using the conveyor based sorting technique in our system.

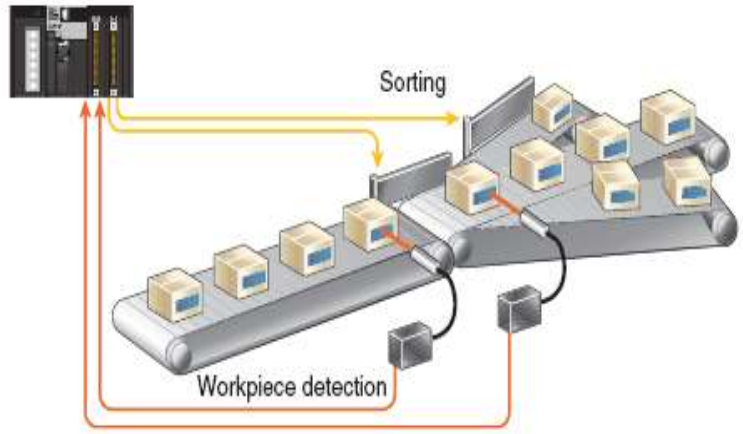

Fig-1: Sorting using conveyor and controller

2. SYSTEM OVERVIEW

The system consists of a conveyor belt which is rotated using DC motors. One IR sensors are mounted on the conveyor to determine the shape of the work pieces in order to sort them. The IR sensors output is processed by the PIC microcontroller and the objects are moved to output tray 1 or output tray 2 or output tray 3 based on the size of the object. The block diagram of the system is shown in Fig 2. There will be three types of work pieces with different shapes. The conveyor will be rotating continuously with a speed which will be 10 rpm in our system. The different work pieces on the conveyor are detected by using the IR Transreceivers which send their output to the microcontroller system. Based on the output which is obtained from the IR transreceivers the shape of the object is decided. The sorting hardware will then drop the work pieces based on their shape into Tray 1 or Tray 2 or Tray 3. The conveyor system and the sorting hardware are also controlled and monitored at the remote location using the LabVIEW Software.

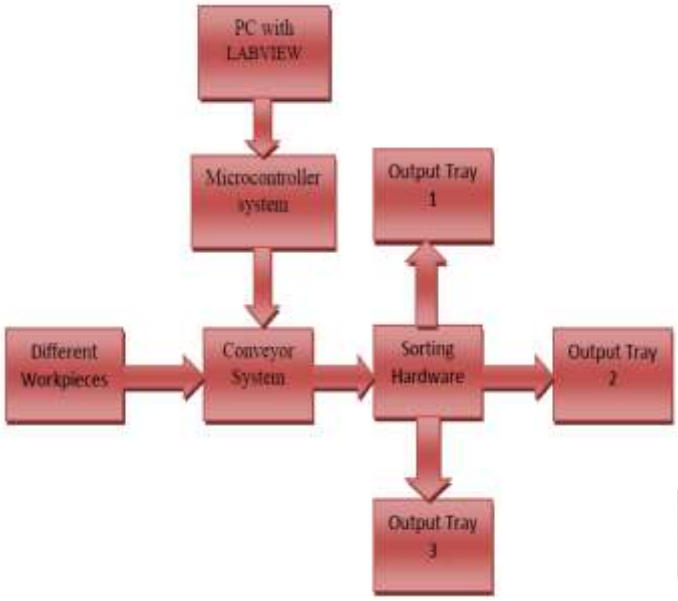

Fig-2: Overall Block Diagram of the system

3. HARDWARE IMPLEMENTATION

Following hardware components are used for designing the system described:

3.1 PIC Microcontroller 16F877A

The 16F877A is one of the most popular PIC microcontrollers and it's easy to see why - it comes in a 40 pin DIP pin out and it has many internal peripherals. The 16F877A is a capable microcontroller that can do many tasks because it has a large enough programming memory 8k words and 368 Bytes of RAM. The gate could be used to more accurately capture an input time e.g. for a reciprocal frequency counter. The volt reference means we don't need an external reference although it will probably not be useful for highly accurate operation. It is definitely more useful in a battery powered operation where you want to compare the input battery voltage to a known reference e.g. using the comparator and the internal 0.6V reference. The internal clock is useful for general operation - it can also be set to 31 kHz so consuming less power. The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to decide what external devices to attach without worrying too much if there are enough pins to do the job. One of the main advantages is that each pin is only shared between two or three functions so it's easier to decide what the pin function (other devices have up to 5 functions for a pin).

3.2 ULN 2003 Motor Driver IC

ULN2003 is a high voltage and high current Darlington array IC. It contains seven open collector darlington pairs with common emitters. A darlington pair is an arrangement of two bipolar transistors. ULN2003 belongs to the family of ULN200X series of ICs. Different versions of this family interface to different logic families. ULN2003 is for 5V TTL, CMOS logic devices. These ICs are used when driving a wide range of loads and are used as relay drivers, display drivers, line drivers etc. ULN2003 is also commonly used while driving stepper motors. Each channel or darlington pair in ULN2003 is rated at 500mA and can withstand peak current of 600mA. The inputs and outputs are provided opposite to each other in the pin layout. Each driver also contains a suppression diode to dissipate voltage spikes while driving inductive loads. The pin configuration of ULN 2003 IC is shown in Fig-3.

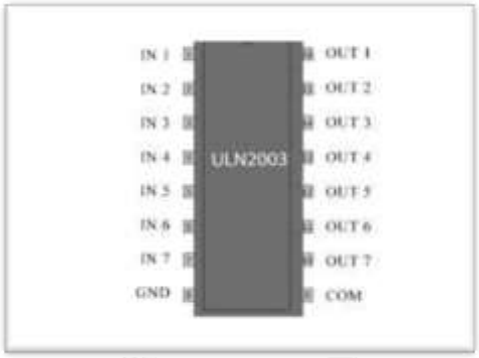

Fig-3: Pin configuration of ULN 2003 IC

3.3 IR Transreceiver

The photo IR sensor uses a photo diode to sense IR Radiations. The output of the infrared sensor circuit is connected to PIC microcontroller pins and the microcontroller will take it as digital input either 0 or 1. According to the output of the infrared sensor module, the microcontroller will react by glowing LED. The output of the infrared sensor circuit is connected to RB0 pin of the PIC microcontroller.

3.4 DC Motor

DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes

3.5 RS232 Serial Interface

RS-232 is a standard communication protocol for linking computer and its peripheral devices to allow serial data exchange. In simple terms RS232 defines the voltage for the path used for data exchange between the devices. It specifies common voltage and signal level, common pin wire configuration and minimum, amount of control signals. As mentioned above this standard was designed with specification for electromechanically teletypewriter and modem system.

3.6 Power Supply Unit

We require a 9V supply so we need LM7805 Voltage Regulator IC. 7805 IC Rating: Input voltage range 7V-35V, Current rating I_C = 1A, Output voltage range $V_{Max=5.2V}$,$V_{Min=4.8V}$. Selecting a suitable DC Adaptor is of great importance. Fig-4 shows a circuit diagram of power supply unit.

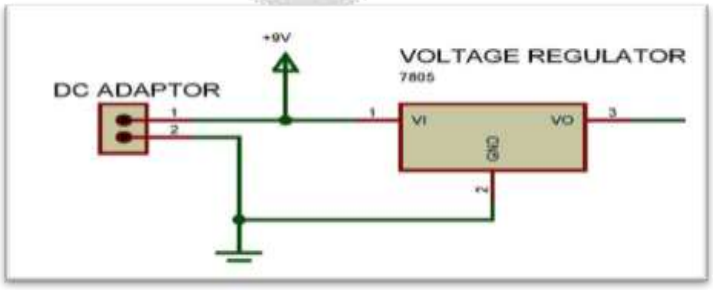

Fig-4: Circuit diagram of Power supply unit

3.7 Stepper Motor

Stepper motors work on the principle of electromagnetism. There is a soft iron or magnetic rotor shaft surrounded by the electromagnetic stators. The rotor and stator have poles which may be teethed or not depending upon the type of stepper. When the stators are energized the rotor moves to align itself along with the stator (in case of a permanent magnet type stepper) or moves to have a minimum gap with the stator (in case of a variable reluctance stepper). This way the stators are energized in a sequence to rotate the stepper motor. Fig-5 shows a schematic diagram of the stepper motor.

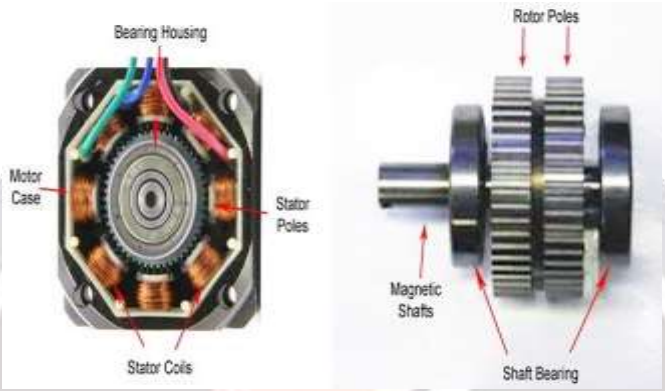

Fig-5: Stepper motor

3.8 Camera

Cameras have been used for taking real time view of the object. The camera used for capturing the video image. The camera was interfaced with a computer through USB port. The proposed algorithm was implemented in Lab VIEW Real Time Environment for Moving workpiece sorting system. The camera used is QHM495LM and is shown in Fig-6.

Fig-6: Quantum Web Camera

4. SOFTWARE IMPLEMENTATION

The PIC Microcontrollers are programmed by the embedded C language or assembly language by using dedicated software MpLab IDE and PIC USB ICSP Serial Programmer. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a highly productive development environment for a visual programming language. Test point, Measurement Studio, LabVIEW is most widely used due to advantages like parallel programming, code re-use, large available libraries, etc. The algorithm for data processing in LabVIEW and microcontroller is shown in Fig-7.

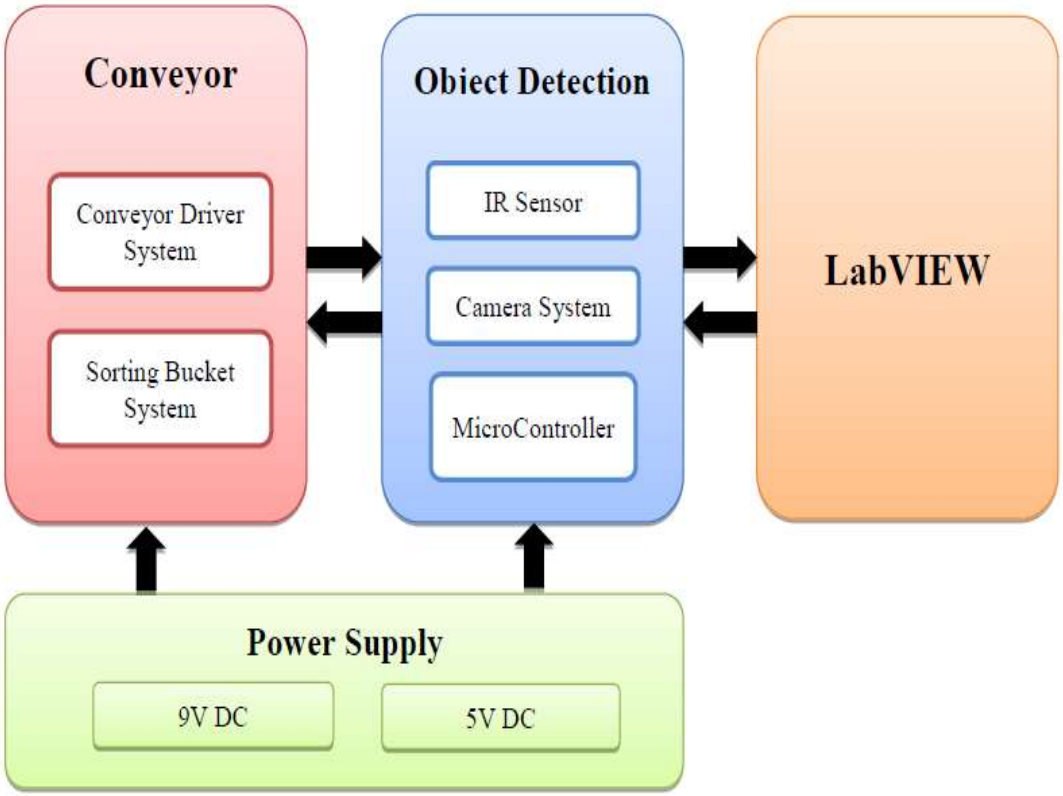

Fig-7: Algorithm for data processing in LabVIEW and Microcontroller

5. Results and Discussions

The LabVIEW based Work Piece Sorting system is implemented successfully. Fig-8 below shows the hardware implementation of the system.

Fig-8: Hardware implementation of the Sorting system

Figures-9(a)-9(d) shows the block implementation in the back panel of the LabVIEW software. Various loops and counters are used in order to achieve the required output.

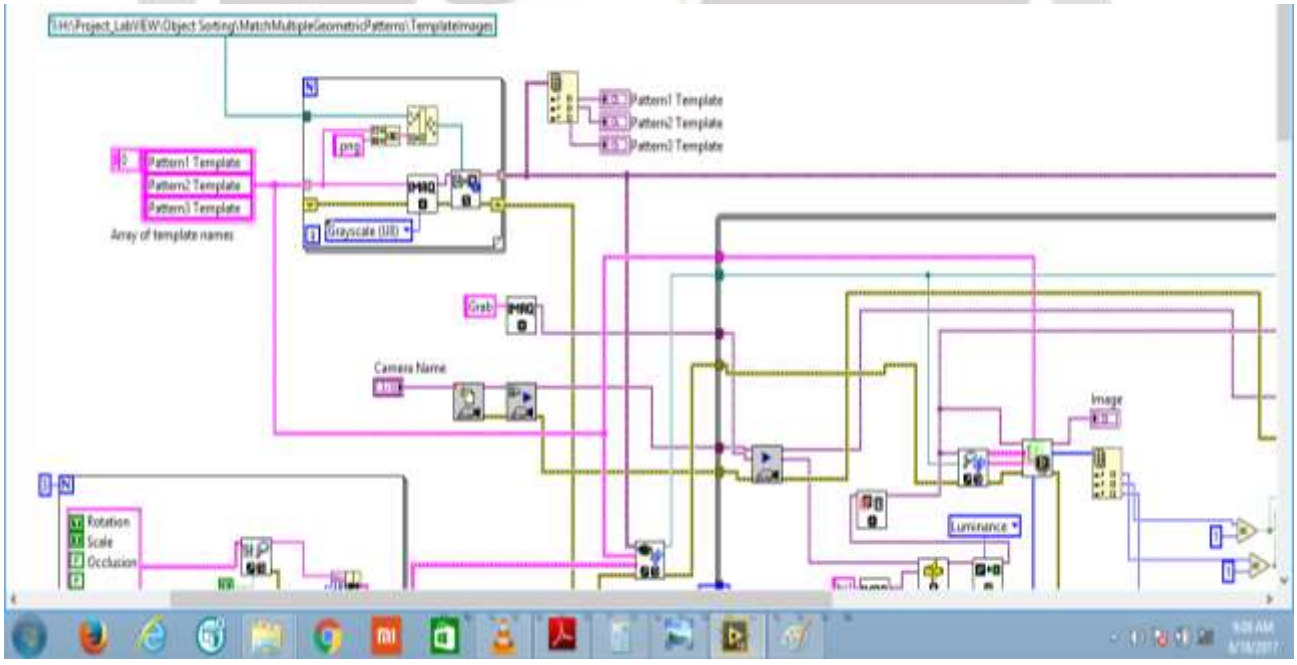

Fig-9 (a): Block diagram of system in LabVIEW

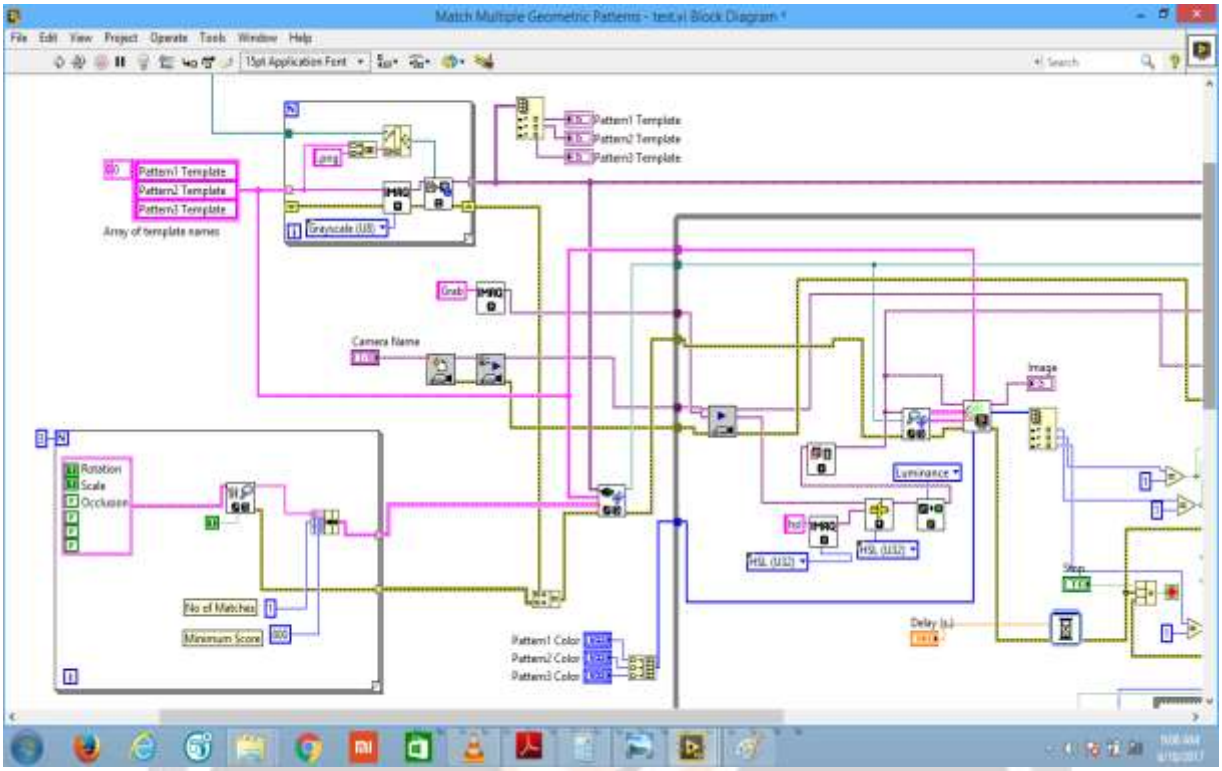

Fig-9 (b): Block diagram of system in LabVIEW

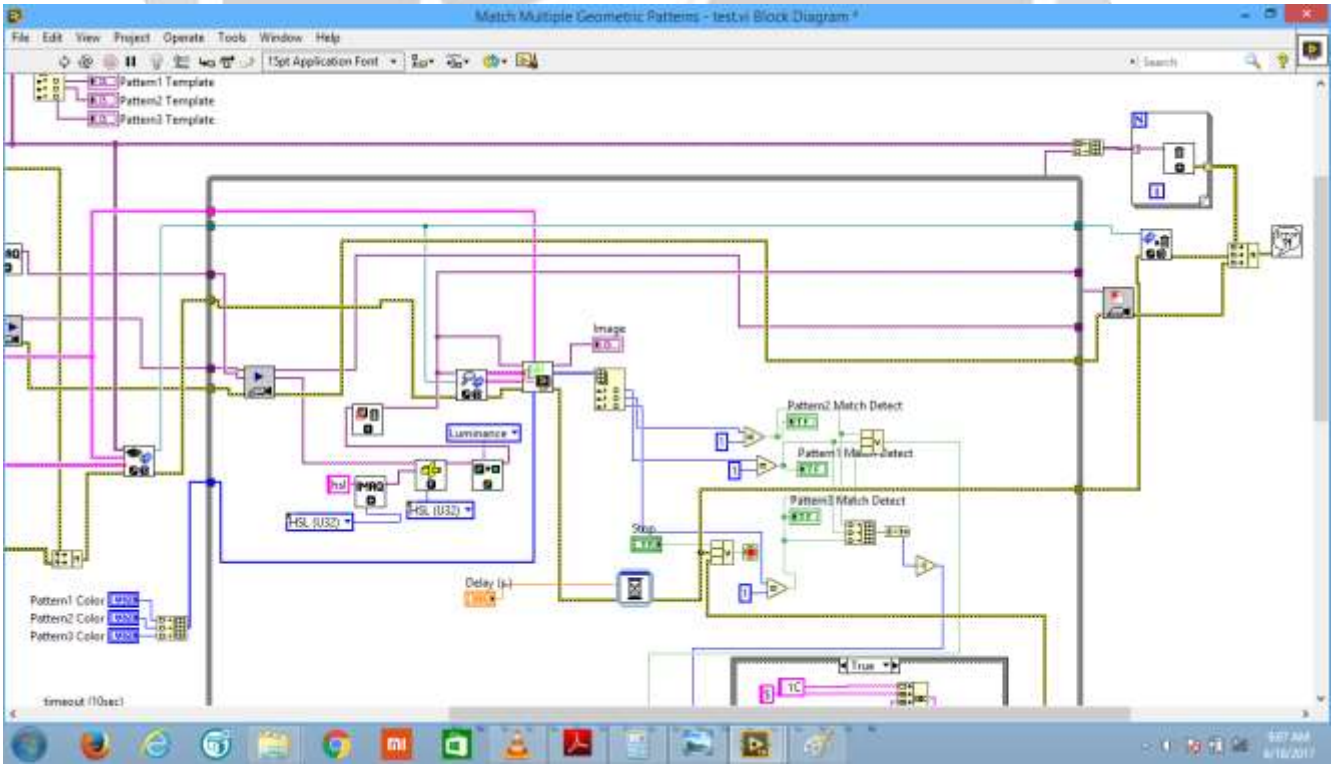

Fig-9(c): Block diagram of system in LabVIEW

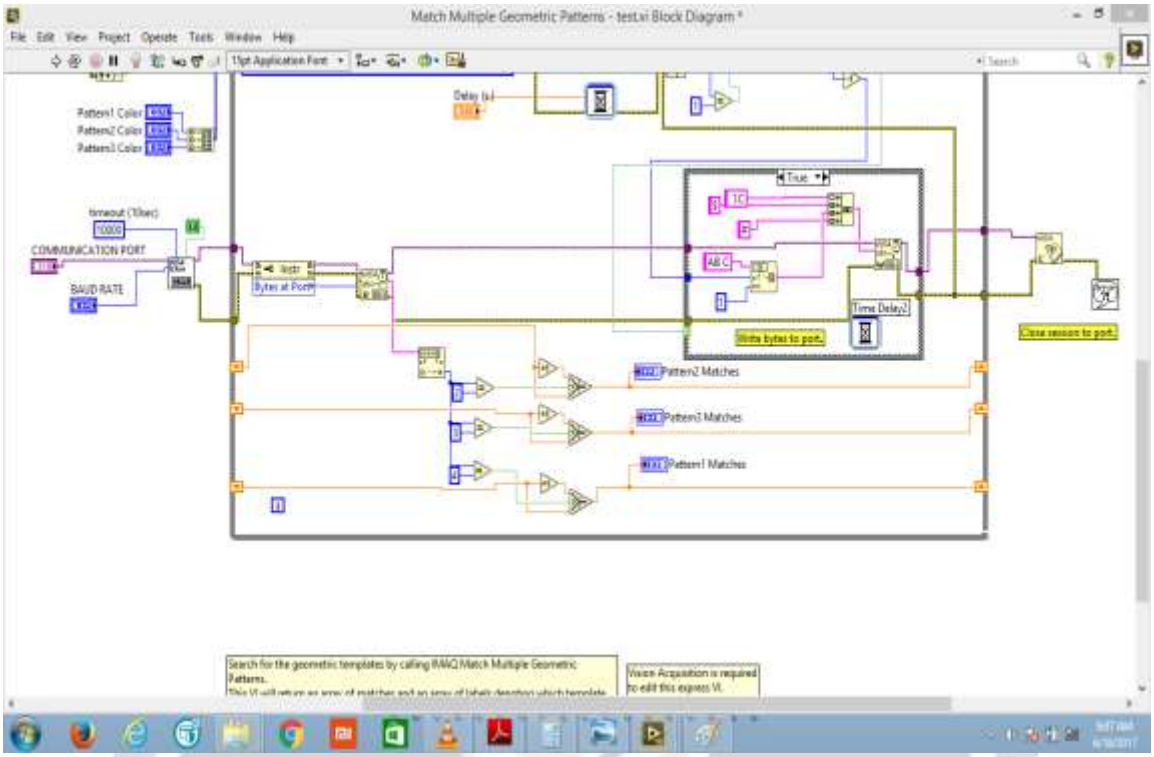

Fig-9(d): Block diagram of system in LabVIEW

Fig-10 shows the user interface screen designed in LabVIEW software. When the object is not placed on the conveyor belt it moves further and initially the sensors indicators are not glowing as shown in the Fig-10 (a).

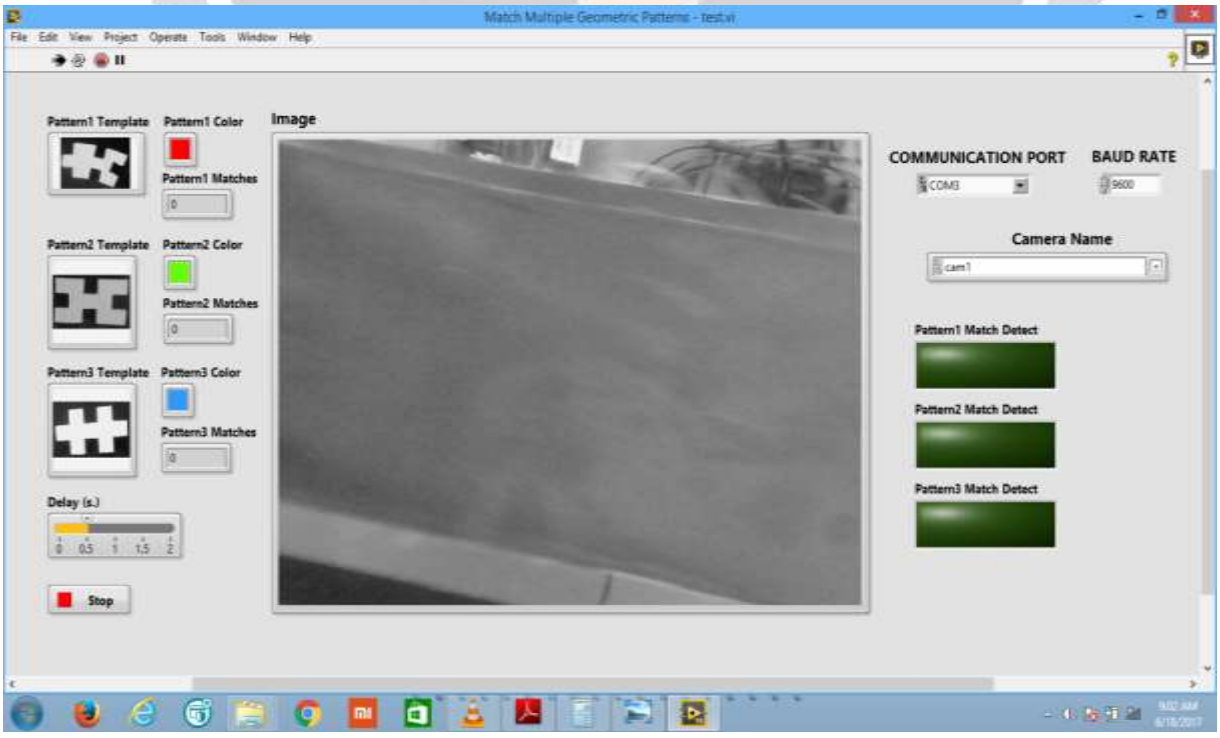

Fig-10 (a): Front Panel of the Sorting System in LabVIEW

The work piece moves on the conveyor belt it is detected by the sensor and it is indicated by glowing the sensor Led Red on the front panel of the LabVIEW as indicated in Fig-10 (b).

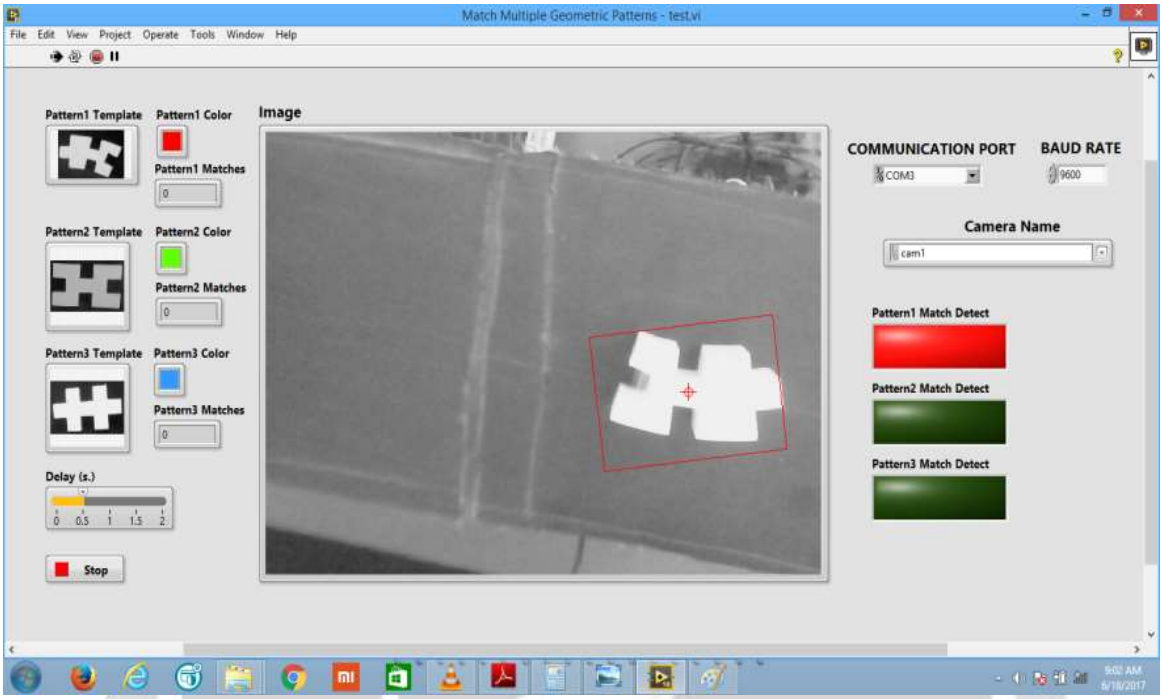

Fig-10(b): Front Panel of the Sorting System in LabVIEW

As the work piece moves further on the conveyor belt it is detected by the sensor and it is indicated by glowing the sensor Red green on the front panel of the LabVIEW as indicated in Fig-10 (c).

Fig-10 (c): Front Panel of the Sorting System in LabVIEW

As the work piece moves further on the conveyor belt it is detected by the sensor and it is indicated by glowing the sensor Led Blue on the front panel of the LabVIEW as indicated in Fig-10 (d).

Fig-10 (d): Front Panel of the Sorting System in LabVIEW

Hence the design and implementation of the low cost moving work piece sorting system based on LabVIEW is implemented successfully.

6. CONCLUSIONS

The moving workpiece sorting system has been employed for identification of objects in terms shape. An interactive graphical user interface was developed in LabView with vision assistant module. The user can observe the field of view along with the part count in each category. Further the control panel identifies the shapes including rectangle and triangle with an LED indicator. The cameras ability to separate the noisy colors is a prime factor in this analysis. Also, the program has ability to identify the more number of shapes.
In real practice, the industry requires parts separation as per the attributes described above and we employ some actuation mechanism to separate the objects as per the signal received from the moving workpiece sorting system.

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