GRAPHICAL SYSTEM DESIGN FOR QUALITY ANALYSING AND DYE MIXING OF PAPER

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Abstract: Paper holds a powerful and often sacred place in the history of human interaction. Historic papers continue to inspire millions, centuries after they have been scribed. Paper ignites controversy in the form of literature and political proclamations. Paper certificates help define who we are, where we live, what we have learned and how we earn a living. It is fascinating to think that such a simple invention could have such a monumental impact upon civilization. And also today's fast world requires fully automated system for easy access and executing the work in the simple manner. Automation is an area where lots of cost and efforts are saved. While, the major problem that the paper machine faces is the improper mixing of colour dye which results in bad colour quality of paper. So we proposed the system where mixing of colour dye is monitored automatically .With the help of Lab VIEW and DAQ we acquire the signal from the sensor unit, valve unit and mixing unit to deliver the correct volume of the colour dye and wood pulp to the paper producing machine with the help of image sensing unit the sample image and the acquired image is compared, once the pattern is matched the solenoid valve gets opened and the dye will be delivered to the storage tank.

Keywords: color mixing phase, color dye;

I.   INTRODUCTION

1. SHORT   SUMMARY   OF   PAPER MANUFACTURING:

Paper is an aqueous deposit of any vegetable fiber in sheet form. If you tear a piece of paper you will see a number of minute 'whiskers' stick out from the line of the tear. These are the fibers, they are very small in and there are millions of them in any piece of paper. Paper is made from cellulose, trees being the main source of cellulose fiber (or wood pulp). Besides wood pulp, paper can be made from other materials such as cotton, flax, esparto, straw, hemp, manila and jute. Some of the pulp properties depend upon the process used to separate the fibers from the timber. The main processes are called mechanical and chemical. If the pulp mill is close to the paper mill, i.e. it is part of an integrated mill; the liquid pulp is

pumped direct to the paper mill. Otherwise, after straining, the pulp is dried and packed into bales. In the Paper Mill the bales of dry pulp are broken up in a hydrapulper (a large circular metal tank in which a mixture of pulp and water circulates). The liquid pulp, looking a little like porridge, is then pumped to machines known as refiners.

These modify the fibers by passing them between sets of fixed and rapidly moving metal bars. As the fibers undergo this treatment they are chopped or bruised to varying extents. This operation, sometimes referred to by its older name of 'beating', is extremely important as it mainly controls the type of paper being made.

2.   Color Ink Diffusion Rendering Method:

This paper proposes an image-based painterly rendering algorithm for automatically synthesizing an image with color ink diffusion. We suggest a mathematical model with a physical base to simulate the phenomenon of color colloidal ink diffusing into absorbent paper. Our algorithm contains three main parts: a feature extraction phase, a Kubelka-Munk (KM) color mixing phase, and a color ink diffusion synthesis phase. In the feature extraction phase, the information of the reference image is simplified by luminance division and color segmentation. In the color mixing phase, the KM theory is employed to approximate the result when one pigment is painted upon another pigment layer. Then, in the color ink diffusion synthesis phase, the physically-based model that we propose is employed to simulate the result of color ink diffusion in absorbent paper using a texture synthesis technique.

Our image-based ink diffusing rendering (IBCIDR) algorithm eliminates the drawback of conventional Chinese ink simulations, which are limited to the black ink domain, and our approach demonstrates that, without any strokes, a color image can be automatically converted to the diffused ink style with a visually pleasing appearance

Drawbacks:
- The algorithms are complex to understood

- Not easy to change l, a, b values

3. Automated masking of voltage-sensitive dye imaging data Method

This paper discusses the development of an algorithm to mask poor quality data in fluorescence videos of cardiac tissue stained with voltage-sensitive dye. The aim was to simplify further analysis by eliminating the step of manually masking areas of poor signal quality and areas outside the preparation of interest. Our algorithm estimates signal to noise ratio (SNR) from the power spectral density (PSD) for each pixel. This information is combined with information about the fluorescence intensity in each pixel, according to a user-selectable weighting factor. A threshold is then applied to the resulting combined measure. This approach resulted in an effective algorithm that is capable of automatically creating a "mask" that can be applied to the data to exclude parts of the data from further analysis. The algorithm is sufficiently efficient to allow interactive use, allowing the user to adjust the parameters of the algorithm and instantly view the resulting mask. This tool will be useful as a technique to simplify further analysis of voltage-sensitive dye imaging data.

Drawbacks:

- Skilled labor is required

- For commercial process large number of small voltage levels is required.

4. Manual control method:

In many of the paper industries mixing of colour dye with wood pulp is often handled by human effort. The colour dye is placed in the separate container and water in another container. Some fixed values are given to the operating personnel to control the dye and water flow into the preparation tank. Sometimes it becomes difficult to open and close the valves. If small fraction of the dye to water ratio changes then the entire process have to be repeated. Accuracy is not possible so we need to automate the process which results in better accuracy and safety operation.

Drawbacks:

- Less accuracy
- Time consuming process
- Skilled labor is required

II.   PROPOSED SYSTEM

In most of the paper industries the mixing of colour dye with the wood pulp is done manually. It requires skilled person to carry out that task and it is a time consuming process. If the mixing is not done in the correct proportion then the colour and quality of the paper is not perfect. In order to provide good quality colour paper automation of the colour mixing process is the only way. Automated color control to gauge colour accuracy and density, calculate the paper machine's speed, stock consistency, and paper dry weight, and then determine the proper dye amounts to create and maintain the correct colour. An automated liquid-dye mixing and distribution skid to replace the manual weighing, hand mixing, and manual dumping of dye into pulpers. With the help of Lab VIEW and DAQ we acquire the signal from the sensor unit, valve unit and mixing unit to deliver the correct volume of the colour dye and wood pulp to the paper producing machine. It consists of the following modules:

- Colour preparation module
- Tank module
- Image processing module
- Solenoid valve control module
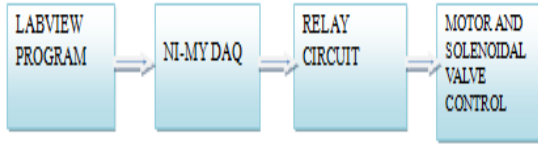

Fig 1: Block diagram

Fig 2: Flow diagram

Colour preparation tank module:

This is the first module which deals with the preparation of colour dye .Inputs like water, colour dye are mixed in some proportion in the preparation tank. Steam is very essential because only at certain temperature the colour dye gets completely dissolved in the water. Steam temperature varies according to the colour dye and nature of the wood pulp. We have to completely stir the mixture inside the tank. In order to do so we have used agitator to stir the mixture.

Agitator:

Agitator is a device used to stir chemicals. There are three main types of agitation machines. This is a device formed by a metallic bar which is normally covered by a plastic layer, and a sheet that has underneath it a rotator magnet or a series of electromagnets arranged in a circular form to create a magnetic rotatory field. During the operation of a typical magnetic agitator, the agitator bar is moved inside a container such as to dissolve a substance in a liquid.

Fig 3: Agitator

Solenoid valve control module:

When the colour dye is prepared it has to be sent to the storage tank immediately. Manually we are opening the valves and sometimes it becomes tight and difficult to open. For making the opening process simpler we are using solenoid valve in colour dye tank, water tank, preparation tank and storage tank. When the tank is full level sensor indicates and sends a signal to the controller unit to close the valve. The solenoid valve uses an electric current which

moves the solenoid. This pulls a piston preventing it from stopping the flow of air and fluid. The valve will need a constant flow of electrical current to remain open because when there is no current flow, the electromagnetic field scatters and the valve returns to its original position.
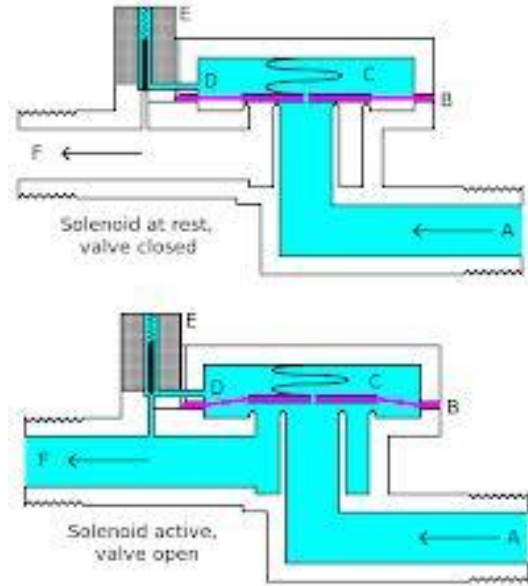

Fig 4: Solenoid valve

4.6 Image processing module:

In this module we are going to match the obtained color image with the standard color image. With the help of image vision technique in Lab VIEW we will compare the image using smart camera and display the details regarding the image. If the two images are same then the color dye will be sent to storage tank else the dye and water are again added and stirred until the match is found. In industries they are using spectrometer to determine the color which is very costly.

Fig 5: USB camera

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A spectrometer or spectrograph is an instrument attached to a telescope to analyze the radiation from astronomical objects. It uses a prism or a grating to spread the light from the object into a spectrum, a rainbow of colors. This allows astronomers to detect many of the chemical elements by their characteristic fingerprints. Typically these are dark bands in specific locations in the spectrum caused by energy being absorbed as light passes through an atmosphere of gas.

If the object is glowing by its own light, it will often show bright lines caused by the glowing gas itself. These lines are named for the elements which cause them, such as the Hydrogen Alpha, Beta, and Gamma lines. The spectrometer is the most powerful and widely used tool in astronomy aside from the telescope itself. Almost all of our knowledge of the chemical makeup of the universe comes from spectra.

Based on the L, A, B values we can determine the nature of paper.

L=Lightness
A=Red/green value
B=Yellow/blue value

L=52.99   A=8.82   B=54.33
Fig 6: Spectrometer picture values

Storage Tank module:

Once the colour dye is prepared and verified by image processing technique it is sent to the storage tank. In storage tank some of the inorganic salts in colour dye don't completely dissolve and this leads to degradation of colour quality and appear as dark patches in the paper.

You have seen these patches often in low quality paper, brown sheet. So we have to remove these sediments before sending to the main tank. Here we are using some level sensor to detect and report the level of sediments to the LABVIEW. Two storage tanks have been used. The storage tank have to be cleaned often doing so the main tank have to be shut down for few minutes but this is not possible as the main tank have to run continuously.

NI myDAQ hardware overview:

NI myDAQ provides analog input (AI), analog output (AO), digital input and output (DIO), audio, power supplies, and digital multimeter (DMM) functions in a compact USB device.

Integrated circuits supplied by Texas Instruments form the power and analog I/O subsystems of NI myDAQ. The arrangement and function of the NI myDAQ subsystems. Refer to Table 5 for more information on all of the Texas Instruments components used in NI myDAQ.

Analog input (AI):

There are two analog input channels on NI myDAQ. These channels can be configured either as general-purpose high-impedance differential voltage input or audio input. The analog inputs are multiplexed, meaning a single analog-to digital converter (ADC) is used to sample both channels. In general-purpose mode, you can measure up to ±10 V signals. In audio mode, the two channels represent left and right stereo line level inputs. Analog inputs can be measured at up to 200 kS/s per channel, so they are useful for waveform acquisition.

Analog inputs are used in the NI ELVISmx Oscilloscope, Dynamic Signal Analyzer, and Bode Analyzer instruments.

Analog output (AO):

There are two analog output channels on NI myDAQ. These channels can be configured as either general-purpose voltage output or audio output. Both channels have a dedicated digital-to-analog converter (DAC), so they can update simultaneously.

Digital Input/output (DIO):

There are eight DIO lines on NI myDAQ. Each line is a Programmable Function Interface (PFI), meaning that it can be configured as a general-purpose software-timed digital input or output, or it can act as a special function input or output for a digital counter. Refer to Digital I/O (DIO) and Counters/Timers section for more information about the counter on NI myDAQ.

Power supplies:

There are three power supplies available for use on NI myDAQ. +15 V and –15 V can be used to power analog components such as operational amplifiers and linear regulators. +5 V can be used to power digital components such as logic devices. The total power available for the power supplies, analog outputs, and digital outputs is limited to 500 mW (typical)/100 mW (minimum).
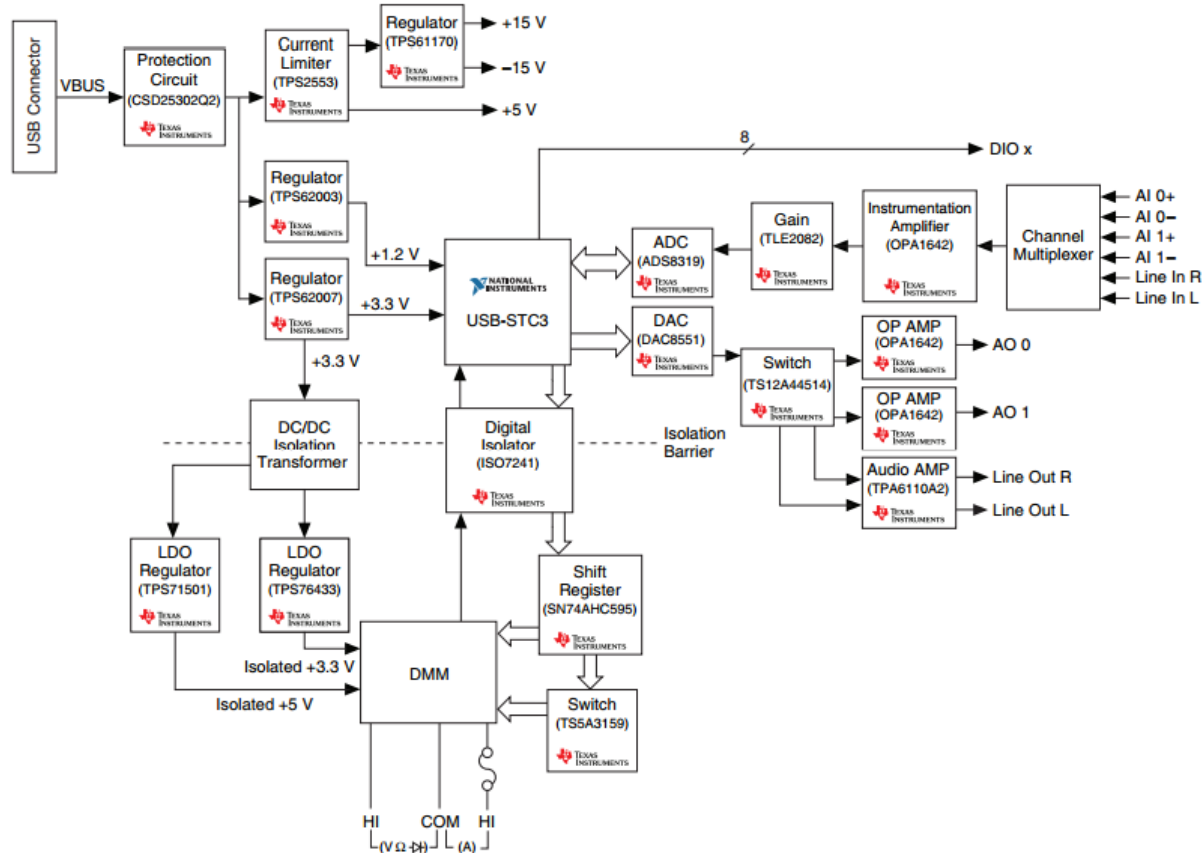
Fig 7: NI myDAQ hardware overview

To calculate the total power consumption of the power supplies, multiply the output voltage by the load current for each voltage rail and sum them together. For digital output power consumption, multiply 3.3 V by the load current. For analog output power consumption, multiply 15 V by the load current. Using audio output subtracts 100 mW from the total power budget.

Digital Multimeter (DMM):

The NI myDAQ DMM provides the functions for measuring voltage (DC and AC), current (DC and AC), resistance, and diode voltage drop.DMM measurements are software-timed, so update rates are affected by the load on the computer and USB activity.

NI ELVISmx Driver Software:

NI ELVISmx is the driver software that supports NI myDAQ. NI ELVISmx uses Lab VIEW-based software instruments to control the NI myDAQ device, providing the functionality of a suite of common laboratory instruments. Refer to the Using NI myDAQ with Soft Front Panel (SFP) Instruments section for information on the NI ELVISmx suite of measurement instruments. NIELVISmx is located on

your driver software installation media included in the NI myDAQ kit, or can be found by searching for ELVISmx on the Drivers and Updates page at ni.com/drivers.

A relay is an electrically operating switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Relay Operation:

- Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a **Form A** contact or "make"

contact. **NO** contacts may also be distinguished as "early-make" or **NOEM**, which means that the contacts close before the button or switch is fully engaged.

- Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a **Form B** contact or "break" contact. **NC** contacts may also be distinguished as "late-break" or **NCLB**, which means that the contacts stay closed until the button or switch is fully disengaged.

- Change-over (**CO**), or double-throw (**DT**), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a **Form C** contact or "transfer".
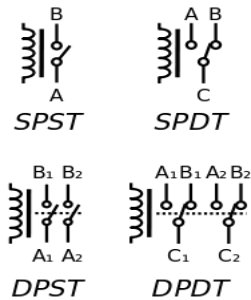

Fig 8: Relay types

An electric motor is an electric machine that converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

Rotor:

In an electric motor the moving part is the rotor which turns the shaft to deliver the mechanical power. The rotor usually has conductors laid into it which carry currents that interact with the magnetic field of the stator to generate the forces that turn the shaft. However, some rotors carry permanent magnets, and the stator holds the conductors.

Stator:

The stationary part is the stator, usually has either windings or permanent magnets.

Air gap:

In between the rotor and stator is the air gap. The air gap has important effects, and is generally as small as possible, as a large gap has a strong negative effect on the performance of an electric motor.

Windings:

Windings are wires that are laid in coils, usually wrapped around a laminated soft iron magnetic core so as to form magnetic poles when energized with current. Electric machines come in two basic magnet field pole configurations: salient-pole machine and nonsalient-pole machine. In the salient-pole machine the pole's magnetic field is produced by a winding wound around the pole below the pole face. In the nonsalient-pole, or distributed field, or round-rotor, machine, the winding is distributed in pole face slots. A shaded-pole motor has a winding around part of the pole that delays the phase of the magnetic field for that pole. Some motors have conductors which consist of thicker metal, such as bars or sheets of metal, usually copper, although sometimes aluminum is used. These are usually powered by electromagnetic induction.

Commutator:

A Commutator is a mechanism used to switch the input of certain AC and DC machines consisting of slip ring segments insulated from each other and from the electric motor's shaft. The motor's armature current is supplied through the stationary brushes in contact with the revolving commutator, which causes required current reversal and applies power to the machine in an optimal manner as the rotor rotates from pole to pole. In absence of such current reversal, the motor would brake to a stop.

Motor supply & control:

AC motors' commutation can be either slip ring Commutator or externally commutated type can be fixed-speed or variable-speed control type, and can be synchronous or asynchronous type. Universal motors can run on either AC or DC. Fixed-speed controlled AC motors are provided with direct-on-line or soft-start starters. Variable speed controlled AC motors are provided with a range of different power inverter, variable-frequency drive or electronic Commutator technologies. The term electronic Commutator is usually associated with self-commutated brushless DC motor and switched reluctance motor applications.
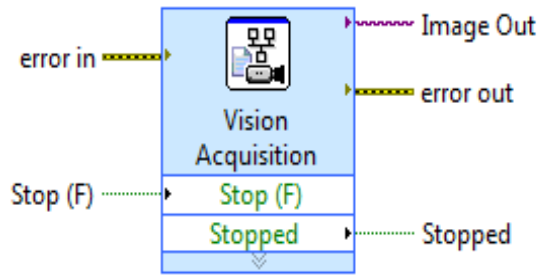
Vision acquisition:

Fig 9: Vision acquisition

- Single Acquisition with Processing: Acquires a single image.

1. Select Single Acquisition with processing from the available configuration options.
2. Click Next.

- Continuous Acquisition with Inline Processing: Continuously acquires images until an event stops the acquisition.

3. Select Continuous Acquisition with Inline Processing from the available configuration options.
4. Select an Acquire Image Type. The following options are available.
- Acquire Most Recent Image—Use this mode to acquire the most recent image. This mode could miss some images, but the image returned will always be the most recent.
- Acquire Every Image—Use this mode for applications in which acquiring every image is necessary.

5. If applicable, specify the Number of Images to Buffer.

- Finite Acquisition with Inline Processing: Acquires a specified number of images and returns each image as it is acquired. All images are allocated on the first iteration. Processing can occur while images are acquired without affecting acquisition speeds. Select Finite Acquisition with Inline Processing from the available configuration options.
1. Specify the Number of Images to Acquire.
2. Click Next.

- Finite Acquisition with Post Processing: This mode is the same as Finite Acquisition with Inline Processing, except the images are only available after they are all acquired. Complete the following steps to configure a finite acquisition with post processing:
1. Select Finite Acquisition with Post Processing from the available configuration options.
2. Specify the Number of Images to Acquire.
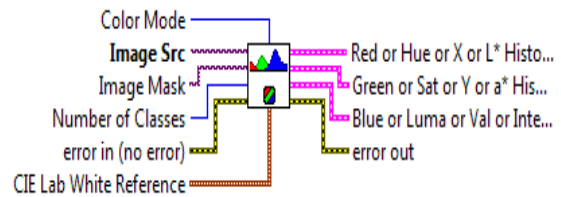3. Click Next.

8.3 IMAQ Color Histogram VI:

Fig 10: IMAQ Colour Histogram VI

Calculates the histograms extracted from the three planes of an image. This VI can function in one of six modes corresponding to the six color models (RGB, HSL, HSV, HSI, CIE L*a*b*, or CIE XYZ).

The IMAQ ColorHistograph VI, a variant of the IMAQ Color Histogram VI, has the advantage that its output data is directly compatible with a Lab VIEW graph.
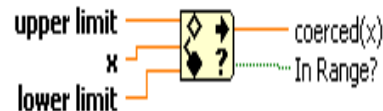
In range or coerce:

Fig 11: In range or coerce

Determines whether x falls within a range specified by the upper limit and lower limit inputs and optionally coerces the value to fall within the range. The function performs the coercion only in Compare Elements mode. This function accepts time stamp values if all inputs are time stamp values. You can change the comparison mode of this function.

DAQ ASSITANT:

Creates, edits, and runs tasks using NI-DAQmx. When you place this Express VI on the block diagram, the DAQ Assistant launches to create a new task. After you create a task, you can double-click the DAQ Assistant Express VI to edit that task. For continuous measurement or generation, place a while loop around the DAQ Assistant Express VI.

Parameter	Description
Data	Contains samples to write to the task. data is an output for measurement tasks and an input for analog and digital output tasks. Data does not appear for counter output tasks.
error in	Describes error conditions that occur before this Express VI runs.
number of samples	Specifies the number of samples to acquire or generate for each channel in a finite task.
Rate	Specifies the sampling rate in samples per channel per second. This input does not appear for some channel types and sample timing types.
Stop	stop For single-point and finite tasks, this input is TRUE by default, meaning the task stops after all samples are acquired. To optimize single-point performance when using this Express VI in a loop, wire this input to the same stop control you wire to the conditional terminal of the while loop.
Timeout	Specifies the amount of time in seconds to wait for the VI to read or write all samples. This VI returns an error if the time elapses. For input operations, the VI also returns any samples read before the time elapses. The default timeout is 10 seconds. If you set timeout to -1, the VI waits indefinitely. If you set timeout to 0, the VI tries once to read or write the samples and returns an error if unsuccessful. NI-DAQmx performs a timeout check only if the VI must wait to read or write samples.

Table 8.1 DAQ inputs

When you place this Express VI on the block diagram, the DAQ Assistant launches to create a new task. After you create a task, you can double-click the DAQ Assistant Express VI to edit that task. For continuous measurement or generation, place a while loop around the DAQ Assistant Express VI.

Using the DAQ Assistant Express VI creates a task accessible only to the Express VI. To make the task globally accessible from any application, you must convert the Express VI to an NI-DAQmx task saved in MAX .You can generate NI-DAQmx API code from a DAQ Assistant Express VI.

Parameter	Description
Data	Contains samples read from the task. data is an output for measurement tasks and an input for analog and digital output tasks.
error out	Contains error information. If error in indicates that an error occurred before this Express VI ran, error out contains the same error information. Otherwise, it describes the error status that this Express VI produces.
Stopped	Indicates whether the task stopped. The task stops if the stop input is set to TRUE or an error occurs. This output appears for continuous or hardware-timed single-point tasks only.
Task out	Contains a reference to the task after this VI completes execution. Wire this output to other NI-DAQmx VIs to perform other operations with this task.

Table 8.2 DAQ outputs

Right-click the DAQ Assistant Express VI and select Generate NI-DAQmx Code from the shortcut menu to generate both configuration and example code for the task.
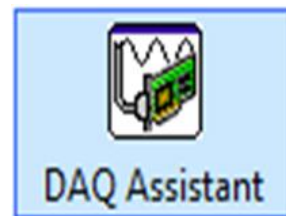

Fig 12: DAQ Assistant

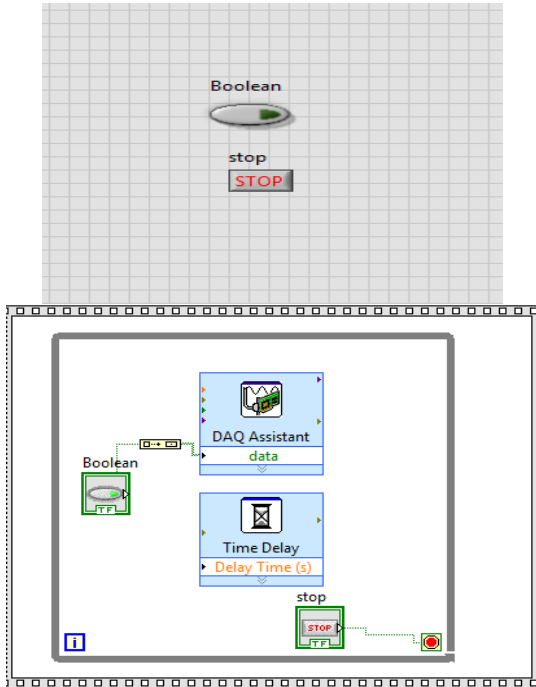### III.   SIMULATION RESULTS

Fig 13: Starting DC motor module

In this module DAQ assistant is used to generate a digital output of 3.3v .This 3.3v is converted into 5v using Darlington circuit and used to trip a relay which in turn provides a 12v dc supply to open the motor controlled valve.
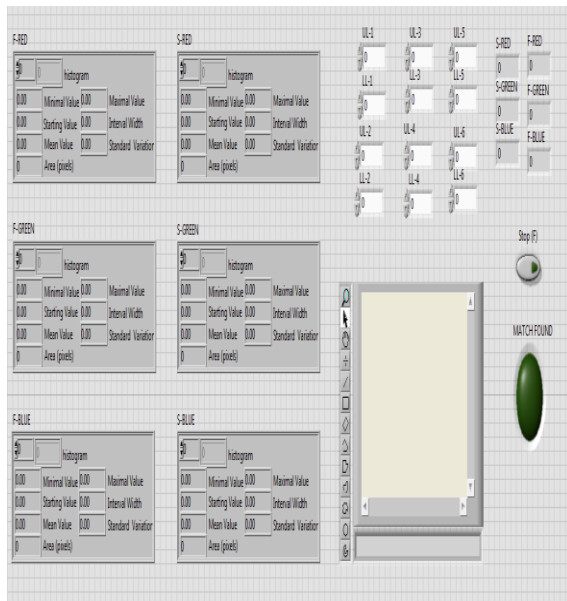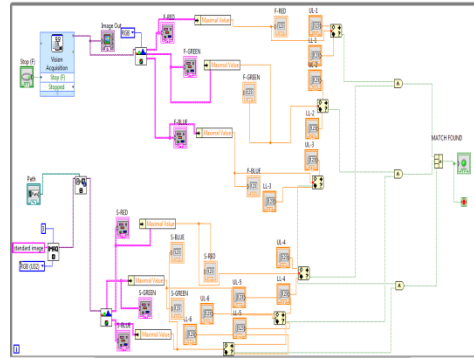

Fig 14: Image comparison module

Fig 15: Image comparison module

In this module the USB camera is used to acquire the image obtained in the preparation tank .the acquired image is processed to generate RGB values. Then the standard image is loaded in the comparison module using path file control. Thus the two images are compared once the RGB values of both the images fall within the range specified then the Boolean indicator glows indicating the match is found.
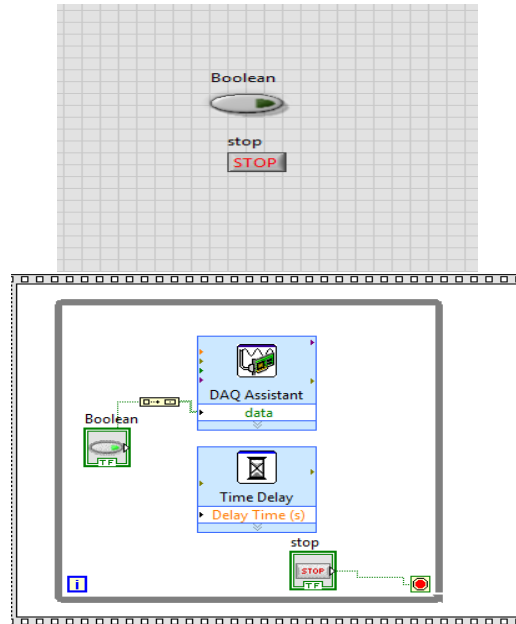
Solenoid valve control module:

Fig 16: Solenoid valve control module

Once the match is found between standard image and acquired image the   Boolean indicator glows and generate a digital output of 3.3v and this 3.3v is converted to 5v using Darlington circuit and used to trip a relay   which in turn provide a 12v dc supply to the solenoid valve using regulated power supply.

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Fig 17: Color dye tanks

Fig 18: Mixer unit

Fig 19: Overall view.

IV.   CONCLUSION

Thus the graphical system design for quality analyzing and dye mixing of paper has been designed and tested using lab view and NI vision feature where we control the color dye tanks, mixer unit, and solenoid valve automatically and also the pattern is matched successfully. We can also use this prototype model for taking paints, chemicals, solvents etc. And this project cost is very much affordable and reliable. Our module is user friendly. It can be easily understood by workers. It is a flexible one and can be altered according to the required conditions.

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