Replacing Various Analog Signal Sensors with Digital Cameras

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Abstract— **Process industries require several thousand control points for smooth operation, for which different sensors are installed at various points distributed across the plant. At present the sensors include Temperature Detector (RTDs), Thermo couple (TC) for temperature measurement, strain Gauge (SG) for pressure measurement, cylindrical capacitive transducer for moisture measurement etc., other parameters of measurement include flow, quality of oil, position of object etc. For all those measurements different type of sensors are required. From these sensors analog signals are generated and then brought to the operator station. Then these signals are converted to digital signal for feeding to computer. The computer converts the digital signals to engineering units like Degree Centigrade, parts per million (PPM), etc, using the look up table value stored inside the computer, by linear interpolation method. These values are then compared with normal values stored inside computer and reported for abnormalities. The system generates control signal afterwards. This type of control signal generation is tedious procedure with the following disadvantages. Different sensors are required for different parameter measurement. Also analog signals give errors during long distance transmission. Again analog to digital conversion is required. To overcome all these difficulties, the state of art technology Digital Image Processing (DIP) is experimented for replacing different types of sensors. Only web (Digital) cameras are installed at various parameter measuring points. Let us consider a case of level measurement. A digital camera installed near the boiler drum in a Thermal power station takes continuous photographs of water levels and forwards the digital image signal to the computer at regular interval. These images are compared with standard image stored inside the computer with suitable algorithm. When the received image matches the standard image, control action is initiated. The same procedure can be adopted with digital camera for moisture measurement, oil density measurement, flow measurement, etc. This system gives real time display of various field images super imposing on the animated mimic diagrams in computer monitor, which is not possible in the old environment with analog sensors. MATLAB is extensively used. JPEG image file format isused.**

Keywords— *Sensors, DIP, MATLAB, JPEG*

I. INTRODUCTION

Most industrial plants are hazardous in nature. The technical development in Electronics, Information technology, Image processing and industrial computers resulted in the development of remote control and monitoring the plants. Remote operation field needs quite a good amount of instrumentation support for control as well as monitoring purposes. Nowadays plant size has grown bigger which needs control of many parameters like flow, level, pressure, speed, temperature, displacement, vibration etc.,

Sensors like RTDs, Thermocouple, strain gauges, tachometers, LVDT's etc generate analog signals. Errors in these sensors are prone to happen which are discussed below. Hence getting accurate results are not possible. . So many correcting methods are to be employed. Also analog signal transmission is erroneous which is discussed below.

A new technique to solve these problems is to use Digital Cameras in place of analog sensors. The digital images are taken and continuously transmitted to the operator station. Digital image processing [1] paves way for generating control signals by comparing the just received image with the standard image already stored inside the computer.

A. Errors in Reading Analog Sensors

A measurement cannot be made without errors in analog sensors. These errors can be only minimized but not eliminated completely. It is essential to know the different errors that can possibly enter into the measurement.

The error can be classified into three categories:
- Gross errors
- Systematic errors
- Random errors

B. Gross Errors

Gross errors are largely due to human factors such as misreading of instruments, incorrect adjustment and improper application of instruments. The computational errors are also grouped under this type of errors.

When human beings are involved in measurement, gross errors will inevitably be committed. Complete elimination of gross errors is probably impossible in analog meters. This error is almost eliminated in auto ranging digital meters. One common gross error frequently encountered in measurement work involves the improper selection of the instrument. When a voltmeter is used to measure the potential difference across two points in a circuit, the input impedance of the voltmeter chosen should be at least 10 times greater than the output impedance of the measuring circuit. As the output impedance of a circuit is normally not known before hand, the selection of the voltmeter may not be made correctly, leading to a gross error.

C. Systematic Errors

Systematic errors are due to shortcomings of the instrument and changes in external conditions affecting the measurement. These are classified into two categories.
- Instrumental errors
- Environmental errors

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Instrumental errors arise out of the changes in the properties of the components used in the instrument. This can be avoided by calibrating the instrument frequently.

Environmental errors are due to the changes in the environmental conditions such as temperature, humidity, pressure and electrostatic and magnetic fields. For example, the resistance of a strain gauge changes with variation in temperature. These errors can be minimized by controlling the environmental conditions in the laboratory. However, it is difficult to have a controlled environment in a industrial atmosphere.

Systematic errors can also be divided into static and dynamic errors. Static errors are caused by the limitations of the measuring device or the assumption in the physical laws governing its behavior. Dynamic errors are caused by the instruments slow response in following the changes in the measured variable.

Systematic errors have definite magnitude and direction. These are usually more troublesome as repeated measurements may not reveal them.

D. Random Errors

Random errors are unpredictable errors and occur even when all systematic errors are accounted for. Although the instrument is used under controlled environmental and accurately pre-calibrated before measurement, it will be found that the readings vary slightly over a period of observation. This change cannot be corrected by any method and it cannot be explained without detailed investigation. However, these errors can be reduced by taking more number of readings and using statistical methods to obtain the best approximation of the true value.

II. ERROR ANALYSIS

The analysis of the measurement data is necessary to obtain the probable true value of the measured quantity. Any measurement is associated with a certain amount of uncertainty. The systematic way of specifying this uncertainty is the statistical method. A large number of measurements is usually required to make statistical methods and interpretation meaningful. Also the systematic errors should be small compared with random errors, because statistical treatment of data cannot remove a fixed bias contained in all the measurements.

When fluid pressure in a container is to be measured, 10 readings are taken over a period of time by means of a Bourdon gauge. Each of these 10 readings may be different from the others. One will be wondering which one of these is the correct reading. The statistical methods will give the most probable true value of the pressure. The statistical methods use terms like arithmetic mean, deviation, mode, median, which are explained below.

A. Arithmetic Error

The most probable value of a measured variable is the arithmetic mean of the number of readings taken. Arithmetic mean is defined as the average value of the readings which is given by,

$$X = \frac{x_1 + x_2 + x_3 + \dots\dots\dots\dots\dots + x_n}{n}$$

$$= \frac{\sum_{\alpha=1}^{n} X_\alpha}{n}$$

Where X_α is the individual reading and n is the total number of readings. When n is very large, best results are obtained.

Deviation:

Deviation is the departure of a given reading from the arithmetic mean of a group of readings. For a reading x1, the deviation is given by

$$d_1 = x_1 - x$$

Average deviation is defined as the average of the modulus of the individual deviations and is given by

$$D = \frac{|d1| + |d2| + \dots\dots + |dn|}{n}$$

$$= \frac{\sum_{\alpha=1}^{n} |d_\alpha|}{n}$$

$$= \frac{\sum_{\alpha=1}^{n} |(x_\alpha - \overline{X})|}{n}$$

The average deviation gives an indication of the repeatability of the instrument.

B. Standard Deviation

Another deviation which is commonly used in statistical analysis is standard deviation which is defined as,

$$\sigma = \sqrt{\frac{\sum_{\alpha=1}^{n} d_\alpha^2}{n-1}} = \sqrt{\frac{\sum_{\alpha=1}^{n} (x_\alpha - x)^{\overline{2}}}{n-1}}$$

When the number of reading are less than or equal to 20

When the number of reading is more than 20, standard deviation is defined as,

$$\sigma = \sqrt{\frac{\sum_{\alpha=1}^{n} d_\alpha^2}{n}}$$

C. Variance

Variance is another term which is sometimes used in statistical analysis. This is the square of the standard deviation and is given by,

$$V = \sigma^2 = \frac{\sum_{\alpha=1}^{n} d_\alpha^2}{n-1} \qquad \text{for } n \leq 20$$

$$= \frac{\sum_{\alpha=1}^{n} d_\alpha^2}{n} \qquad \text{for } n > 20$$

EXAMPLE:

In an experiment, ten observations of pressure are made which are given below.

Trial No.	1	2	3	4	5
Scale reading (K Pa)	10.02	10.20	10.26	10.20	10.22
Trial No.	6	7	8	9	10
Scale reading (K Pa)	10.13	9.97	10.12	10.09	9.9

(i) arithmetic mean (ii) average deviation (iii) standard deviation and (iv) variance are found out as follows.

(i) Arithmetic Mean(x)

$$=\frac{10.02+10.20+10.26+10.20+10.22+10.13+9.97+10.12+10.09}{10}$$

$$= 10.111 KP_a$$

(ii) Average deviation absolute:

$$d = \frac{|d1| + |d2| + \ldots\ldots + |dn|}{n}$$

$$d=\frac{0.091+0.089+0.149+0.109+0.019+0.141+0.009+0.021+0.211}{10}$$

$$= 0.0928\ KPa$$

(iii) $[\text{Standard Deviation}]^2 = \sigma^2$

$$= \frac{0.001[8.281+7.921+2.2201+7.921+11.881+0.361+19.881+0.081+0.441+44.521]}{9}$$

$$= -0.12349 / 9 = 0.0137$$

σ = Standard Deviation = 0.117 KP_a

(iv) Variance $V = \sigma^2 = 0.0137$

D. Median

Median is also used to indicate the most probable value of the measured quantity when a set of readings are taken. When the readings are arranged in the ascending or descending order of magnitude, the middle value of the set is taken as the median. For example, the temperature of a bath is noted by eleven observers as follows.

66.5∘C, 63.8∘C, 65.7∘C, 66.1∘C, 64.8∘C, 67.0∘C, 65.3∘C, 63.9∘C, 64.4∘C, 65.9∘C, 66.5∘C

It is rearranged in the ascending order as follows

63.8∘C, 63.9∘C, 64.4∘C, 64.8∘C, 65.3∘C, 65.7∘C, 65.9∘C, 66.1∘C, 66.5∘C, 66.5∘C, 67.0∘C

Now the median is the sixth reading, ie. 65.7°C.

E. Mode

Mode is the value which occurs most frequently in a set of observations and around which other items of the set cluster densely.

For example, the frequency distribution of a set of 101 observations is given as follows.

Pressure reading KPa	50	51	52	53	54	55	56	57
No. of readings	4	9	16	25	22	15	7	3

The value of pressure reading corresponding to maximum number of occurrences is 53KPa hence mode is 53 KP_a.

F. Probability of Errors

By the very nature of the random errors, the uncertainty associated with any measurement cannot be predetermined. Only the probable error can be specified using statistical error analysis. Some of the statistical methods of analyzing the errors are discussed in the following sections.

G. Normal Distribution of Errors

The measurement data can be pictorially represented by a histogram for a better, visual appeal and quick understanding of information. Histogram is a bar graph display of the number of occurrences of a particular observed value in a measurement. For example, 60 temperature readings were taken over a small period of time and tabulated as shown in table 1.1.

The histogram is plotter taking temperature reading of the number of occurrences in the Y-axis, as shown in Fig.1.2.

Fig. 1.2 shows that the largest number of readings (22) occurs distributed more or less symmetrically on either side of the middle. If more readings were taken, the distribution of observation would have remained symmetric about the central value. With increased number of observations taken with high resolution meters, the contour of the histogram would become a smooth curve as shown by the broken line in fig.1.2. This bell shaped broken line curve is known as the Gaussian curve. If the curve is sharp then one may state with confidence that the most probable true value is the central value.

TABLE 1.1 TABULATION OF TEMPERATURE READINGS

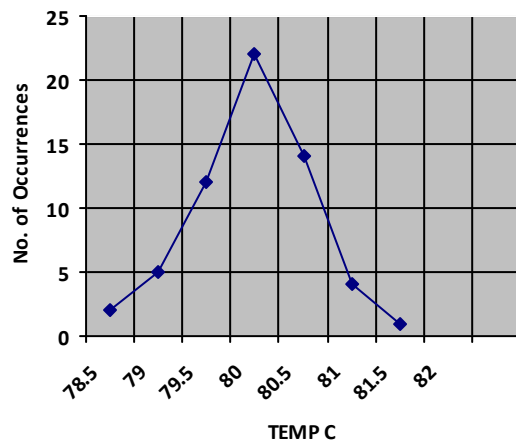| Temperature reading (deg. C)	Number of readings
78.5	2
79	5
79.5	12
80	22
80.5	14
81.0	4
81.5	1
	60

Fig. 1.2 Histogram showing the frequency of occurrence.

H. Probable Error

It is quite often useful to specify the probable error in a measurement due to random error.

If the Central value of a Gaussian curve is assumed as the true value, then error V, number of occurrences in the measurement can be plotted as shown in Fig.1.3

Fig. 1.3 Error distribution
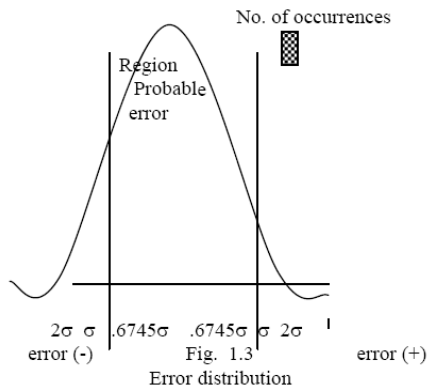
For a Gaussian distribution of data, it is found that about 68% of the total number of observations have errors lying with in $\pm \sigma$. It is also found that about 50% of the total number of observations has errors lying within $\pm 0.6745 \sigma$ and this is taken as the probable value of error because there is an even chance for any one observation to have a random error more than this value. Hence probable error, $r = \pm 0.6745\sigma$.

I. Limiting Error

The accuracy of a measuring instrument is usually specified by its manufacturer as a percentage error for various values of reading. However, the percentage error for various values of readings taken will be more than the percentage specified. The limiting error is defined as the maximum deviation in the reading. For example, the accuracy of a 0-150°C thermometer is specified as ± 1 % of full scale reading. The limiting error of this thermometer is ± 1.5°C. Hence, when the thermometer reads 60°C, the maximum possible deviation is ± 1.5°C and the percentage error at this reading is $\pm 1.5/ 60 \times 100 = \pm 1.5$°C. Limiting error is also called as guarantee error.

J. Odds in Specification

The specification of limiting error is in itself uncertain because the manufacturer himself is not sure about the accuracy because of the presence of random errors. To add a further specification of the uncertainty in a measurement Kilns and McClintoch have proposed to specify certain odds for the uncertainty. For example, a temperature reading may be expressed as

$$T = 110°C \pm 1.5°C \text{ (20 to 1)}$$

This means that, if 21 readings are taken, one reading is likely to have an error more than ± 1.5°C.

The relation between probability of occurrence and odds is given by

Odds/(odds+1) = probability of occurrence

Table 1.2 gives the relation between deviation, probability and odds.

σ is the standard deviation.

TABLE 1.2

Deviation	Probability of occurrence within the deviation	Odds
$\pm 0.6745 \sigma$	0.5000	1:1
$\pm \sigma$	0.6828	2.15:1
$\pm 2 \sigma$	0.9546	21:1
$\pm 3 \sigma$	0.9974	256:1

K. Propagation of Errors

When the readings from a number of instruments are used to compute some quantity, the overall limiting error should be computed from the individual limiting errors of the instruments.

Consider the problem of computing a quantity α from n independent measurements $u_1, u_2, \ldots, u_n$. Now α can be expressed as,

$$A = f(u_1, u_2, \ldots, u_n) \quad (1.1)$$

Let the limiting errors in $u_1, u_2, \ldots, u_n$ be $\pm \Delta u_1 \pm \Delta u_2, \ldots, \pm \Delta u_n$ respectively. These errors lead to an error of $\pm \Delta \alpha$ in the computed value of α. Therefore,

$$\alpha \pm \Delta \alpha = f(u_1 \pm \Delta u_1, u_2 \pm \Delta u_2, \ldots, u_n \pm \Delta u_n) \quad (1.2)$$

Expanding the function f in equation (1.2) using Taylor's series, we get,

$$f(u_1 \pm \Delta u_1, u_2 \pm \Delta u_2, \ldots, u_n \pm \Delta u_n)$$
$$= f(u_1, u_2, \ldots u_n) + \Delta u_1 \frac{\partial f}{\partial u_1} + \Delta u_2 \frac{\partial f}{\partial u_2} + \ldots \Delta u_n \frac{\partial f}{\partial u_n} +$$

$$\frac{1}{2} (\Delta u_1^2 \frac{\partial f}{\partial u_1} + \Delta u_2^2 \frac{\partial f}{\partial u_2} + \ldots \Delta u_n^2 \frac{\partial f}{\partial u_n}) \quad - 1.3$$

In actual practice, the limiting errors Δu_1, Δu_1 . . . etc are small quantities and hence the higher powers of Δu's are negligible. Hence equation 1.3 becomes

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$$f (u_1 + \Delta u_1, u_2 + \Delta u_2, \ldots, u_n + \Delta u_n)$$
$$= f (u_1, u_2, \ldots un) + \Delta u_1 \frac{\partial f}{\partial u_1} + \Delta u_2 \frac{\partial f}{\partial u_2} + \ldots \Delta u_n \frac{\partial f}{\partial u_n} \quad 1.4$$

Hence the absolute error Δ is given by,

$$\Delta = \left| \Delta u_1 \frac{\partial f}{\partial u_1} \right| + \left| \Delta u_2 \frac{\partial f}{\partial u_2} \right| + \ldots + \left| \Delta u_n \frac{\partial f}{\partial u_n} \right| \quad (1.5)$$

The absolute values signs are used because some of the partial derivatives might be negative and for a positive Δu such a term would reduce the total error.

When the Δu's are considered not as absolute limits of error, but rather as statistical bounds such as $\pm 3\sigma$ limits, probable errors, or uncertainties, the formulae for computing overall errors must be modified. It can be shown that the proper method of combining such errors is according to the root-sum square (r.s.s.) formula.

Earss
$$= \sqrt{ \Delta u_1 \frac{\partial f}{\partial u_1} + \Delta u_2 \frac{\partial f}{\partial u_2} + \ldots + \Delta u_n \frac{\partial f}{\partial u_n} } \quad - 1.5$$

EXAMPLE:

The power dissipated in a resistor of $50 \pm 1\Omega$ is computed by measuring the current through the resistor using the formula $P = I^2 R$. The ammeter used has an accuracy of $\pm 1\%$ and its full scale reading is 5A. The limiting error in the computed value of power, when the ammeter reads 3A is found out as follows..

Limiting error for ammeter $= \frac{\pm 1 \times 5}{100} = \pm 0.05A$

$$\Delta = \left| \Delta u_1 \frac{\partial f}{\partial u_2} \right| + \left| \Delta u_2 \frac{\partial f}{\partial I} \right| = \left| \frac{\Delta I \, \partial I^2 R}{\partial R} \right|$$

$$= |0.05 \times 2IR| + |1 \times I^2|$$

Advantage of New technique over analog Signals (Sensor):

Old methods use sensors like RTDs, Thermocouples,

Strain gauges, tachometers, LVDTs etc for measuring temperature, pressure, speed, displacement etc. These sensors generate analog signals. Errors in analog signal are highlighted in detail.

The new technique uses Digital Cameras in place of analog sensors. Digital Cameras generate Digital Signal images. The errors highlighted with analog signals are not available with digital signals. Hence the new technique of using digital cameras is superior.

L. PROCESS CONTROL SYSTEM:

Real-time computer control system [2] used in process control applications have many characteristics that are different from traditional processing used in business applications. Foremost among these is design for efficiency and time-critical response.

III. OPERATOR STATION

At the heart of the system is a stand Intel Pentium IV Computer. The purpose of the Computer is to execute the control and monitoring programs and image updating functions. Mat lab based interface software allows real time display of various field images in accordance with the control operation. Field switched images are progressively reconstructed for final high-resolution field images and are displayed in the Operator Station.

IV. IMAGE CAPTURING UNIT

The image capturing unit consists of an image capturing card with color image acquisition front end, dual ported color image buffer memory and a DSP for executing required image algorithms. It communicates controls and parameter information with the server. Instantaneous images are streamed for image transmitted.

V. PROGRAMMABLE LOGIC CONTROL

PLCs are used for industrial control [3] today. A PLC has three basic functions, Control, Input and Output. Based on input and logic writer in the control (known as Ladder Logic, sequence or statement list), output are activated.

A. Usage of Networking for Control and Monitoring System

Historically, PLC and Video capturing unit are deployed relatively close to field element. These elements are connected through the use of local networks promise virtually unlimited distance. Tying existing control system into a facility's existing network using Ethernet converters might be a better decision.

VI. SOFTWARE SETUP

The Software setup consists of a PC-based user-interface component for progressive image transmission termed smartision screen copy, Command and Auto sequence programs termed PLC programs and control and monitoring based image-processing [4] component termed Mimic. These components communicate through an Ethernet protocol. Following is a description of each component.

A. Smartision Screen Copy:

The smartision screen copy component is responsible for progressively transmitting images from the video capturing unit. This is accomplished by first loading the image processing component onto the image capturing card. This component is specified in the settings. Second, the user-interface is presented. Third, images are transmitted to the control & monitoring system. Smartision Screen Copy is a tool used to create auto screenshots in a very easy and quick way. With Auto screenshot, screenshot interval is selected. JPEG images [5] are files used to have better quality. The resulting executable file is "C: \ Program Files \ Screen Copy \ SSC.exe"

Video capturing unit replaces analog standards of signal transmission. There are two reasons for the success of digital video. On the one hand the available computing power of recent processors increases rapidly. On the other hand new sophisticated coding algorithms have been developed which use this computation power to achieve a high-quality transmission. The main goal during the development of today's most commonly used video capturing card has been a high compression ratio at low bit rates by removing redundant information from the video sequence. Information which can be reconstructed at the receiver is omitted, only the coded video will be very sensitive to transmission errors. Even very short transmission errors are likely to propagate spatially and temporally, a single error will affect a large area within the picture for many frames. Unfortunately, in the packet switched networks, transmission errors such as lost or delayed packets occur quite often. In this case the perceived quality is seriously decreased. Many research projects focus on the development of error resilient coding algorithms or methods to conceal errors in the decoded video sequence.

B. Mimic Component

The Mimic component is responsible for executing the integration of image processing [4] with control and monitoring system in real time [2]. It achieves this by first communicating with the PC based component through Ethernet protocol for updated user-interface parameter and control information, second processing the image frame according to the image control panel requirements and third storing the control events for offline analysis.

8.0 MATLAB Program:

Throughout this project, MATLAB was used extensively as a test-bed for the development of the image processing based control and monitoring system. The result is a GUI based MATLAB tool termed AV for Active Vision image analysis. Reference to this application is made throughout the contents of this paper.

This Graphical User Interface (GUI) was developed under MATLAB 'Version 6.5.0.180913a (R13)' and utilizes the IMAGE PROCESSING toolbox 'Version 3.2 (R13).' Place the two files listed below somewhere on the MATLAB path and then type 'Mimic' to execute the user interface from the MATLAB command line. The display detail the GUI and also contains a series of labels which reference a sequence of events associated with a typical run when implementing integration of field images. A simple description accompanies each labeled event to guide the user through a successful implementation. Before starting the GUI, completed mimic backgrounds are converted into a set of (TIF) images. After executing mimic press 'start' to display the complete mimic diagrams and image display. Crop and rotate operations are carried out by enabling the hold functions.

GUIDE is the Mat lab happy interface for creating a Graphical User Interface (GUI). When GUIDE is run (by typing 'guide' in the command window), a window opens, with some little icons on the left side. The icons denote objects that you can create, objects like axes, pushbuttons, sliders, and so forth. GUIDE generates TWO files – one with mimic code ('m-file') and one with the GUI information created by GUIDE ('Fig – file'). That is, when you create a gui interface with GUIDE and then save the results, a file is created with the suffix'. fig.' it is called a 'fig-file'. Its base name is the same as the m-file that contains all the other code of your program. Thus, TWO files exist and must be in the same directory in order to run the program.

VII. Transport Protocols

Transmission Control Protocol (TCP or TCP/IP) and User Datagram Protocol (UDP or UDP/ IP) are both transport protocols. Various types of communication protocols are compared below.

A. Stream Versus Packet

TCP/IP is a stream-oriented protocol, while UDP is a packet-oriented protocol. This means that TCP/IP is considered to be a long stream of data that is transmitted from one end of the connection to the other end, and another long stream of data flowing in the opposite direction. The TCP/IP stack is responsible for breaking the stream of data into packets and sending those packets while the stack at the other end is responsible for reassembling the packets into a data stream using information in the packet headers. UDP, on the other hand, is a packet-oriented protocol where the application itself divides the data into packets and sends them to the other end. The other end does not have to reassemble the data into a stream. Note, some applications might present the data as a stream when the underlying protocol is UDP. However, this is the layering of an additional protocol on top of UDP, and it is not something inherent in the UDP protocol itself.

B. TCP/IP Is A Reliable Protocol, While UDP is Unreliable

The packets that are sent by TCP/IP contain a unique sequence number. The starting sequence number is communicated to the other side at the beginning of communication. The receiver acknowledges each packet, and the acknowledgement contains the sequence number so that the sender knows which packet was acknowledged. This implies that any packets lost on the way can be retransmitted (the sender would know that they did not reach their destination because it had not received an acknowledgement). Also, packets that arrive out of sequence can be reassembled in the proper order by the receiver. Further, timeouts can be established because the sender knows (from the first few packets) how long it takes on average for a packet to be sent and its acknowledgement received. UDP, on the other hand, sends the packets and does not keep track of them. Thus, if packets arrive out of sequence, or are lost in transmission, the receiving end (or the sending end) has no way of knowing. Note that 'unreliable' is used in the sense of "not guaranteed to succeed" as opposed to "will fail a lot of the time." In practice, UDP is quite reliable as long as the receiving socket is active and is processing data as quickly as it arrives.

Preference of UDP over TCP/IP in our setup

UDP has only 8 bytes of overhead, whereas TCP/IP segment has 20 bytes of overhead.

Key advantage of UDP over TCP/IP is speed.

Reliability features built into TCP/IP is expensive in terms of overhead at execution time.

From designer's point of view lack of reliability mechanism is considered an advantage, since the cost of implementing reliability is high. eg. An interactive real-time application may occasionally choose to retransmit a lost message. In this UDP proves to be cost effective than TCP/IP.

Lower latency in UDP. For low-latency application UDP is preferable.

With the above characteristics of UDP & TCP/IP, we prefer to use UDP in our setup, since the receiving socket is active and is processing data quickly as it arrives. Also all the over head in TCP/IP can be avoided in UDP.

C. Creating A Udp Object

UDP object can be created with the UDP function. UDP does not require the name of the remote host as an input argument. However, if udp object is used to communicate with a specific instrument, then host and the port number should be specified. To create a UDP object associated with the remote host 127.0.0.1 and the remote port 4012. u = udp (127.0.0.1',4012).

Once the UDP object is created, the properties listed below are automatically assigned values. These general purpose properties provide descriptive information about the UDP object based on the object type, the remote host, and the remote port. Communicating between two hosts. UDP objects are used to communicate between two hosts.

D. Create An Instrument Object

Create a UDP object for the local host. U1 = udp(",Local Port', 4114). A UDP object is also created for the remote host. Note that the remote host must specify the local host's name and port number. u2 = udp('doejohn.dhcp', 4114)

E. writing and reading data with a udp object

Text are used to read and write operations with a UDP object connected to a remote instrument. UDP sends and receives data in blocks that are called datagram. Each time you write or read data with a UDP object, you are writing or reading a datagram. For example, the string sent to the echo server constitutes a datagram with 13 bytes – 12 ASCII bytes plus the line feed terminator.

VIII. Progressive Image Transmission

Real time field image has been important media for remote monitoring of field process. Initially video was captured and transmitted in analog form. The advent of digital integrated circuits and computers led to the digitization of video, and digital video enabled a revolution in the compression and communication of video. The growth and popularity of the network motivated video communication over best-effort packet networks. Video over best-effort packet networks is complicated by a number of factors including unknown and time-varying bandwidth, delay, and losses, as well as many

additional issues such as how to fairly share the network resources amongst many flows and how to efficiently perform one-to-many communication for popular content.

IX. IMAGE COMPRESSION

Image compression [6] is achieved by exploiting the similarities or redundancies that exists in a typical video signal. For example, consecutive frames in a video sequence exhibit temporal redundancy since they typically contain the same objects, perhaps undergoing some movement between frames. Within a single frame there is spatial redundancy as the amplitudes of nearby pixels are often correlated. Similarly, the Red, Green, and Blue color components of given pixel are often correlated. Another goal of video compression is to reduce the irrelevancy in the video signal that is to only code video features that are perceptually important and not to waste valuable bits on information that is not perceptually important or irrelevant. Identifying and reducing the redundancy in a video signal is relatively straightforward, however identifying what is perceptually relevant and what is not is very difficult and therefore irrelevancy is difficult to exploit.

To begin, image compression is considered, such as the JPEG standard, which is designed to exploit the spatial and color redundancy that exists in a single still image. Neighboring pixels in an image are often highly similar, and natural images often have most of their energies concentrated in the low frequencies. JPEG exploits these features by portioning an image into 8x8 pixel blocks and computing the 2-D Discrete Cosine Transform (DCT) for each block. The motivation for splitting an image into small blocks is that the pixels within a small block are generally more similar to each other than the pixels within a larger block. The DCT compacts most of the signal energy in the block into only a small fraction of the DCT coefficients, where this small fraction of the coefficients are sufficient to reconstruct an accurate version of the image. Each 8x8 block of DCT coefficients is then quantized and processed using a number of techniques known as zigzag scanning, run length coding, and Huffman coding to produce a compressed bit stream. In the case of a color image, a color space conversion is first applied to convert to RGB image into a luminance/chrominance color space where the different human visual perception for the luminance (intensity) and chrominance characteristics of the image can be better exploited.

A video sequence consists of a sequence of video frames or images. Each frame may be coded as a separate image, for example by independently applying JPEG like coding to each frame. However, since neighboring video frames are typically very similar much higher compression can be achieved by exploiting the similarity between frames. Currently, the most effective approach to exploit the similarity between frames is by coding a given frame by first predicting it based on a previously coded frame, and then coding the error in this prediction. Consecutive video frames typically contain the same imagery, however possibly at different spatial locations because of motion. Therefore, to improve the predictability it is important to estimate the

motion between the frames and then to form an appropriate prediction that compensates for the motion. In order to achieve efficient image compression the 2-D discrete wavelet transform based lifting scheme method [7] is used. Recently the lossless image compression [8] is achieved by FELICS (Fast Efficient Lossless Image Compression) algorithm.

X. PROGRESSIVE IMAGE TRANSMISSION INTERFACE

The progressive image transmission system is typically designed using a number of different approaches. Progressive image transmission provides a convenient user interface when images are transmitted slowly. However, most of the existing PIT techniques only considered the objective quality of the reconstructed image. Here an attention model based progressive image transmission approach used to improve the subjective quality of the transmission process. We use both bottom-up image features and top-down semantic information to extract the regions of interest (ROI) and also propose a new ROI coding scheme based on JPEG 2000 to control the trade-off between the transmission of ROI and background.

When people view an image through a low speed connection, for example, via a telephone line or via wireless networks, it will take much time to transmit the whole image. Transmitting a losslessly compressed 800x600 24-bit color image over a 56Kbps connection will require about 60s. Even with increased bandwidth, transmitting large images such as pictures captured by digital cameras is still relatively slow. Experiments have shown that if the delay is too long (>5-10s), user will feel nervous and even give up. Progressive Image Transmission (PIT) techniques have been proposed to alleviate this problem by first sending a coarse version of the original image and then refining it progressively. Using PIT, users can preview the image in advance and therefore decide whether to abort the transferring process or wait for the image to be refined. PIT is especially useful for remote control and monitoring of multiple views.

XI. SIMULATED RESULTS

A. Drip Irrigation:

Watering plants/crops is a part of cultivation/irrigation. In the earlier days water is taken through path made in the ground for water to flow towards the plants. This method of watering plants needs more water. But drip irrigation is the new method followed wherever water scarcity is there. Not only that, whether water scarcity is there or not, drip irrigation is the order of the day in many countries which paves way for avoiding water wastage. Israel is the first country to implement this technology. India also follows that.

In Drip Irrigation water is brought to the root of the plant through tubes and watered at the root in drops. Once sufficient water is poured in the form of drops at the root of the plant, water is stopped. At present this is done manually. Off the late the moisture of the soil is measured at the root of the plant and accordingly watering is done automatically. This further reduces water wastage compared to while being carried out manually.

The technology used for automation is based on Digital Image Processing. A digital camera (Example: Web Camera)

is installed near the root of a plant to take photograph (Digital Images) of the soil. Dry soil image and Wet soil image are stored inside the computer as standard images. The Digital Camera will continuously takes photograph of the soil and forward the images to the computer at the operator station.

When standard image for Dry soil matches the incoming image, the computer generates a control signal to open the valve for drip irrigation. The soil gets wet with drops of water and the moisture level increases. When the desired moisture is attained the computer generates a control signal to close the valve for drip irrigation based on the incoming image from the digital camera. The comparison of the incoming images with standard image is done in the computer through a suitable algorithm. The experimental set up is as shown below fig 11.1 and fig 11.2
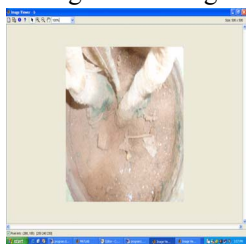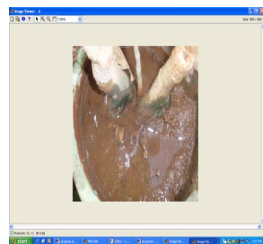

Fig.11.1 Dry soil   Fig11.2 Wet soil

B. Moisture Measurement:

In India during rainy season there will be much moisture in the atmosphere. This will lead fungus creation in the food grain storage. In sirapunchi highest rainfall throughout the year is found. In Kerala rainy season is for almost about six months in a year. Hence moisture removal is a major requirement. Hence our thesis will definitely help M/S FCI (Food Corporation of India) who store food grains to feed out people during famine.

At present we are following the method of generating analog signal to find out the moisture content in the food grains of the storage by inserting a cylindrical capacitor in the storage. The capacitor produces different analog voltage signal based upon the moisture content. In fact the dielectric constant between the plates of the capacitor varies according to the moisture content to produce different permittivity value.

In present digital world we have state of the art technology namely Digital Image Processing (using software algorithms) which is replacing all the analog methods. We are also intending to replace the old method of using analog sensors to measure the moisture. Different photographs (digital camera image) are taken with different levels of moisture content of the food grains. These different moisture levels in the food grain photographs are stored inside the computer and database is created with the experimental setup values.

In the actual environment in the food storage unit, digital images are taken every one hour using digital camera (web camera) and forwarded to the PC. These images are compared with the already stored images of different moisture levels in the PC using suitable algorithm. When a particular incoming image matches with any one of the stored images, a control signal is generated to dry the food grains through a blower. The time of blower to dry the food grains varies according to the moisture level decided by the images.
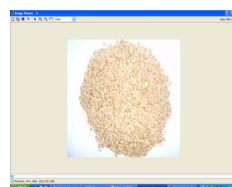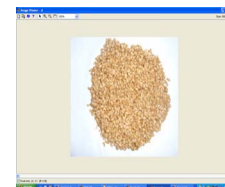

Fig.11.3 Full dry   Fig.11.4. Partially dry

C. Lead placement in pencil:

In our home we daily face a problem of breaking he pencil lead by our children while mending it. We scold the child for that. But the reason is not the child's fault. In fact the fault is with the manufacturer.

It is absolutely essential to place the lead inside the pencil exactly in the centre of the wooden structure. If it is not so, the lead will break when we mint it. The human way of checking the exact centre position of the lead in the wooden frame is not at all possible.

By using Digital Image Processing (DIP) technology, we can analyses the centre position of the lead. First we have to store the exact centre position of the lead photograph inside the PC as standard image. Afterwards the front view of every pencil is photographed and compared with the standard image through a suitable algorithm. When the image of the front view of the new pencil matches with the standard image the pencil is passed by the inspecting supervisor. The experimental setup is shown below:

Fig.11.5.Incorrect position of the lead

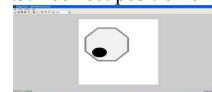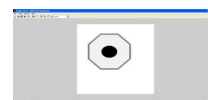Fig.11.6. Correctly (Centre) position of the lead

D. Measurement of Oil Density:

In normal world there is a corruption of adulterating the good quality items to increase the quantity. For example water is mixed with milk; similarly palm oil is mixed with vanaspathi.

In the present days water mixing with milk is checked with lactometer Palm oil mixing with vanaspathi is checked by adding a chemical substance. If there is a mixing a color change is found in the vanaspathi. However the quantity of mixing could not be found out.

The state of art technology of Digital Image Processing opens a new way for analyzing the quantity of adulteration in the liquids. The image taken through digital cameras differs for different adulteration levels. Normal eye cannot identify small quantity of adulteration.

Photographs are taken through digital cameras of different levels of adulteration they are stored inside the computer as an experimental setup.

In the normal checkup the liquid photograph is taken and is compared with the already stored image inside the PC and a signal is generated when it matches the image. This indicates the adulteration quantity even for small amount. The

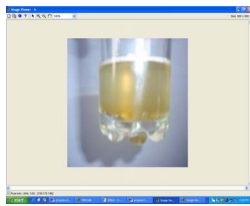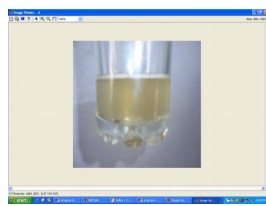experimental setup is as shown below:

Fig.11.7.impure oil   Fig.11.8.Pure oil

XII. CONCLUSION

The major advantages of utilizing the web camera for the above all those set up are as follows:

- Continuous recording of commands during control operation
- Real time display of field images
- Provides both auto and manual control command generation for test operation
- Provides facility for scaling up additional measurements.
- In normal sensors repeated calibration is required once in six months.
- Response and accuracy is more effective in digital Image processing techniques.
- Hysteresis effect is normal in analog signal Sensors can be overcome by this technique.
- The actual image of the remote field is also visible in the computer screen with super imposing on the mimic diagram. This is not possible with the analog sensors.
- The transmission of analog signal from distant location is always erroneous.

The new interesting solution by the integration of Data Acquisition System with Digital image Processing will lead to a Digital Factory. This digital factory will perform the following:

- A total eradication of different types of analog sensors is possible.
- Analog signals from transducers are replaced by field images capturing and processing .This is more accurate than signals from analog sensors.
- This novel architecture opens exciting possibilities in testing fault diagnosis, real time control, performance analysis and drastic improvement on production capacity.
  Here the new interesting solution of Integration of Data Acquisition System with Digital Image processing the high level deterministic real-time capability seem to be very attractive for most demanding remote control applications. The novel architecture and methodology proposed for real-time control and monitoring with a rational network open exciting possibilities in testing and performance analysis. Network with PLC endows control reliability to the system even under extreme conditions.

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