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TABLE OF CONTENTS

WIMAX 802.16E (WORLDWIDE INTEROPERABILITY FOR MICROWAVE ACCESS)

B SAIHASA, II-EIE

1. Introduction to WiMAX

WiMAX - Worldwide Interoperability for Microwave Access: is a wireless communication technology delivering high speed services over large distances. It has the potential to replace a number of existing telecommunications infrastructures. In a fixed wireless configuration it can replace the telephone company's copper wire networks, the cable TV's coaxial cable infrastructure while offering Internet Service Provider (ISP) services. WiMAX provides fixed, portable or mobile non-line-of sight service from a base station to a subscriber station, also known as customer premise equipment (CPE). Some goals for WiMAX include a radius of service coverage of 6 miles from a WiMAX base station for point-to-multipoint, non-line-of sight service.

The emerging WiMAX technology (802.16d today and 802.16e in the near future) will further enable mobility and reduce reliance on wired connections. The initial version of the 802.16 standard, approved by the New-York based IEEE in 2002, operates in the 10-to-66-GHz frequency band and requires line-of-sight towers. The 802.16a extension, ratified in March 2003, does not require line-of-sight transmission and allows use of lower frequencies (2 to 11 GHz), many of which are unregulated.

Additional 802.16 standards are in the works and will cover:

- **802.16b** — Quality of service
- **802.16c** — Interoperability, with protocols and testsuite structures
- **802.16d** — Fixing things not covered by 802.11c, which is the standard for developing access points
- **802.16e** — Support for mobile as well as fixed broadband and is therefore also known as "MOBILE WiMAX".

2. WiMAX Network Architecture and Evaluation

ASN- Access Service Network, NAP-Network access provider,
CSN- Core Service Network, NSP- Network Service
Provider, SS/MS – Subscriber station/ Mobile Station.

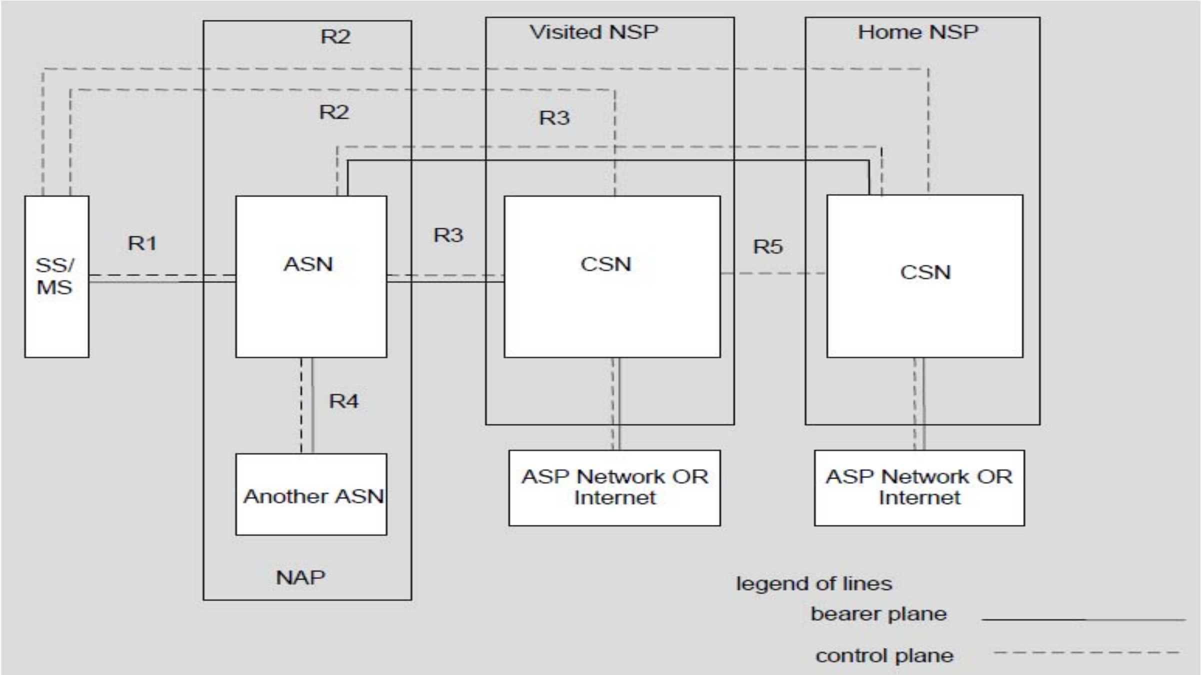


Figure 1. WiMAX Network reference Model (NRM)

2.1 Baseline Reference Model

The baseline WIMAX network architecture can be logically represented by a network reference model, which identifies key functional entities and reference points over which the network interoperability specifications are identified. The WIMAX network model differentiates between network access providers (NAPs) and network service providers (NSPs). The NAP is a business entity that provides WIMAX radio access infrastructure, while the NSP is the business entity, that provides IP connectivity and WIMAX services to WIMAX subscribers according to some negotiated service level agreements (SLAs) with one or more NAPs. The network architecture allows one NSP to have a relationship with multiple NAPs in one or different geographical locations. It also enables NAP sharing by multiple NSPs. In some cases the NSP may be the same business entity as the NAP.

The WIMAX NRM consists of several logical network entities:
MSs – Mobile Station, an access service network (ASN) and a connectivity service network (CSN) and their interactions through refence points R1 to R7. Each MS, ASN and CSN represents a logical grouping of functions as follows:

Mobile Station (MS): Generalized user equipment set providing wireless connectivity between a single or multiple hosts and the WIMAX network.

Access Service Network (ASN): Represents a complete set of network functions required to provide radio access to the MS. These `functions include layer2 connectivity with the MS according ti IEEE 802.16 standards and WIMAX system profile, transfer of authentication, authorization and accounting (AAA) messages to the home NSP, preferred NSP discovery and selection, relay functionality for establishing layer 3 connectivity with MS as well as the radio resource management and ASN-CSN tunneling.

Connectivity Service Network (CSN): A set of network functions that provide IP connectivity services to WIMAX subscriber. The CSN may further comprise network elements such as routers, AAA servers, home agents and user database as well as networking gateways or enhanced network servers to support multicast and broadcast services and location-based services. A CSN may be deployed as part of an incumbent WIMAX NSP.

The ASN may be implemented as an integrated ASN where all functions are collocated in the same logical entity, or it may have a decomposed configuration in which the ASN functions are selectively mapped into separate nodes, as BS and an ASN gateway. A decomposed ASN may consist of one or more BSs and at least one instance of an ASN-GW.

3. An IEEE standard for WiMAX - 802.16e

The IEEE 802.16 standard (also known as the air interface for fixed broadband wireless Access (FBWA) systems or IEEE WMAN air interface) is the first version of 802.16 family standards (published in April 2002). It specifies fixed broadband wireless systems operating in the 10–66 GHz licensed spectrum, which is expensive but there is less interference at the high-frequency band and more bandwidth is available. Because radio waves in this band are too short to penetrate buildings, the 802.16 standard is only used for line-of-sight (LOS) connections. Compared to nonline-of-sight (NLOS) connections, LOS links are not so flexible but are stronger and more stable against transmission errors. IEEE 802.16 is interoperable with other wireless networks, such as cellular systems and wireless local area networks (WLANs).

4. WiMAX ADVANTAGES

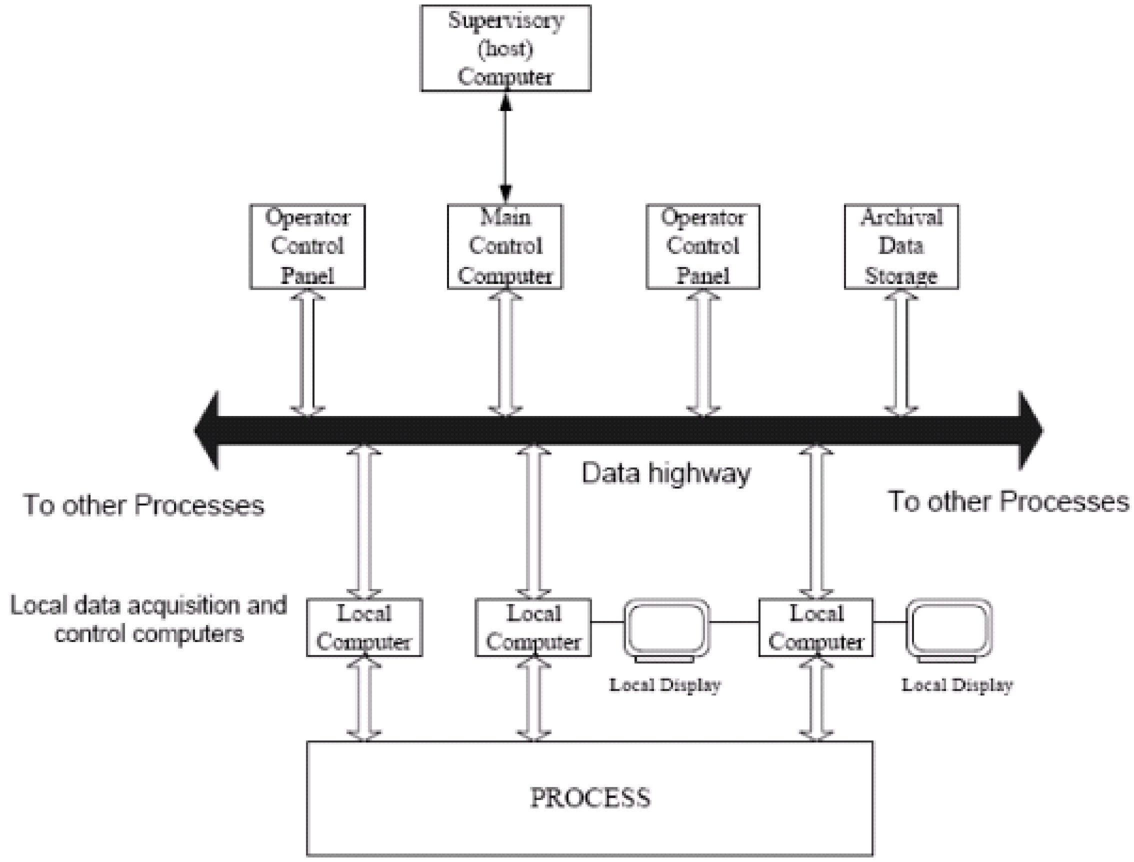
- High Capacity
- Quality of service
- Flexible Architecture
- Mobility
- Improved User connectivity
- Robust carrier class operation
- Scalability
- Non line of sight connectivity
- Cost effectiveness
- Fixed And Nomadic access

5. WiMAX applications

- Automatic teller machines
- Online gaming
- Multimedia communication
- Medical applications
- Vehicular data and voice
- Sensor networks
- Wireless Video Surveillance
- Backup/redundancy
- Telemetric
- Mobile transmission
- Real-time monitoring

- Wireless transmission

6. WiMAX RELATIONSHIP WITH OTHER WIRELESS TECHNOLOGIES



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DCS OR PLC WHICH ONE WOULD YOU CHOOSE?

A S Aiswarya Vallika, II-EIE

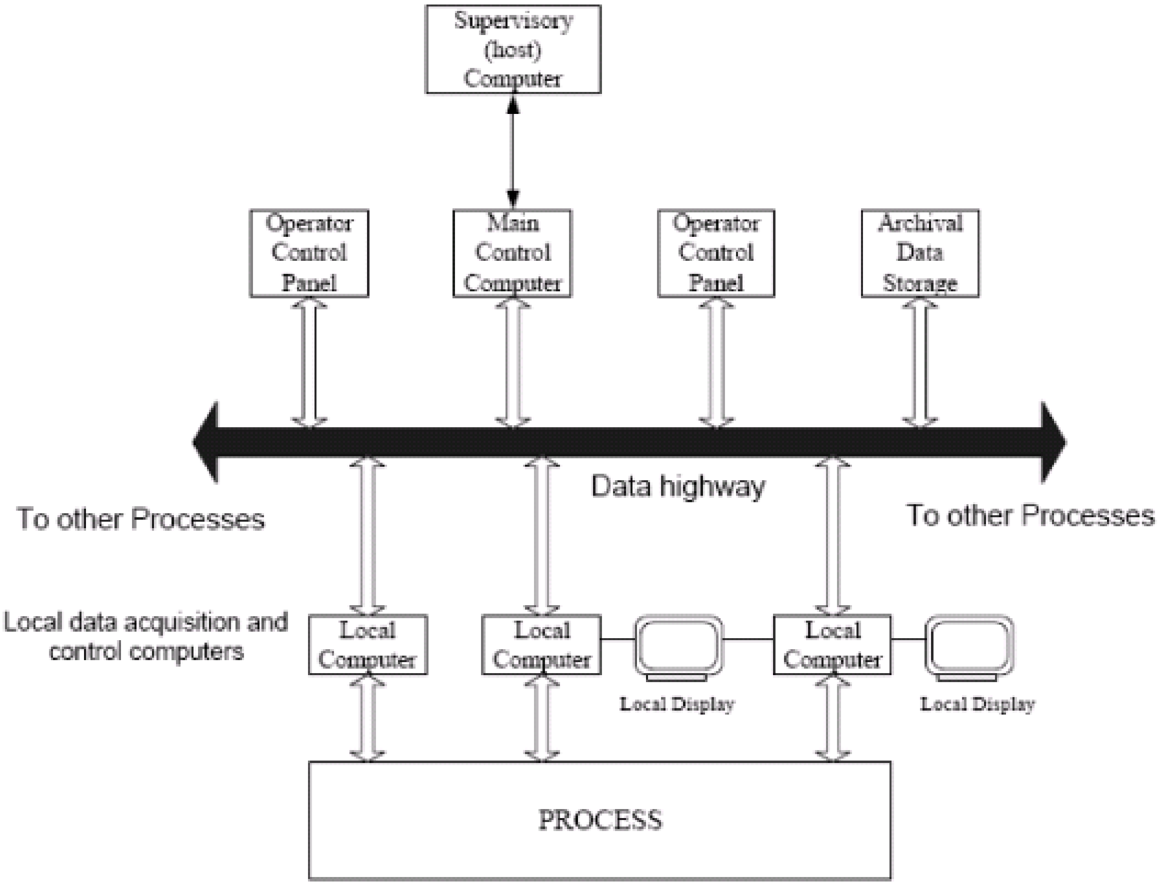
Introduction

Generally, the concept of automatic control includes accomplishing two major operations; the transmission of signals (information flow) back and forth and the calculation of control actions (decision making). Carrying out these operations in a real plant requires a set of hardware and instrumentation that serve as the platform for these tasks. Distributed Control Systems DCS) and Programmable Logic Controllers (PLCs) are two different control platforms for industrial automation. During the early days of its development DCS looked dramatically different from the PLCs. Today, the two technologies share their kingdoms as the functional lines between them continue to blur. Therefore, the purpose of this short article is to briefly explain both these technologies and to compare between the two in terms of suitability of applications.

DCS

Introduced during mid-1970 to replace pneumatic controllers using computers. DCS systems initially performed local control of devices. Distributed control system (DCS) could replace analog panel instruments to perform the corresponding control functions and its user interface mimicked their panel displays. The advantage was low wiring cost. But the disadvantages were that detailed control, remote monitoring, alarming & recording of performance history were not possible. With advent of minicomputers sensors and actuator were controlled using a central computer. When microcomputers were introduced distributed control systems were installed in the plant near the central control room via proprietary data communication lines called Data Highways. DCSs then gained sequence logic capabilities to control batch processes as well as continuous ones. DCSs performed hundreds of analog measurements and controlled dozens of analog outputs, using multi-variable Proportional Integral Derivative (PID) control.

First DCS were developed by Honeywell, US in 1975. Advantages were flexibility in design, easier to modify and upgrade, less failure etc. Disadvantages were lack of interoperability among systems from different manufactures due to proprietary protocols A schematic of the DCS network is shown in figure. Basically, various parts of the plant processes and several parts of the DCS network elements are connected to each other's via the data highway (fieldbus). Although figure shows only one data highway, in practice there could be several levels of data highways. A large number of local data acquisition, video display and computers can be found distributed around the plant. They all communicate to each other through the data highway. These distributed elements may vary in their responsibilities. For example, those closest to the process handle high raw data traffic to the local computers while those farther away from the process deal only with processed data but for a wider audience. The data highway is thus the backbone for the DCS system. It provides information to the multi-displays on various operator control panels sends new data and retrieve historical data from archival storage and serves as a data link between the main control computer and other parts of the network. On the top of the hierarchy, a supervisory (host) computer is set. The host computer is responsible for performing many higher-level functions These could include optimization of the process operation over varying time horizons (days, weeks, or months), carrying out special control procedure such as plant start up or product grade transition and providing feedback on economic performance.

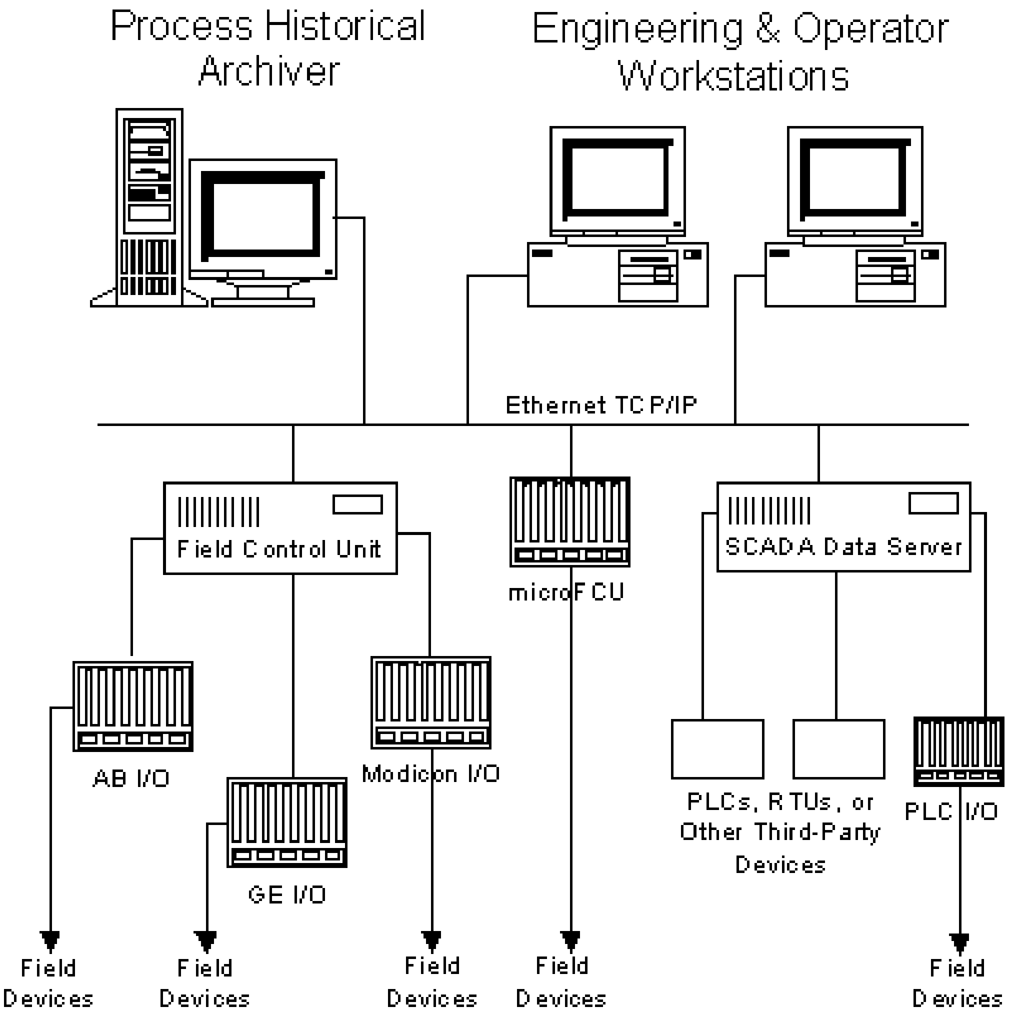


PLC

Introduced in 1960 to replace relays and hardwired programming, Programmable logic controller (PLC) is another type of digital technology used in process control. With the same 8-bit microprocessor technology that gave rise to the DCS, PLCs could replace conventional relay/solid-state logic in machine control. PLCs dealt with contact input/output (I/O) and started/stopped motors by performing Boolean logic calculations. It is exclusively specialized for noncontinuous systems such as batch processes or that contains equipment or control elements that operate discontinuously. It can also be used for many instants where interlocks are required; for example, a flow control loop cannot be actuated unless a pump has been turned on. Similarly, during start-up or shutdown of continuous processes many elements must be correctly sequenced; for example, upstream flows and levels must be established before downstream pumps can be turned on.

The PLC concept is based on designing a sequence of logical decisions to implement the control similar to the above-mentioned cases. Such a system uses a special purpose computer called programmable logic controllers because the computer is programmed to execute the desired Boolean logic and to implement the desired sequencing. In this case, the inputs to the computer are a set of relay contacts representing the state of various process elements. Various operator inputs are also provided. The outputs from the computer are a set of relays energized (activated) by the computer that can turn a pump on or off, activate lights on a display panel, operate solenoid valve, and so on. PLCs can handle thousands of digital I/O and hundreds of analog
I/O and continuous PID control. PLC has many features besides the digital system capabilities. Figure shows a typical control architecture based on a PLC

A typical centralized PLC + HMI SCADA architecture



The Engineering Workstation (EWS) is for project development, including configuration of graphics, logic, alarms, security, etc. The Operator Workstation (OWS) provides the operator interface, including color graphics, faceplates, alarms, logging, trends, diagnostics, etc. The EWS includes an OWS for testing and troubleshooting. The Field Control Unit (FCU) executes sequential and regulatory logic and directly scans inputs/outputs (I/Os). Depending on the FCU's configuration, multiple brands of I/Os can be scanned from one unit.

The I/O Subsystem supports input and output devices from all the standard industry suppliers. The micro FCU is a small PLC that executes sequential and regulatory logic and directly scans onboard I/O.

The SCADA Data Server (SDS) interfaces the system to PLCs, Fieldbus technologies, remote terminal units (RTU), PLC I/O, and other third-party devices. The SDS can also execute sequential and regulatory logic and directly scan supported I/O. It can also act as a data gateway allowing the system to work with just about any device. The Process Historical Archiver (PHA) stores and retrieves historical data collected by the FCU, micro FCU, SDS, or any other intelligent device in the system. The PHA can run standalone or can share an OWS workstation.

PLCs are not typical in a traditional process plant, but there are some operations, such as sequencing, and interlock operations, that can use the powerful capabilities of a PLC. They are also quite frequently a cost-effective alternative to DCSs where sophisticated process control strategies are not needed. Nevertheless, PLCs and DCSs can be combined in a hybrid system where PLC connected through link to a controller, or connected directly to network.

DCS vs PLC

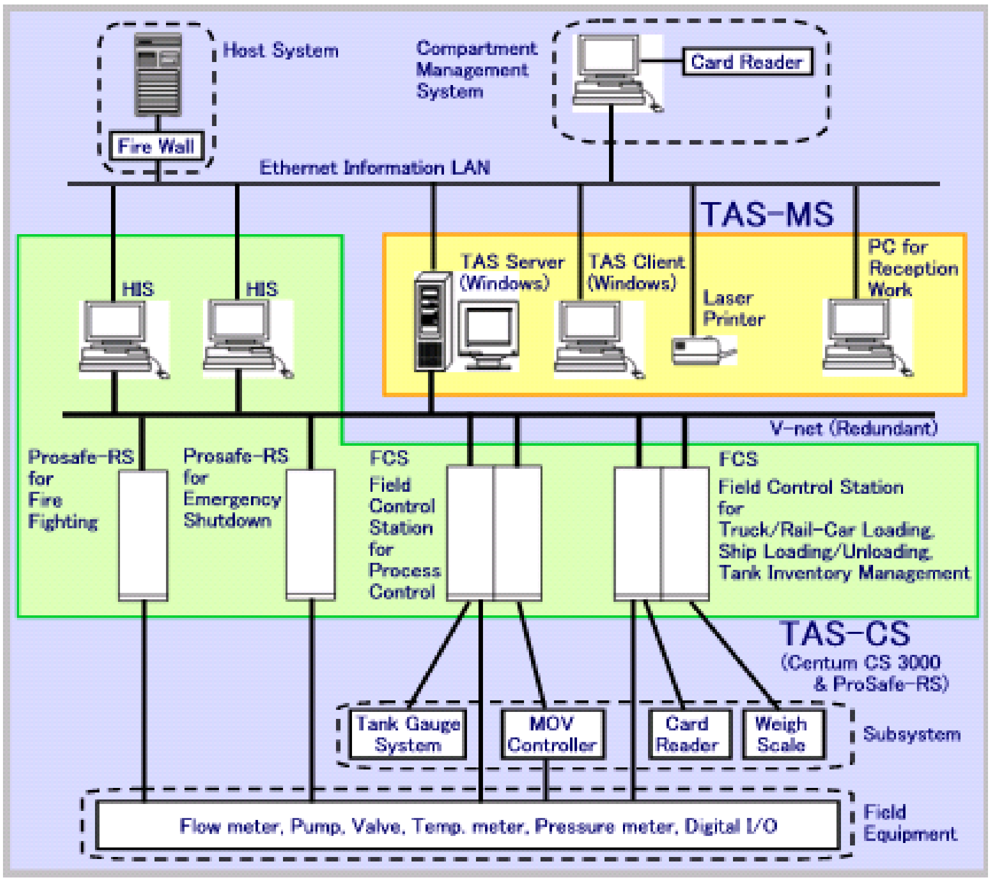
New developments in the field of electronic automation have led to the convergence of PLC and DCS technologies. Let's look at the com components of a DCS or PLC based system to see how different (or similar) they really are. At first glance, the pictured system architectures look very similar. Both systems share the following components:

- Field devices
- Input/output modules
- Field Controllers
- Human Interface Systems (HIS)
- Management Systems for Supervisory Control.
- Business integration using World Wide Web connectivity

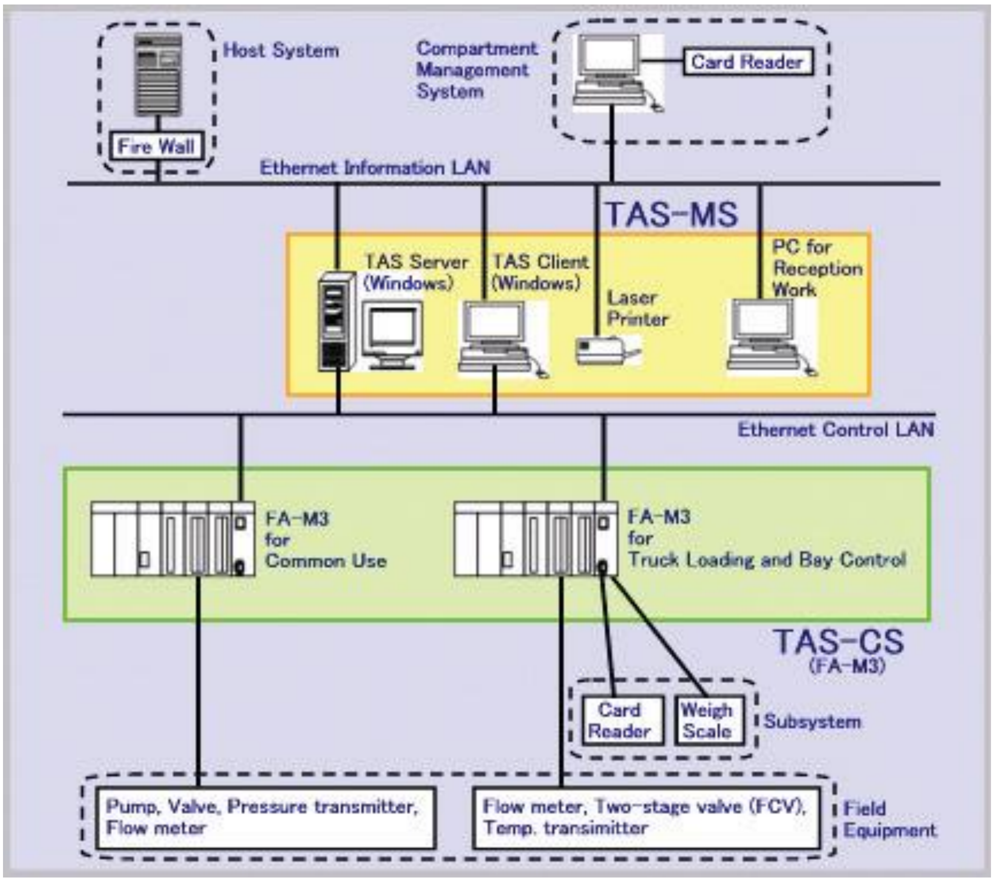
As you look at the following system architectures, you should note that the technologies used in each system are in fact, very similar; the difference becomes more apparent when you consider the nature and requirements of the application.

For example, in the DCS architecture diagram, redundancy is often employed for I/O, controllers, networks, and HMI servers. Since redundancy adds cost and sometimes complexity, DCS users must carefully evaluate their need for redundancy in order to achieve their required system availability and to prevent unplanned downtime. The PLC architecture illustrates one of its most common applications, the control of discrete field devices such as motors and drives. To effectively control motors and drives requires that the controller be able to execute at high speeds (typically a 10–20 msec scan rate). From a technology point of view, one can see that PLC and DCS are not very different, which has paved the way for them to merge. Therefore, we must look beyond technology to the application expertise and domain knowledge that is built in to these systems.

The following schematic shows a Liquified Nitrogen Gas (LNG) Terminal Automation System (TAS) implemented using Yokogawa DCS Centum 3000 as well as Yokogawa PLC unit FA-M3.



Typical architecture of DCS based system



Typical architecture of PLC based system

A terminal/large depot is a storage area where petroleum products are received through cross-country pipelines and/or large marine vessels and are stored in tank farms. Subsequent distribution is carried out using trucks, barges, rail cars (popularly known as tank cars or wagons), and similar means. The management function (called TAS-MS) provides a gateway to upper-level system to properly handle orders downloaded from there. The downloaded data is analysed and managed at TAS-MS to produce sequence of events and information unit understood by TAS-CS for control execution. The control function (called TAS-CS) includes all necessary monitoring and control function, collects data from field device.

A large Liquefied Natural Gas (LNG) terminal.

The Seven Questions to Ask Yourself before Choosing a System

1. What are you manufacturing and how?

PLCs were originally designed for factory automation applications which involved the manufacture and/or assembly of specific items –"things". The process is, by nature, very logic control intensive, often with high-speed requirements. This type of process is often controlled by a PLC and Human Machine Interface (HMI) combination. Where as DCS are designed for process automation applications which typically involve the transformation of raw materials through the reaction of component chemicals or the introduction of physical changes to produce a new, different product – "stuff." These applications may be composed of one or more process unit operations piped together. One key characteristic is that the operator can't see the product. It is usually held within a vessel and may be hazardous in nature. There is usually a large amount of simple to complex analog control (i.e., PID or loop control), although the response time is not that fast (100ms or greater). This type of process is often controlled by a DCS.

2. What is the value of the product being manufactured and the cost of downtime?

If the value of each independent product being manufactured is relatively low, and/or if the cost involved in plant downtime that results in lost production, with little damage to the process is low, then PLC is the likely choice. However if the value of a batch is high, either in raw material cost or market value, and downtime not only results in lost production but potentially dangerous and damaging conditions, the selection should be DCS. In some chemical applications, maintaining the process at steady state is critical, because if the system goes down, the product could solidify in the pipes. Examplt if the cat cracker in a refinery goes down it could be days before it can be brought back on line and that production can resume. This means lots of lost revenue for the refinery. The DCS system, which typically includes optional redundancy, is probably worth the additional upfront investment for these applications. In contrast, the bottling operation of a brewery that only needs to run 10 hours a day to meet production schedules, and which can be shutdown for system maintenance, troubleshooting, or upgrades with very little impact on the bottom line, is a classic PLC application.

3. What do you view as the "heart" of the system?

Typically the heart of a factory automation control system is the controller (PLC), which contains all of the logic to move the product through the assembly line. The HMI is often an on-machine panel or a PC-based station that provides the operator with supplemental or exception (emergency) data. Increasingly, operational information resulting from data analysis is also a requirement for factory automation applications requiring for a more sophisticated HMI. In process automation, where the environment can be volatile and dangerous, and where operators can't see the actual product, the HMI is considered by most to be the heart of the system. In this scenario, the HMI is a central control room console that provides the only complete "window" into the process, enabling the operator to monitor and control the processes which are occurring inside pipes and vessels located faraway and throughout the plant.

4. What is the role played by the operator?

In a PLC environment, the operator's primary role is to handle exceptions or emergencies. Status information and exception alarming help keep the operator aware of what is happening in the process. In many cases the factory can run "lights out", i.e without much operator interferences. The DCS plant requires however an operator to make decisions and continuously interact with the process to keep it running. In fact, the operator's process knowledge is often critical to keep the process running optimally. The operator will change setpoints, open/ close valves, or make a manual addition to move a batch to the next stage of production. Within the HMI, faceplates and analog trends provide a critical view into what is really happening in the production process, while the alarm management system focuses the operator's attention on areas where he must intervene to keep the process running within its target performance envelope. In the event of an HMI failure, the plant could be forced to shutdown in order to keep people and equipment safe.

5. What system performance is required?

The speed of logic execution is a key differentiator. The PLC has been designed to meet the demands of high-speed applications that require scan rates of 10 msecs or less, including operations involving motion control, high-speed interlocking, or control of motors and drives.

Fast scan rates are necessary to be able to effectively control these devices. The DCS doesn't have to be that quick – most of the time. The regulatory control loops normally scan in the 100 to 500 millisecond range. In some cases, it could be detrimental to have control logic execute any faster – possibly causing excessive wear on final control elements such as valves, resulting in premature maintenance and process issues. The extra cost for redundancy, may be well worth it in the case of the typical DCS system, where high availability is mission critical. However, it is often not cost-justified to make a PLC system fully redundant.

6. What degree of customization is required?

The expectation and desire to be able to create a customized application varies greatly between DCS and PLC users. Because the PLC was originally designed to be a jack of all trades, it's understood that the development of customized routines and functions is required to meet the unique needs of an application. A systems integrator may be applying a PLC toward a palletizing machine today and then tomorrow he might be pointing it toward a laser cutting lathe. The PLC delivers a "toolkit" of functions and elemental building blocks that can be custom-developed and chained together to address the requirements of an application. Provisions are available to enable the integration of functions and products into a seamless architecture. Additionally, powerful programming languages are typically available to facilitate the creation of custom code from scratch. However a DCS cannot be so easily customized for such a variety of applications.

7. What are your engineering expectations?

Factory automation engineers want customizable control platforms, which offer the individual components that can be quickly programmed together to accomplish the task at hand. Often integrators and engineers open the PLC "toolkit," roll up their sleeves, and start programming. The tools provided by a PLC are typically optimized to support a "bottom-up" approach to engineering, which works well for smaller applications. DCS engineers, on the other hand, are typically most effective using a "top-down" approach for engineering, which forces them to put significant effort into the upfront design. This focus on upfront design is a key to minimizing costs, compressing the project schedule, and creating an application that can be maintained by plant personnel over the long term. Since DCS applications are typically larger and plantwide in scope, the ability to propagate libraries and templates throughout the application is very important to minimize rework and promote the use of standards.

Summary

Turn the clock back 10-15 years: The programmable logic controller (PLC) was king of machine control while the distributed control system (DCS) dominated process control. We now use each where the other used to rule. However, PLCs still dominate high-speed machine control, and DCSs prevail in complex continuous processes. Think about it this way – The PLC is controlling a machine, while the DCS is controlling the plant. For example, a pencil manufacturer is producing an incredible amount of pencils at an extremely rapid speed using a PLC. By programming in machine code, engineers might be able to squeeze another 10 milliseconds out of the machine, which is now capable of punching out even more pencils and profits.

The PLC engineer demands that kind of flexibility and open architecture. The process engineers controlling entire plants with a DCS require more intuitive programming platforms, which utilize predefined and pre-tested functions to save time and to ensure repeatability.

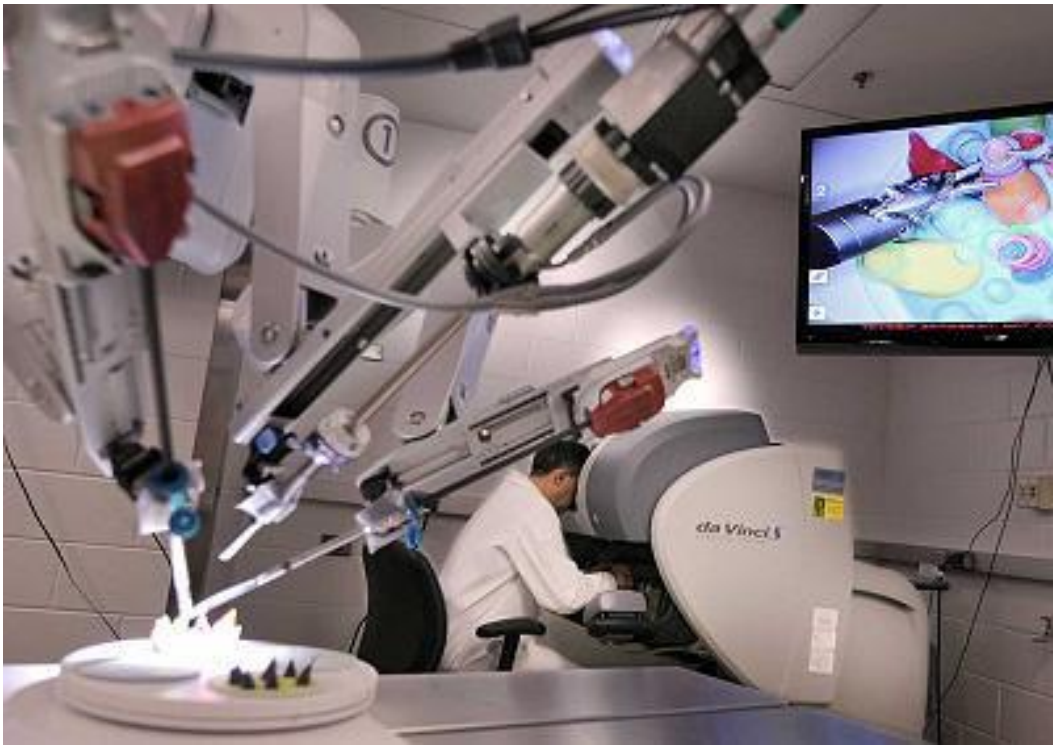
ROBOTICS IN MEDICINE

K Karthik Murthy, II-EIE

The future of robotic technology paved way in medicine, surgery, reproductive endocrinology, and its role in surgical education & telepresence surgery. Robots play a very crucial role in the modern medicine. Robots are being developed in order to overcome several limitations of man. Dr. David Gow created the first bionic arm in 1998 called the EMAS (Edinburgh Modular Arm System). Recent technological researches have undergone much advancement in using robots for complicated surgery and other medical activities. One of the most important field in which robots have been most effectively used is robotic assisted surgery, robots are being used in many complicated surgeries like cardiothoracic surgeries, vascular surgery, ortho surgeries, surgeries in brain, kidney and other complicated areas. Pill sized robots are being used in imaging of the internal organs and in analyzing the hormone levels as well as many biological activities. Robots are also being used to aid the disabled.

The use of robotics in medical field can be broadly classified into three different fields namely macro robotics, micro robotics and bio robotics on the basis of their purpose and complexity of approach in order to develop these machines. Macro robotics deals with the development of robots, wheelchairs and manipulators for rehabilitation as well as new more powerful tools, techniques and equipments for surgery and other related applications. It mainly focuses on developing powerful equipments and mechanical devices to aid the disabled and generally they are designed to be operated by people with less expertise. Micro robotics includes the development of machines which aid the field of minimally invasive surgery as well as to the development of a new generation of miniaturized mechatronic tools for conventional surgery.

These tools are usually developed to be handled by people who are specially trained and is designed to handle more complicated tasks. Precision and accuracy of these instruments is an unavoidable fact and adds to the complication of the design. Bio robotics deals with the issues of modeling, simulating and studying biological systems in order to provide a better insight and a better understanding about the human physiology. This field of robotics mainly aims at recreating locomotion and simulating other psychological activities aimed at developing prognostics and other lifesaving equipments.



The major advantage of using a robot is its accuracy i.e. it can locate itself incisions over the critical parts of the body thus preventing excessive bleeding and related complications. It helps in miniaturization of the equipments and it also provide a better zoomed and clear view and better understand the body parts or region to be operated. Since robotic surgery techniques are highly precise it reduces the days of hospital stay since patient recovery is quick because of reduced blood loss and use of pain medication. Major disadvantage of robotic technology in medicine is the cost associated with its development. The robotic equipments which had to be planted inside the body need to be sterile which accounts for most of the cost of its production. In most cases maintenance of these robotic parts are highly expensive and expert training is required to handle them. In spite of all these disadvantages researches in using robots in the field of medicine is gathering pace and in the near future robots will help humans in medical operations and analysis and will help in faster identification and curing of the diseases. In medicine and more specifically surgery, robotic technology has become a viable surgical alternative to provide minimally invasive surgery with the advantages of traditional open surgical techniques. In addition, robotics has a role in the surgical training at home by increasing the precision and accuracy of the learning process, although this has yet to be translated to the operating room. Robotics may also allow for telementoring and telepresence surgery facilitating global access health care and new approaches are needed to definitively determine the future role of robotics.

IMAGE CLASSIFICATION USING NEURAL NETWORK

S K MOHINUDDIN, I-EIE

It is very difficult to classify the images with a robust success rate using classical statistical algorithmic approaches. For such classification problems, the application of Artificial Neural Networks (ANN) is found to be very successful. A multilayer feed forward network can be used for classifying the images. The network can be trained with a large number of images using back propagation algorithm to produce an acceptable level of robustness. Multiple back propagation methods and a variable number of hidden layers can be incorporated with the neural networks for a comparative study of their respective efficiencies.

The application of ANN is ideally suited for classification problems as it can make adaptive guesses even from incomplete or vague information and hence provides an inexpensive and intuitive method for image classification. By applying the supervised learning technique, a network can learn from illustrative exemplars, and it creates an internal structure of rules to classify different inputs, such as distinguishing images. Image processing and neural network methodologies can be integrated to achieve the goal. The system can have two interconnected stages, a feature extraction stage that characterize the essential information content of the input data set, followed by a classifier network that performs the required classification as shown in Fig 1.

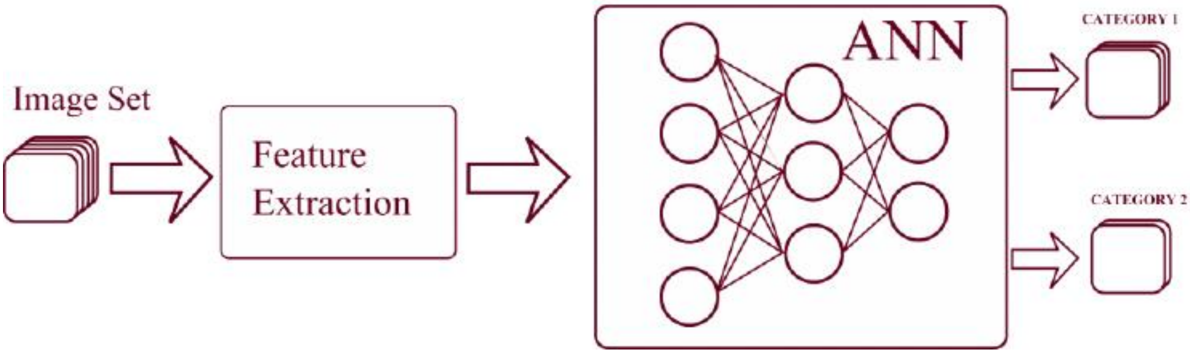


Fig 1. Architectural overview

The methodological classification of images can be executed by firstly, processing the given image set to obtain the salient features, creating the neural network followed by training the network with a randomly chosen training set, testing the neural network with a new testing set and finally, the optimization. In order to decrease the complexity of the network and time required to train the network, the number of inputs applied to neural network are reduced by extracting salient features from the image. Then the neural network can be created. A multilayer feed forward neural network is a good choice. There is no theoretical limit on the number of hidden layers, but typically it is one or two. There are no known rules for specifying the number of neurons in hidden layer, hence it is chosen either based on prior experience or simply chosen arbitrarily and then refined by testing. The neural network can be trained using back propagation algorithm with sufficient number of images belonging to both categories giving the target/desired outputs for each input. The network is then tested with images in the testing set. Networks with different number of neurons in hidden layer can be created. The network which gives optimum performance in terms of maximum overall success rate and minimum time for training is selected, which is the optimization phase.

As an example, let us consider the classification of underwater images into natural underwater shapes (NU shape) and human made wrecks (HM wreck) or unnatural shapes. As a first step, the given image is resized to 100 by 100 pixels. Then it is divided into 100 segments each of 10 by 10 pixels and average of each segment is computed. These average pixel values are applied as input to the neural network. Hence it requires 100 neurons in the input layer. As second step, a neural network having an input layer with 100 neurons, a hidden layer and an output layer with one neuron is created. Output value set was binary such that 0 represents NU shape and 1 represents HM wreck. The trained networks are tested with the training set to ensure that training was successful. Then it is tested with another testing set and the success rate is calculated. Some of the images belonging to the two categories are shown in Fig 2.a. and Fig 2.b.

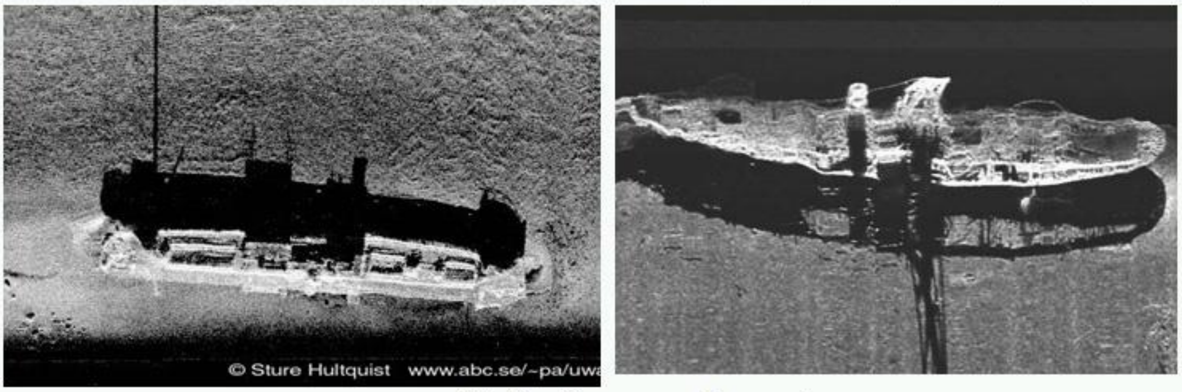


Fig 2.a Human made wrecks

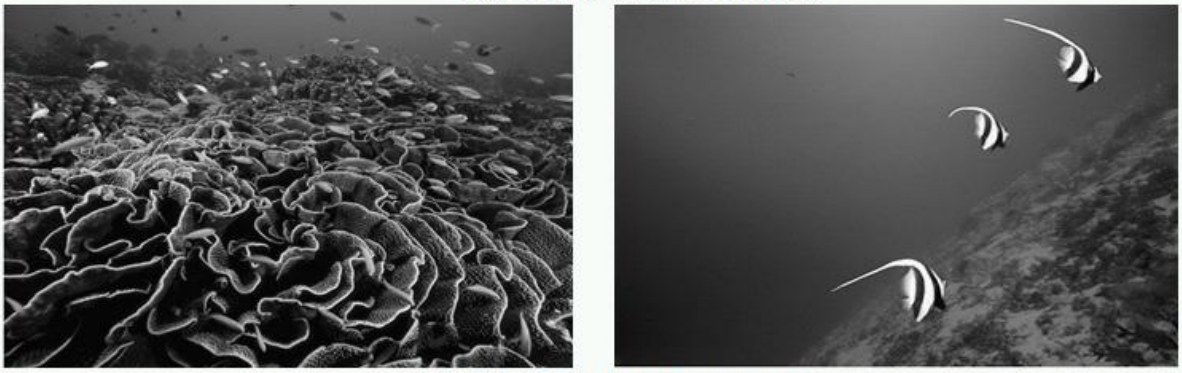


Fig 2.b Natural Underwater images

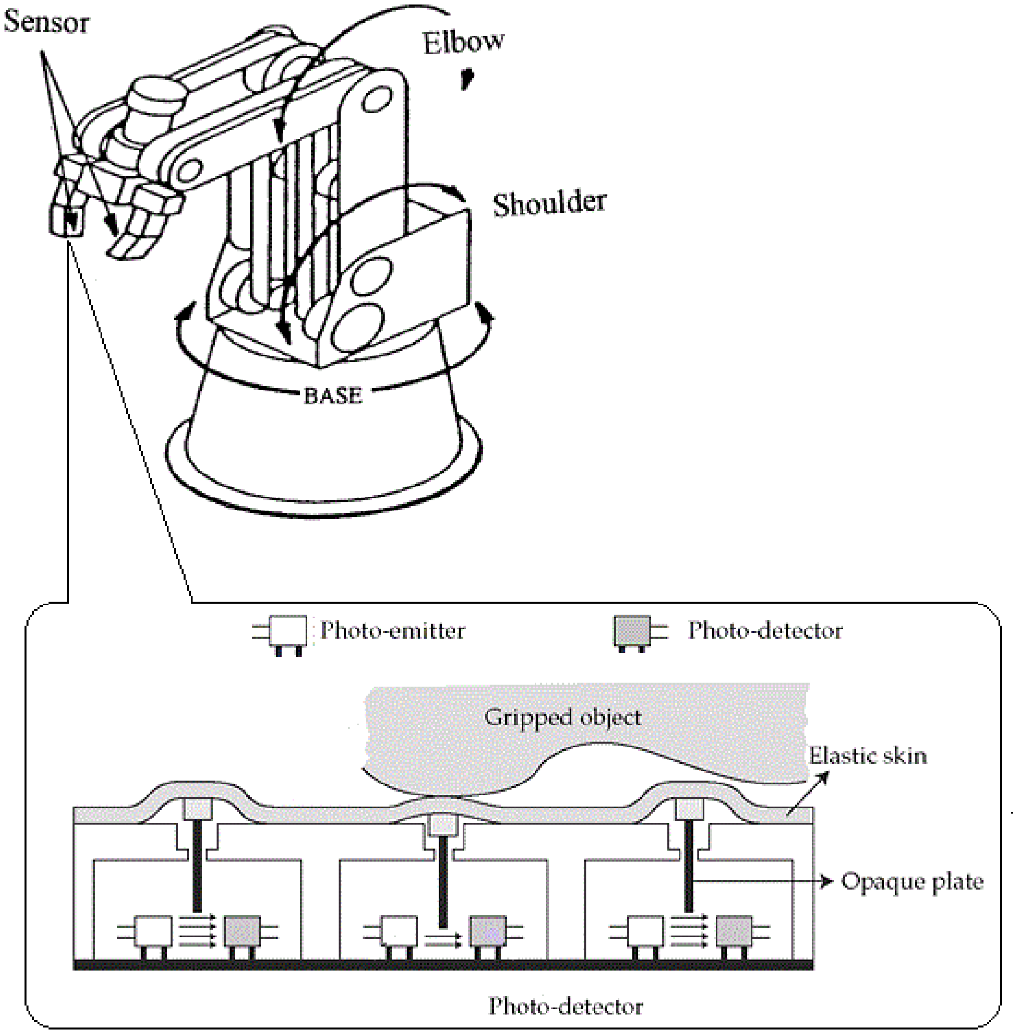
Several variations of back propagation algorithm such as, Levenberg- Marquart algorithm, Resilient back propagation algorithm etc can be used for training. The results can be compared. Normally, Levenberg-Marquardt training is used for small and medium size networks, if enough memory is available. If memory is a problem, then there are a variety of other fast algorithms available such as Resilient back propagation training algorithm. It is found that overall success rate is lower in case of resilient back propagation compared to the system trained with Levenberg-Marquardt algorithm. The timerequired for training is small in the case of training with Resilient back propagation even for very large networks. From the results, it can also be seen that as the number of neurons in hidden layer increases, the time required for training increases. Thus we can see that artificial neural networks are a good choice for image classification compared to conventional classification methods.

OPTICAL TACTILE SENSORS

P AKHIL SAI, I-EIE

A tactile sensor is a transducer which is capable of detecting and measuring properties like shape, surface texture, etc of an object by making physical contact with it and then converting that information into a signal which can be processed. Tactile sensation is the process of determining physical properties of an object through physical contact with that object. A tactile sensing system, therefore, is a system that is capable of detecting and collecting such information by means of tactile sensors. In other words, it is the process of detecting and measuring the spatial distribution of forces on a sensory surface. Unlike other sensing modalities in humans, tactile sensing is determinant and direct. It is not distorted by perspective, confused by external lighting, or greatly affected by the material constitution or surface finish of objects. In addition to the direct information perceived by tactile sensing, it also provides us with information to maintain the posture of our body, to monitor walking, to grasp items, to manipulate objects, and to warn of physical danger. One important area of application of tactile sensors is robotics.

Optical tactile sensors make use of light sources and light detectors. They are used to detect the presence, absence, position and shape of an object. These sensors can be used for sensing both touch as well as force. The figure below shows the working principle of the sensor. touch sensors opaque plates are moved according to the profile of the object and the gripping force thus producing a 2D signal as a function of the object profile. These signals can be processed with special pattern recognition algorithms by a computer for performing pick and place tasks. More details of tactile sensors can be found in the e –book given in reference [1].



Reference:

1) Siamak Najarian, Javad Dargahi, Ali Abouei Mehrizi. Artificial Tactile Sensing in Biomedical Engineering. http://accessengineeringlibrary. com/

GAS LEAKAGE DETECTING INSTRUMENT / GAS ANALYZER

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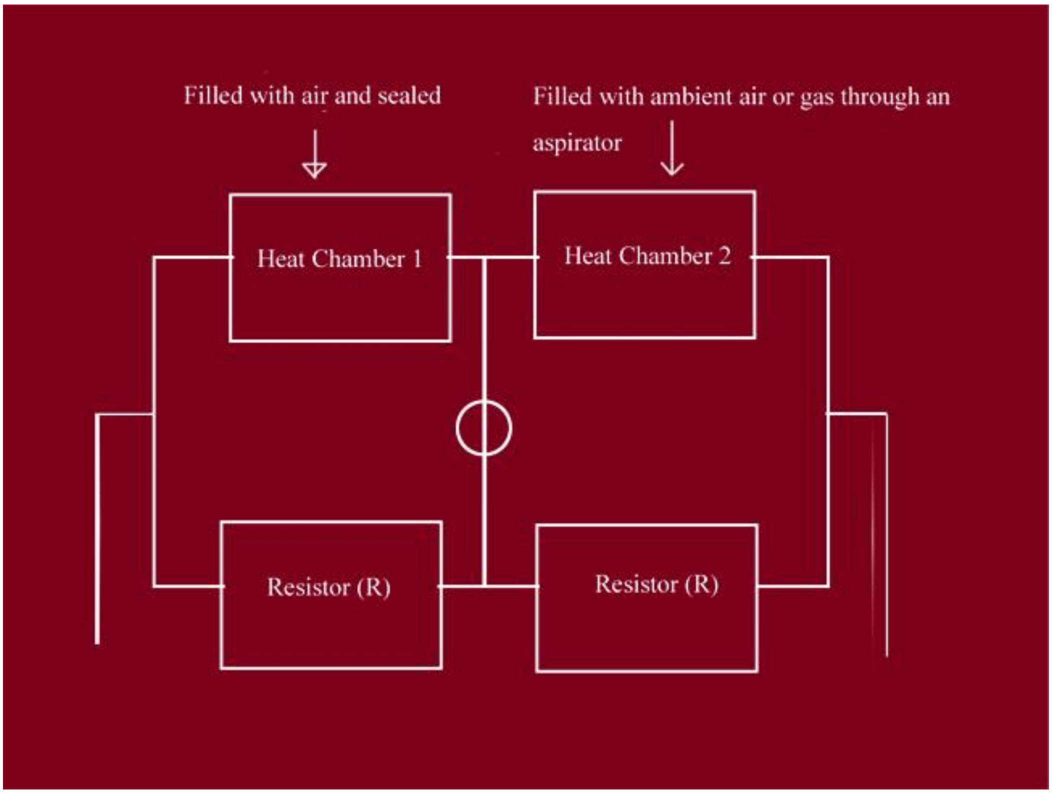
In recent years, one of the most commonly used item in household is liquefied petroleum gas (LPG). As we depend on it for most of our cooking activities, this becomes an inevitable source of energy. But, lack of awareness and care leads to many problems. Some of the major questions that arise are:

“Worried that it may lead to explosions···!”
“Oh! it’s very difficult to detect a gas leakage...? an so on.
So, here we introduce a “GAS LEAKAGE DETECTOR”.



It detects the gas that are generally combustible and thus provides a safe environment. Materials Required

- Two heat chambers:
- Heat chamber 1 and heat chamber 2. Heat chamber 1 is filled with air and is sealed.
- Heat chamber 2 is filled with ambient gas or air through an aspirator.
- These chambers also include a platinum sensor
- Two resistors in which both of them are having same value of resistance
- An external power supply · An output meter

Working and Construction

The working is based on ‘Wheatstone bridge principle’ The heat chambers contain temperature sensors. The sensor material used is platinum

Why we use platinum?

- Possesses fine response towards temperature
- High accuracy
- Linear range of relation between temperature and resistance ie, as temperature increases resistance also increases. We now consider the actul working of the gas leakage detector. It can have two different conditions or operations.

Case 1 : When both the heat chambers are subjected to normal ambient temperature then no ignition is produced since no combustible gases are present, hence produce no output signal for the gas leakage detector

Case 2: When there is any gas leakage, then heat chamber 2 will be filled with combustible gases taken through an aspirator (an aspirator is a gas sucker that is adjusted in such a way that it sucks very minute amount of gas). Once it is filled with combustible gases, the chamber is ignited and it produces an unbalanced condition due to ignition. The corresponding output is then obtained. The output signal can be digital or analog based on our convenience.

Design

Phase 1: Sensor design ie, to design and build the sensor.
Phase 2: To setup the external circuit ie, a wheatstone bridge. This works with the change in “thermal conductivity” ie, a measure of ability of a substance to conduct heat by changing the temperature, the resistance of the platinum changes and this leads to change in output

Advantages

· Using gas detectors for analyzing gas leakage is cheap
· Provides safety

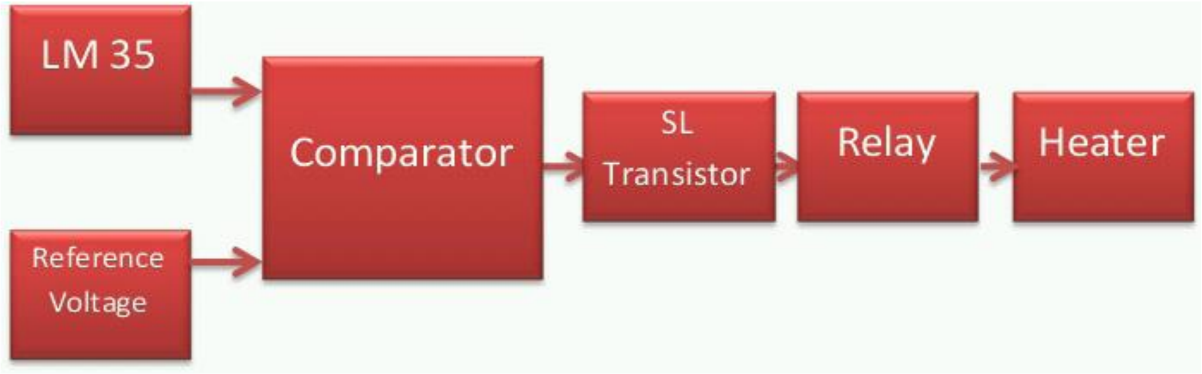
Reference

·Ernst Deoblin: Principles of Instrumentation Systems, Instrumentation Engineering GATE 2010, Platinum Sensors Ltd.

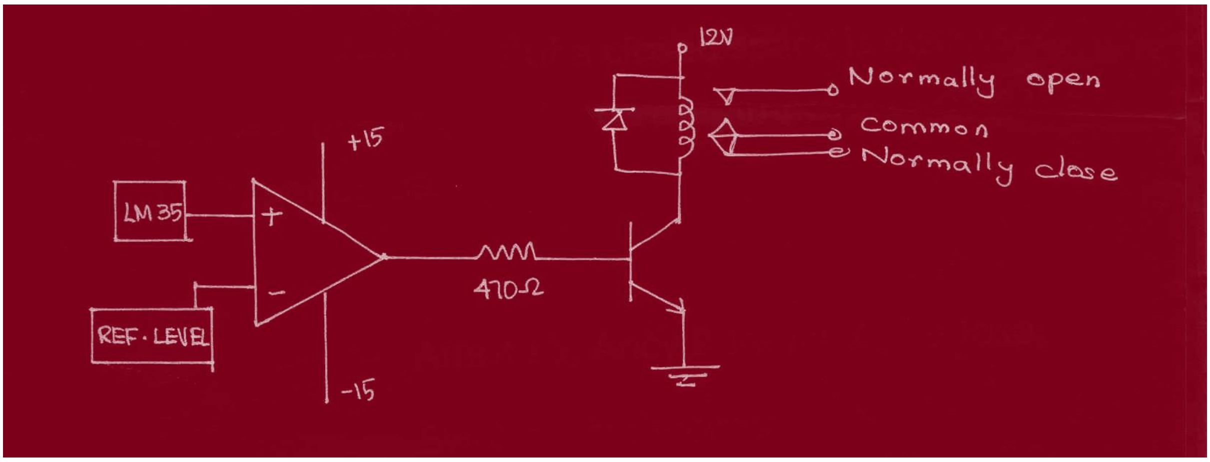
TEMPERATURE CONTROL SYSTEM FOR INSTRUMENT AIR DRYING TOWER

T SIVA SREE, I-EIE

Temperature is one of the main parameters of thermodynamics. If no net heat flow occurs between two objects, the objects have same temperature; otherwise heat flows from the hotter object to the colder object. This is the content of zeroth law of thermodynamics. Temperature control finds varied uses in our everyday lives, be it common room coolers or large industrial devices like boilers etc. The ability to control temperature has not only improved our everyday lifestyle but has also aided in almost all industrial processes. Our project aims at developing a temperature control system for instrument air drying tower. The heater inside the tower should be turned off when the temperature inside the tower exceeds a certain value and heater should remain ON if the temperature does not exceed the value. The figure below shows the block schematic representation.



The temperature inside the tower is sensed using the temperature sensor LM35. It senses the ambient temperature in terms of mV. The output of the sensor is given to the non-inverting terminal of a comparator as shown in figure.



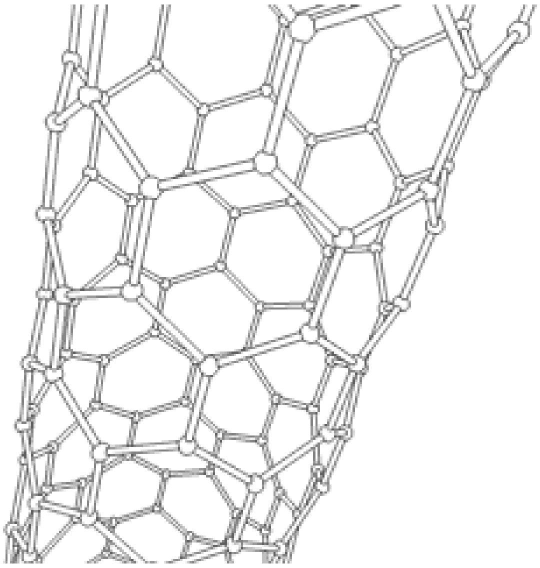
The other input is a reference voltage. When the LM35 output exceed the reference voltage i.e. when the temperature is very high, the output of comparator is high and this drives the transistor SL100, which in turn drives the relay. The supply for relay is 12V. The relay in the normally closed position is connected in such a manner that the heating coil is connected to a 12V DC. As soon as the ambient temperature becomes more than the reference, comparator output through the transistor drives the relay into normally open position and the heater is turned off.

If the LM35 output is less than the reference, then the output of comparator is low, there is no base drive to transistor SL100 and the relay remains in normally closed position. A simple, yet effective method to control the ambient temperature of a closed space is discussed here. This method can be further improved to deal with larger areas.

CARBON NANOTUBES

M SAI SNEHITHA, III-EIE

In this modern era of miniaturization, the development of devices that are small, light, self-contained and that will replace larger microelectronic equipment is one of the goals of the nanotechnology revolution. Nanotechnology has application in many fields, including medicine, technology, computers, weapons, etc. One of the most promising things about it in the near future is carbon nanotubes. Using nanotech, they can create materials out of these nanotubes that are 100 times stronger than steel and 10 times lighter. Advances in understanding carbon nanotubes have a major impact on the whole field of nanotechnology. Carbon nanotubes have found their applications in fabricating tear resistant textiles, in concrete to increase the tensile strength and to halt crack propagation, ultra-capacitors for storing large amount of electric charge, reinforcing structural materials in buildings, cars and airplanes etc. Carbon nanotubes are allotropes of carbon with a cylindrical nanostructure. An ideal nanotube can be thought of as a hexagonal network of carbon atoms that has been rolled up to make a cylinder. The cylinder can be tens of microns long, and each end is "capped" with half of a fullerene molecule. Since each unit cell of a nanotube contains a number of hexagons, each of which contains two carbon atoms, the unit cell of a nanotube contains many carbon atoms. If the unit cell of a nanotube is N times larger than that of a hexagon, the unit cell of the nanotube in reciprocal space is 1/N times smaller than that of a single hexagon. The chemical bonding of nanotubes is composed entirely of sp2 bonds, similar to those of graphite. This bonding structure, which is stronger than the sp3 bonds found in diamonds, provides the molecules with their unique strength. Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). Singlewall nanotubes can be thought of as the fundamental cylindrical structure, and these form the building blocks of multi-wall nanotubes. The ordered arrays of single-wall nanotubes are called ropes. Single-walled nanotubes consist of a single thick layer of graphite which is rolled in the form of a cylinder. One-atom-thick layer of graphite is called graphene. The arrangement of graphene is represented by a pair of indices (n, m) called the chiral vector. The integer's n and m denote the number of unit vectors along two directions in the crystal lattice of graphene. If m = 0, the nanotubes are called "zigzag". If n = m, the nanotubes are called "armchair". Otherwise, they are called "chiral". Most single-walled nanotubes (SWNT) have a diameter of 1 nanometer, with a tube length that can be many millions of times longer. Multiwalled nanotubes (MWNT) consist of multiple rolled layers (concentric tubes) of graphite and are constructed of multiple cylinders, one inside the other.



The simplest form of multiwalled nanotubes is double-walled nanotubes whose properties are similar to SWNT but their resistance to chemicals is significantly improved. Multi-wall carbon nanotubes do not need a catalyst for growth but single-wall nanotubes can only be grown with a catalyst. Single-wall carbon nanotubes are also expected to be very strong and to resist fracture under extension. Single-wall nanotubes are remarkably flexible. They can be twisted, flattened and bent into small circles or around sharp bends without breaking, and severe distortions to the cross-section of nanotubes do not cause them to break. In many cases the nanotube should regain its original shape when the stresses distorting it are removed. How to make nanotubes A relatively efficient way to produce bundles of ordered single-wall nanotubes was found in 1996. These ordered nanotubes are prepared by the laser vaporization of a carbon target in a furnace at 1200 °C. A cobalt-nickel catalyst helps the growth of the nanotubes, because it prevents the ends from being capped during synthesis, and about 70-90% of the carbon target can be converted to single-wall nanotubes. By using two laser pulses 50 ns apart, growth conditions can be maintained over a larger volume and for a longer time. This scheme provides more uniform vaporization and better control of the growth conditions. Flowing argon gas sweeps the nanotubes from the furnace to a water-cooled copper collector just outside of the furnace. The most commonly used method for synthesizing carbon nanotubes is arc discharge method. In this method, the cathode used is a movable graphite rod. The anode includes a cylinder pressed from a mixture of evenly dispersed graphite powder, catalyst metal, and growth promoter. The atmosphere is selected from the group consisting of pure hydrogen and a mixture of at least 80% hydrogen and 20% argon by volume.

The catalyst metal includes at least two metals selected from the group consisting of Fe, Co, Ni, and Y. The anode and the cathode are perpendicular to each other. Inducing an electric arc across the anode and cathode to thereby consume the anode and produce the single-walled carbon nanotube product.

Applications

Many of the applications now being considered involve multiwall nanotubes than single-wall nanotubes. It has also been suggested that carbon nanotubes could be used in displays or for the tips of electron probes. Other applications could result from the fact that carbon nanotubes can retain relatively high gas pressures within their hollow cores. Carbon nanotubes could act as a template for synthesizing new carbides structured on the nanoscale. Structures based on carbon nanotubes offer exciting possibilities for nanometre scale electronic applications. Carbon nanotubes could be combined with a host polymer to tailor their physical properties to specific applications. Since carbon nanotubes are so small, they could be used in polymer composites that could be formed into specific shapes, or in a low-viscosity composite that could be sprayed onto a surface as a conducting paint or coating. In the future, nanotubes may replace silicon in electronic circuits, and prototypes of elementary components have been developed. Carbon nanotubes may eventually replace the standard silicon computer chip, allowing increased performance in a smaller size. Nanotubes are also expected to be used in the construction of sensors and display screens.

DESIGN OF AXI4 INTERCONNECT MATRIX?

V SRAVYA, I-EIE

The objective of the industrial training is to design the AMBA AXI4 interconnect matrix. AMBA AXI4 (Advanced eXtensible Interface 4) is the fourth generation of the AMBA interface specification from ARM. The AXI4 protocol is an industry standard for on-chip communications. The AXI4 specification includes features such as address pipelining, out of - order completion, and multi-threaded transactions. All of these features, when taken together, allow much higher performance systems than those over other bus architectures. The AMBA AXI4 protocol is targeted at high-performance, high frequency system designs and includes a number of features that makes it suitable for high-speed submicron interconnects. AXI 4 interconnect finds its use in the LCD-Pro Evaluation board which enables evaluation of the LCD-Pro library, a set of flexible, configurable IP cores which can be used to implement versatile and powerful display control, graphics and video applications like Industrial and automated control, Automotive graphics and video systems, Medical monitors and instrumentation, Household consumer products (washing machines, refrigerators), Building automation HMI, Marine systems, Consumer automation (kiosks, vending machines, ATMs) etc.

- Industrial training details
- Literature Survey on AMBA Protocol including AXI 4 version
- Literature Survey on AXI4 interconnect
- Design of AXI4 interconnect matrix
- Coding of AXI4 interconnect matrix.
- Testing of the interconnect matrix.
- Programming Language: VHDL
- Simulation Tool: Modelsim SE 6.5.

ISSUE - 2

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