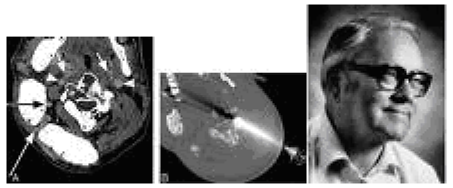
Emerging Trends in Medical Diagnostics and Therapy

High-tech devices and materials such as fibre optics help to perform surgery .In minimally invasive surgery; miniaturized medical instruments enter the body via existing orifices or small incisions. This leaves the patient with less scarring and pain, it helps faster recovery. Also complications are much less than the conventional invasive methods. Major procedures such as angioplasty can be done with the body remaining "sealed." As technology reached the micro level, many procedures became non-invasive: capsule- sized robots are now used to photograph a patient's digestive tract in real time and in full colour, identifying gastrointestinal conditions ranging from inflammation to cancer, and doing away with exploratory surgery.

The Seldinger technique is one example .Here blood vessels are punctured with a fine, hollow needle for procedures such as angiography or chest drains. It not only results in making surgery more successful, but also allows the field of interventional radiology (image guidance) to expand and become a standard surgical practice. Total hip and knee arthroplasties also have been performed using minimally invasive procedures, proving the technology's growing value in more complex surgery.



PET scanning

All surgical procedures, even if minimally invasive, carry risks to the patient, and medicine has long relied on diagnostic tools that also do not impair the patient's health. Medical imaging is now a very powerful tool in aiding doctors not only for diagnose, but also for planning the process of surgery. Invariably such systems must be highly precise and accurate. Positron emission tomography (PET) is a nuclear medicine imaging technique that produces precise and accurate three-dimensional map of functional processes in the body. PET scans are being used now for detection and diagnosis of cancer.

As part of the procedures preparing a patient for scanning, an injection with a short lived radioactive isotope that emits a positron, is given. This isotope gets chemically incorporated into a metabolically active molecule (glucose) that accumulates in the tissue of interest in a short time. When the positron is emitted, it very quickly impacts on an electron, resulting in annihilation of the two particle. This event produces highly energetic gamma radiation. These rays are detected using scintillator material in the scanning device. This fluorescence is detected by photomultiplier tubes or silicon avalanche photodiodes to produce a 3D image.

Unlike computed tomography (CT) and magnetic resonance imaging (MRI), PET scanners capture molecular biology in sharp detail. PET scans are used to find the disease source in ontological, neurological, and cardiological applications, and also to identify dementia-inducing brain disorders. With lymphoma, PET scanning has an accuracy of 88%, while conventional techniques stand at 64%; PET's accuracy in diagnosing cervical/uterine cancers is 87% over the 43% from conventional method. -Sheeba V

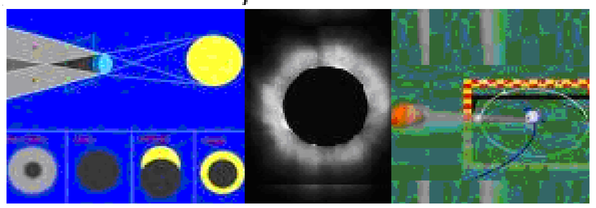
Bode – Titius law: The distances of planets from the Sun were represented by Bode and Titius, by a series which came to be known as Bode – Titius law.

Take the series: 0, 1, 2, 4, 8, 16, 32, 64, 128, 256,

and multiply each by 0.3 and add 0.4 to get: 0.4, 0.7, 1.0, 1.6, 2.8, 5.2, 10.0, 19.6, 38.8, 77.2.

Now compare these numbers with the distances of the planets from the Sun. Take the distances in astronomical units, i.e., in terms of the distance of Earth from the Sun. You will see excellent match between the two, except for two positions: corresponding to 2.8, there is no planet, which in fact lead to the search for one leading to the discovery of the asteroid belt between Mars and Jupiter. The law also fails to give the right figure for Neptune(distance nearly 70) but Pluto (distance nearly 39.5) fits the value given by the law. Remember that many scientists preferred to consider Pluto and Neptune together as a single system. In 2006 International Astronomical Union concurred to consider Pluto only as a dwarf planet.

Curiosity corner



Also check these products : 223 times 29.5306; 242 times 27.212; 239 times 27.554.

You find the product as very nearly 6585.3.

What is it all about?

First correct answer will win a prize.

Answers can be mailed to meenav@rajagiritech.ac.in

Answer to the question in the previous issue

See there are three parts to the figure. It shows photograph of the great scientist Bode, the frequency response plot in log-log scale known as the Bode plot, and the solar system. The distances of planets from the Sun were represented by Bode, along with another scientist Titius, by a series which came to be known as Bode – Titius law.

APPTRONICS review

Volume 2, Issue 6, 2009 June 30

Who will bell the cat?

Can you think of a modern industry where an applied electronics or instrumentation engineer does not have a good role?

Can you find out an advanced research area where the service of an applied electronics or instrumentation engineer is not very much required?

Can you find any communication application which can be done fully without the active participation of an applied electronics or instrumentation engineer?

Spend all your energy to find out important areas of research, industry or services where you don't want to depend on an applied electronics or instrumentation engineer. Be sure, all such efforts will be in vain.

And yet...

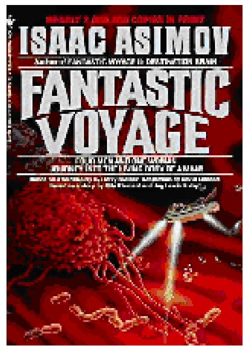
There are not many institutes which offer post graduate courses suitable for the applied electronics profession. Entry level/selection procedures for electronics area of most of the leading industries and R&D organisations are structured to suit electronics and communication branch. Why does it happen so?

It is because of the basic lethargic nature of our industries and R&D: always lagging, but being not bothered at all. This lag, in fact, is beyond limits which any progressive or developing society can support. We are far behind in updating our knowledge.

This must change. Let us hope that concerned authorities will take note of this great anomaly.

From the editors' desk

Have you read the famous science fiction, 'Fantastic Voyage'?



Four men and a woman are reduced to a microscopic fraction of their original size, sent in a miniaturized atomic sub through a dying man's carotid artery to destroy a blood clot in his brain. If they fail, the entire world will be doomed. Of course, they did not. That was fantastic science fiction by Isaac Asimov, the great popular science writer, who has authored more than 270 books. Read the article 'Emerging Trends in Medical Diagnosis' by Sheeba V, on the last page.

Introducing journals:

Defence Science Journal

Defence Science Journal is a publication by Defence Scientific Information & Documentation Centre (DESIDOC), Delhi for the Defence Research and Development Organisation (DRDO). It publishes original research papers having direct bearing on defence. It is a bimonthly with issues in the months of January, March, May, July, September and November.

The journal covers various disciplines of science, technology and engineering. Major subject fields covered include: applied physics, chemical technology, material sciences, biomedical sciences, computer sciences, engineering, electronics, and aeronautics.

The journal endeavours to bring recent developments in information technology, as applicable to library and information science, to the notice of librarians, documentation and information professionals, students and others interested in the field.

Articles published in the journal are indexed/reviewed in Chemical Abstracts, INSPEC, Science Abstracts (Parts A, B & C) Mathematical Reviews, Current Mathematical Publications, MATHSCI, BIOSIS, COMPENDEX, Engineering Index, Indian Science Abstracts, International Aerospace Abstracts and Cambridge Scientific Abstracts. Submissions may be uploaded via the online submission system at http://publications.drdo.gov.in/ojs/ in MS Word format for fast processing of manuscript for publication. The journal is available in RASET library.

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Observations/Comments

[A column by PRM]

I discussed in some detail about the objectives, major steps, etc. of student projects in one of the previous issues(Vol. 1, Issue 5). I thought it would be good to talk about the project activities once again, this time a little about the how and why of teachers' (guides') participation.

Every one of us has enough experience with student projects to understand that projects in undergraduate level cannot be properly completed without serious involvement of the teacher guides. Let us try to see what this involvement means, and to what extent it has to be there.

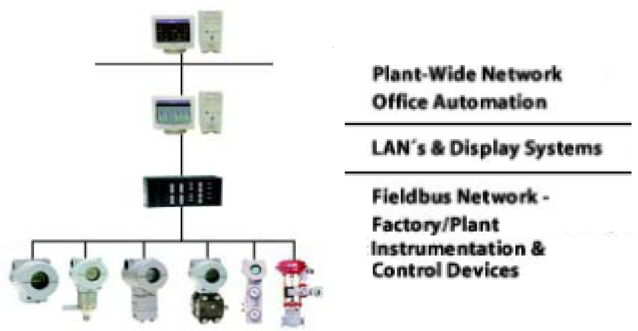
When we discussed about the objectives of undergraduate level projects, it was clearly noted that the main objective is not to do something original, but to learn the process of scheduling, planning and executing an engineering project. Yet, there is no ban on doing new things; in fact, we always look for something new. But any new design and development has, associated with it, issues too. Some of the issues could be easily solved, where as majority of the issues might not be that easily solvable. What do you do then? Leave the project there? Change the topic? It is a common tendency to raise both your hands before such issues and to take up something which has already been proved. That is not good; that is not acceptable. Then?

We can adopt a two phase approach then. The first phase involves redefining the objectives of the student project for him to be able to complete it to a satisfactory level within the prescribed time. This simply demands circumventing the issue for the time being. The second phase is more important, which is solving the issues and realising the project without much deviation from the originally conceived objectives. This phase may not turn out to be simple. It could demand a lot of patient and systematic studies, experimental and otherwise, and effort. It may be difficult most of the time to involve the student in this second phase, except for short spells. The teacher guides who were associated with the project must take up these activities leading to publications/technology transfer/patenting.

It is obvious then that the role of guides cannot be a passive one. Guide must be active, sometimes more active than the student being guided. The guide might have to do many things along with the student, and sometimes independently. Get prepared for that.

Introduction to Field Bus

Field bus is a recent innovation in the area of computerised process control. It is a local area network (LAN) for instruments used in both process and automated manufacturing. It is an all-digital, serial, two-way communication system, interconnecting field devices such as sensors, actuators and controllers. It has built-in capability to distribute the control application across the network. A sample architecture of field bus is shown in figure. It differs from any other communication protocol as it is designed to resolve process control applications, not for just transfer of data in a digital mode



Fieldbus can also be seen as the family of industrial communication protocols used for real-time distributed control, now standardized as **IEC 61158**. Devices can be networked and configured according to the user needs. The system is fully scalable in the sense that it can be implemented for small plants to large plants.

Field Bus Signals

Fieldbus signals are encoded using the well-known Manchester Biphase-L technique. The clock information is embedded in the serial data stream, and so the signal is called synchronous serial.

Advantages of field bus

The field bus systems have many advantages compared to traditional DCS or PLC based controls in terms of reliability and intrinsic safety. In addition, high resolution and distortion free characteristics of digital communication used in field bus enables improved control capability, leading to increased yield and quality.

- Krishna Kumar

To the optimist, the glass is half full.

To the pessimist, the glass is half empty.

To the engineer, the glass is twice as big as it needs to be.

Improving PID Controller Performance

Proportional integral derivative (PID) control is the most commonly used control algorithm in the industry today. PID controller popularity can be attributed to the controller's effectiveness in a wide range of operation conditions, its functional simplicity, and the ease with which engineers can implement it using current computer technology.

PID controllers have some drawbacks that limit their effectiveness. They work best with systems that have only one input and output (single input, single output # SISO). With these systems, we have only one variable to control and only one actuation to apply. We also can control systems that have more inputs/outputs with PID controllers if we apply decoupling techniques to the different variables so the final overall control involves a number of SISO PID controllers. This technique is not easily implementable because it depends heavily on how tight the correlation between the variables is. Quite a good amount of interest is there among researchers to model, design and implement new approaches to multivariable PID controllers. [Ref: 1. Uduehi, D. *et. al.*, Multivariable PID controller design using online generalised predictive control optimisation, Proceedings of the 2002 International Conference on Control Applications ; 2. Garcia, D, *et. al.*, PID Controller Design for Multivariable Systems Using Gershgorin Bands, infoscience@epfl.ch. **]**

Another challenge for PID controllers (and for every control algorithm) is that the plant we need to control might not behave in a linear fashion. In other words, the output for a given input does not exhibit a linear response. Some examples of nonlinearity are dead zones, saturation and hysteresis. Another challenge is that plant dynamics might also change over time. This can happen due to changes on the plant loads, normal wear and tear, or mechanical effectiveness in mechanical elements. To compensate for plant behaviour changing over time, we need expert users to recalibrate our PID gains, which drive up costs for both labour and downtime. Lastly, when tuning PID controllers, we won't achieve optimal overall system performance because stability is a concern, and tuning for better performance might lead to losing control over the system.

There are several techniques to improve system performance and PID behaviour. A few of these are briefly discussed below.

1. Increased Loop Rate

With current technology, we can run PID loops up to 20 kHz using NI Compact Field Point controllers, 40 kHz with NI PXI technology, and up to 1 MHz with NI Compact RIO hardware when using PID functions based on field programmable gate arrays (FPGAs).

2. Gain Scheduling

To help cope with a system that exhibits high nonlinear behaviour, we can schedule the gain in different ranges differently to take care of the nonlinearity. One drawback with this technique is that PID gain tuning is required for the different operating ranges.Also, range transition might lead to instabilities if the PID controller is not designed to make smooth transitions.

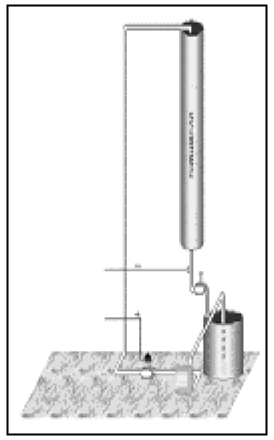
3. Adaptive PID

We can use another advanced variant of PID controllers that involves gain change based on the dynamics of the system. While gain scheduling works only with the plant output to define the operating range, adaptive PID considers both inputs and outputs to fix the gains.

4. Analytical PID

One of the difficulties being faced with PID controllers is with regard to gain tuning. Even with the implementation of auto tuning algorithms, service of an experienced operator cannot be totally eliminated, to ensure that the system remains stable through fine-tuning the controllers. By using Analytical PID functionality, we can design PID gains. With the Analytical PID libraries included in the Lab VIEW Control Design and Simulation Module, we have the tools to find sets of PID gain values automatically for a given user model, which ensures system closed-loop stability. We can also input minimum gain and phase margin values to specify the optional performance constraints on the PID controller.

5. Optimal Controllers



Linear quadratic controllers are designed for optimal performance on the system based on design specification. They typically require us to control a model of the system so that control gains are calculated based on a cost algorithm. This cost is user-defined and can include time to reach stable output, amount of energy used, and so on.

One of the main challenges of applying optimal controllers is finding a software model of the system.

Conclusion

PID control algorithms are popular and offer many benefits. Some PID implementations are examined along with means to improve system performance while replacing current PID controllers with other advanced algorithms.

-Anu S S