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МЕТОДИЧЕСКИЕ УКАЗАНИЯ

к практическим занятиям по дисциплине
«Английский язык» для студентов I-II курсов
факультета «ТАМПТ» специальности «Приборы
точной механики» дневной формы обучения

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Методические указания к практическим занятиям по дисциплине «Английский язык» для студентов I-II курсов факультета «ТАМПТ» специальности «Приборы точной механики» дневной формы обучения / Сост. Р.В. Камышников. – Севастополь: Изд-во СевНТУ, 2011. – 44 с.

Методические указания предназначены для практических занятий и самостоятельной работы студентов I-II курсов специальности «Приборы точной механики» факультета «ТАМПТ» дневной формы обучения. Их целью является привитие навыков чтения, понимания и перевода литературы по специальности, обучения активному владению языковым материалом, ведению беседы на английском языке в пределах рассматриваемых тем.

Методические указания рассмотрены и утверждены на заседании кафедры Практики романских и германских языков (протокол №… от ……2011 г.).

Допущено учебно-методическим центром и научно-методическим Советом СевНТУ в качестве методических указаний.

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СОДЕРЖАНИЕ

ВВЕДЕНИЕ

Данные методические указания предназначены для использования на практических занятиях по английскому языку и для самостоятельной работы студентов I и II курса специальности «Приборы точной механики» факультета «ТАМПТ» дневной формы обучения.

Основной целью методических указаний является совершенствование языковых знаний и коммуникативных умений студентов благодаря активизации использования лексики (как общего характера, так и профессиональной направленности) при переводе технических текстов и написании аннотаций, а также благодаря развитию умений принимать участие в беседе (как в академической, так и в профессиональной среде).

Данные методические указания состоят из восьми уроков, каждый из которых включает тексты для чтения и перевода, обсуждения и составления аннотаций, систему упражнений для предтекстового, текстового и послетекстового этапов работы, которые направлены на реализацию задач, расширение словарного запаса и совершенствование навыков практического владения английским языком. Цикл уроков завершает итоговый тест, который состоит из двух вариантов и направлен на проверку усвоения информации и лексики, содержащейся во всех восьми уроках данных методических указаний.

LESSON 1
LASER RANGEFINDER

Lexical units:

laser rangefinder – лазерный дальномер
target – цель, объект
high precision – (здесь) точный
sub-millimeter measurements – измерения очень малых единиц длины
triangulation – тригонометрическая съёмка
rise time – время нарастания
fall time – время спада
reading – показание прибора
to vanish – исчезать
gradient – отклонение
time-of-flight – «время пролёта»
single-face – единичный
to merge – поглощать, соединять
archery – стрельба из лука
stock management – управление запасами
real estate – недвижимость
tape measure – рулетка

TEXT

A laser rangefinder is a device which uses a laser beam to determine the distance to an object. The most common form of a laser rangefinder operates on the time of flight principle by sending a laser pulse in a narrow beam towards the object and measuring the time taken by the pulse to be reflected off the target and returned to the sender. Due to the high speed of light, this technique is not appropriate for high precision sub-millimeter measurements, where triangulation and other techniques are often used.

The precision of the instrument is determined by the rise or fall time of the laser pulse and the speed of the receiver. One that uses very sharp laser pulses and has a very fast detector can range an object to within a few millimeters.

Some of the laser light might reflect off leaves or branches which are closer than the object, giving an early return and a reading which is too low. Alternatively, over distances longer than 1,200 ft (365 m), the target may simply vanish into a mirage, caused by temperature gradients in the air in proximity to the heated desert bending the laser light. All these effects have to be taken into account.

Nowadays laser rangefinders are used extensively in 3-D object recognition and 3-D object modelling. This technology constitutes the heart of the so-called time-of-flight 3D scanners. (This measures the time taken for a light pulse to travel to the target and back. With the speed of light known, and an accurate measurement of the time taken, the distance can be calculated.) In contrast to different military instruments, laser rangefinders offer high-precision scanning abilities, with either single-face or 360-degree scanning modes.

A number of algorithms have been developed to merge the range data retrieved from multiple angles of a single object to produce complete 3-D models with as little error as possible. One of the advantages that laser rangefinders offer over other methods of computer vision is that the computer does not need to correlate features from two images to determine depth information as in stereoscopic methods.

Special laser rangefinders are used in forestry. These devices have anti-leaf filter and are working with reflector. Laser beam only reflects from this reflector, and so exact distance measurement is guaranteed. For example, laser rangefinders with anti-leaf filter are used for forest inventories.

Laser rangefinders may be effectively used in various sports that require precision distance measurement, such as golf, hunting, and archery. An important application is the use of laser rangefinder technology during the automation of stock management systems and production processes in steel industry.

Laser rangefinders are also used in several industries like construction, renovation and real estate as an alternative to a tape measure. Whereas with a tape measure one would need two people to measure a large object like a room with a straight run with no obstructions to stretch the tape, with a laser measuring tool the job can be completed by one operator with just a line of sight. Laser measuring tools typically include the ability to produce some simple calculations such as the area or volume of a room.

Comprehension

Exercise 1. True or false?

1) The precision of the instrument is determined by the rise or fall time of the laser pulse only.
2) Special laser rangefinders are used in various sports, as football, curling, and weight lifting.
3) Laser rangefinders are used extensively in 3-D object recognition.
4) You only need one operator to measure a large object with a laser rangefinder.

5) The most common form of laser rangefinders operates on the flight-in-time principle.
6) Triangulation is often used for high precision sub-millimeter measurements.
7) Some laser measuring tools include the ability to produce simple calculations.
8) The computer does not need to correlate features from two images to determine depth information.
9) Sometimes temperature gradients in the air in proximity to the heated desert cause a mirage.
10) A laser rangefinder determines the distance to different objects.

Exercise 2. Complete the sentences using the correct words from the text:
1) In contrast to different … instruments, laser rangefinders offer … … abilities.
2) An important … is the use of laser … technology during the automation of stock … systems.
3) Over distances … than 365 m, the … may simply vanish into a ….
4) Due to the high speed of …, this technique is not … for high precision … measurements.
5) The … can be calculated with the … of light known, and an accurate … of the time taken.
6) With a … measure one would need … people to measure a large … like a room.
7) Laser rangefinders are used … in … object recognition and … object ….
8) The most … form of a laser rangefinder operates on the … of … principle.

Vocabulary

Exercise 3. Give the English or Russian equivalents for the following word combinations:
Распознавание объектов; laser measuring tools; время спада импульса; with as little error as possible; вследствие высокой скорости света; to reflect off leaves or branches; производственные процессы в стальной промышленности; to require precision distance measurement; на расстоянии более 365 метров; very sharp laser pulses.

Exercise 4. Match the words with their meanings:

1) tool	a) accuracy; freedom from error
2) measurements	b) implement or apparatus used in performing an action, especially for scientific work
3) precision	c) trade or manufacture
4) instrument	d) mechanism for emitting electromagnetic radiation via the

	process of stimulated emission
5) industry	e) figures of measurement as shown on a dial, scale, etc
6) mode	f) device that can be used to produce or achieve something, but that is not consumed in the process
7) laser	g) figures about length, breadth, depth, etc
8) readings	h) way in which something is done

Exercise 5. Translate from Russian into English:
1) Как известно, лазерный дальномер – это устройство, состоящее из импульсного лазера и детектора излучения. 2) Способность электромагнитного излучения распространяться с постоянной скоростью даёт возможность определить расстояние до объекта. 3) Сегодня технологии лазерного дальномера широко применяются при производстве высококачественных стальных и медных изделий. 4) Если бы лазерный луч не применялся в этом приборе, его показания не были бы такими точными. 5) Не каждый может в одиночку измерить объём и площадь большого помещения с помощью рулетки. 6) Тригонометрическая съёмка применяется многими исследовательскими организациями для измерения очень малых единиц длины. 7) Измеряя время, которое затрачивает луч на путь до отражателя и обратно, и зная значение скорости света, можно рассчитать расстояние между лазером и отражающим объектом. 8) Технологии распознавания и моделирования трёхмерных объектов постоянно развиваются и никогда не стоят на месте. 9) Если лазерные измерительные приборы не имеют программ для ведения простых математических расчётов, спрос на такие приборы падает. 10) В пустыне миражи появляются вследствие отклонений температуры воздуха на расстоянии трёх метров от земли.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What is a laser rangefinder?
2) Could you describe the most common principle of its work?
3) What conditions are necessary to range any object within a few millimeters?
4) Could you name the effects to be taken into account concerning the work of a laser rangefinder?
5) Could you give the characteristic to the time-of-flight technology?
6) What is the advantage of a laser rangefinder as compared to any stereoscopic methods?

7) How can a laser rangefinder be used in forestry? And in sports?
8) Why can we consider a tape measure an out-of-date and inconvenient tool nowadays?

LESSON 2
ALL THE TRUTH ABOUT MICROSCOPES

Lexical units:

scanning probe microscope – сканирующий зондовый микроскоп
to magnify – увеличивать с помощью микроскопа
magnification – увеличение
transmitted light – проходящий свет
condenser lens – конденсорная линза
eyepiece – окуляр
objective turret – турель объектива
stage – предметный столик
focus wheel – винт микроскопа
comparison microscope – сравнительный микроскоп
inverted microscope – инвертированный микроскоп
to be a household name – быть на слухý
in essence – по сути
transillumination – трансиллюминация, просвечивание
incident light – падающий свет
charge-coupled device camera –
камера с зарядовой связью (для сканирования)
to omit – не включать, пропускать
specimen – образец
particle beam – пучок частиц
resolving power – разрешающая способность
failure analysis – анализ отказов/повреждений
raster scan – растровое сканирование
piezoelectric actuator – пьезоэлектрический регулятор

TEXT

A microscope is an instrument to see objects too small for the naked eye. Thereafter, the science of investigating small objects using such an instrument is called microscopy.

Of course, you may guess that there are many types of microscopes. The most common and first to be invented (in 1590) is the optical microscope which

uses light to image the sample. Other major types of microscopes are the electron microscope and the scanning probe microscope.

The optical microscope, often referred to as the "light microscope," uses visible light and a system of lenses to magnify images of small samples. Basic optical microscopes can be very simple, although there are many complex designs which aim to improve resolution and sample contrast. Historically optical microscopes were easy to develop and are popular because they use visible light, so the sample can be directly observed by eye.

All modern optical microscopes designed for viewing samples by transmitted light share the same basic components of the light path, listed here in the order the light travels through them: 1) light source, usually a mirror; 2) diaphragm and condenser lens; 3) objective; 4) ocular lens (eyepiece). In addition the vast majority of microscopes have the same structural components: objective turret to hold multiple objective lenses, stage to hold the sample, and focus wheel to move the stage.

There are many variants of the basic compound optical microscope design for specialized purposes. Some of these are stereo microscope, comparison microscope, inverted microscope, etc. But we'd better pay attention to the USB microscope and to the digital microscope as they are now household names just everywhere.

A USB microscope is a low-powered digital microscope which is connected to a computer, normally via a USB port. They are widely commercially available. In essence, USB microscopes are a webcam with a high-powered macro lens and generally do not use transillumination but rely on incident light instead. As the camera attaches directly to the USB port of a computer, eyepieces are not required and the images are shown directly on the monitor. They offer modest magnifications (up to about 200×) without the need to use eyepieces at very low cost, although lack of illumination optics limits their use. USB microscopes are most useful when examining flat objects such as coins or banknotes. They can be used even in the field, attached to a laptop computer.

A digital microscope is a variation of a traditional optical microscope that uses optics and a charge-coupled device (CCD) camera to output a digital image to a monitor, sometimes by means of software running on a computer. A digital microscope differs from an optical microscope in that there is no provision to observe the sample directly through an eyepiece. Since the optical image is projected directly on the CCD camera, the entire system is designed for the monitor image. The optics for the human eye are omitted.

An electron microscope is a type of microscope that produces an electronically-magnified image of a specimen for detailed observation. The electron microscope uses a particle beam of electrons to illuminate the specimen and create a magnified image of it. The microscope has a greater

resolving power than an optical microscope, because it uses electrons that have wavelengths about 100,000 times shorter than visible light (photons), and can achieve magnifications of up to 2,000,000x, whereas light microscopes are limited to 2,000x magnification. Industrially, the electron microscope is primarily used for quality control and failure analysis in semiconductor device fabrication.

With the use of scanning probe microscopes, an image of the surface is obtained by mechanically moving the probe in a raster scan of the specimen. The resolution varies somewhat from technique to technique, but some probe techniques reach a rather impressive atomic resolution. They owe this largely to the ability of piezoelectric actuators to execute motions with accuracy at the atomic level.

Comprehension

Exercise 1. True or false?

1) The optical microscope is often referred to as the "light microscope."
2) A microscope is an instrument to see objects in the outer space.
3) The optical microscope was invented in 1950.
4) A USB microscope is a high-powered digital microscope.
5) The electron microscope uses electrons to illuminate the specimen.
6) The optics for the human eye are omitted in digital microscopes.
7) Optical microscopes may be connected to a laptop via USB ports even in the field.
8) At first the light travels through an ocular lens and then through a mirror.
9) Piezoelectric actuators are able to execute motions with accuracy at the atomic level.
10) An electron microscope offers rather modest magnifications.

Exercise 2. Complete the sentences using the correct words from the text:

1) A … microscope differs from an … microscope in that there is no provision to observe the sample directly through an ….
2) The optical microscope uses … light and a system of … to magnify images of small ….
3) USB … are most useful when … flat objects such as … or banknotes.
4) The … microscope has a greater … power than an … microscope.
5) It uses … that have … about 100,000 times shorter than visible ….
6) Optical microscopes can have many … designs which … to improve … and sample contrast.
7) … of illumination optics … the use of … microscopes.
8) As the … attaches directly to the … … of a computer, … are not required.

Vocabulary

Exercise 3. Give the English or Russian equivalents for the following word combinations:
Анализ повреждений; to observe the sample directly through an eyepiece; постоянно быть на слуху; objective turret to hold multiple objective lenses; использовать свет для создания изображения образца; semiconductor device fabrication; маломощный цифровой микроскоп; basic components of the light path; веб-камера с макролинзами большой мощности; to be useful when examining flat objects.

Exercise 4. Match the words with their meanings:

1) USB	a) electronic light sensor used in digital cameras
2) raster scan	b) ability to do or act
3) charge-coupled device	c) a point toward which light rays are made to converge
4) focus	d) rectangular pattern of image capture and reconstruction in television
5) power	e) piece of glass or substance like glass with one or both sides curved
6) design	f) one of a number taken to show what the rest is like
7) lens	g) specification to establish communication between devices and a PC
8) specimen	h) drawing or outline from which something may be made

Exercise 5. Translate from Russian into English:
1) Глаз каждого человека представляет собой естественную оптическую систему, которая характеризуется определённым разрешением. 2) Сканирующий зондовый микроскоп позволяет регистрировать взаимодействие зонда с отдельными атомами и молекулами. 3) Создание изображений высокого разрешения было бы невозможно, если бы учёные не создали электронный микроскоп. 4) Для получения изображения в электронном микроскопе используются специальные магнитные линзы, которые управляют движением электронов при помощи магнитного поля. 5) Оптическая система микроскопа состоит из объектива и окуляра, которые закреплены в подвижном тубусе, расположенном на металлическом основании. 6) Большинство стереомикроскопов дает меньшее увеличение, чем современные оптические микроскопы, однако имеет большее фокусное расстояние, что позволяет рассматривать крупные объекты. 7) Разрешающей способностью микроскопа называется его способность выдавать чёткое раздельное изображение двух близко

расположенных точек объекта. 8) Если бы мы не забыли наш ноутбук, мы бы смогли поучаствовать в практическом занятии с USB-микроскопом в лаборатории университета. 9) Под микроскопией мы понимаем совокупность технологий изготовления и практического применения микроскопов. 10) Растровое изображение – это прямоугольная сетка пикселей или точек цветов на компьютерном мониторе, бумаге и других устройствах и материалах.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) Could you give any definitions to the terms microscope and microscopy?
2) Could you name three major types of microscopes?
3) What is the secret of popularity of the optical microscope?
4) What are the general components of all optical microscopes?
5) Would you be so kind as to state the most popular variants of optical microscope design?
6) How can you describe the essence of a USB microscope?
7) Where can we find a CCD camera? And what are its functions here?
8) Why does the electron microscope have a greater resolving power than an optical microscope?
9) Could you describe a scanning probe microscope?

LESSON 3
DIGITAL SIGNAL PROCESSING

Lexical units:

digital signal processing (DSP) – цифровая обработка сигналов
real-world analog signal – практический аналоговый сигнал
analog-to-digital converter – аналого-цифровой преобразователь
output signal – выходной сигнал
computational power – вычислительные возможности
purpose-built – специализированный
application-specific integrated circuit (ASIC) –
интегральная схема, специализированная для решения конкретной задачи
field-programmable gate array (FPGA) –
программируемая пользователем вентильная матрица

stream processor – процессор для потоковой обработки данных
spatial domain – пространственная область
multidimensional – многомерный
autocorrelation – автокорреляционная функция
wavelet – вейвлет, всплеск
(математическая функция анализа частотных компонентов данных)
discrete Fourier transform – дискретное преобразование Фурье
recognition – распознавание
crossover – разделитель спектра сигнала
equalization – стабилизация или компенсация канала связи
magnetic resonance imaging (MRI) – отображение магнитного резонанса
fixed-point arithmetic – арифметическая операция с фиксированной запятой
(формат представления вещественного числа в памяти ЭВМ в виде целого числа)
floating point arithmetic – арифметическая операция с плавающей запятой
(форма представления действительных чисел, в которой число хранится в форме мантиссы и показателя степени)

TEXT

Digital signal processing (DSP) is concerned with the representation of signals by a sequence of numbers or symbols and the processing of these signals. It is clear that DSP and analog signal processing are subfields of such a great modern scientific doctrine as signal processing.

The goal of DSP is usually to measure, filter and then, if necessary, compress continuous real-world analog signals. The first step is usually to convert the signal from an analog to a digital form, by sampling it using an analog-to-digital converter, which turns the analog signal into a stream of numbers. However, often, the required output signal is another analog output signal, which requires a digital-to-analog converter. Even if this process is more complex than analog processing and has a discrete value range, the application of computational power to digital signal processing allows for many advantages over analog processing in many applications, such as error detection and correction in transmission as well as data compression.

DSP algorithms have long been run on standard computers, on specialized processors called digital signal processors, or on purpose-built hardware such as application-specific integrated circuit (ASIC). Today there are additional technologies used for digital signal processing including more powerful general purpose microprocessors, field-programmable gate arrays, digital signal controllers, and stream processors.

In DSP, engineers usually study digital signals in one of the following domains: time domain (one-dimensional signals), spatial domain

(multidimensional signals), frequency domain, autocorrelation domain, and wavelet domains. They choose the domain in which to process a signal by trying different possibilities as to which domain best represents the essential characteristics of the signal. A sequence of samples from a measuring device produces a time or spatial domain representation, whereas a discrete Fourier transform produces the frequency domain information, that is the frequency spectrum. Autocorrelation is defined as the cross-correlation of the signal with itself over varying intervals of time or space.

The main applications of DSP are audio signal processing, audio compression, digital image processing, video compression, speech processing, speech recognition, digital communications, RADAR, SONAR, seismology, and biomedicine. Specific examples are speech compression and transmission in digital mobile phones, room correction of sound in hi-fi and sound reinforcement applications, weather forecasting, economic forecasting, seismic data processing, analysis and control of industrial processes, medical imaging such as CAT scans and MRI (magnetic resonance imaging), MP3 compression, computer graphics, image manipulation, hi-fi loudspeaker crossovers and equalization, and audio effects for use with electric guitar amplifiers.

Digital signal processing is often implemented using specialised microprocessors to process data using fixed-point arithmetic, although some versions are available which use floating point arithmetic and are more powerful. For faster applications FPGAs might be used. Beginning in 2007, multicore implementations of DSPs have started to emerge from a range of global companies. For faster applications with vast usage, ASICs might be designed specifically. Vice versa, a traditional slower processor such as a microcontroller may be adequate. Also a growing number of DSP applications are now being implemented on Embedded Systems using powerful PCs with a Multi-core processor.

Comprehension

Exercise 1. True or false?

1) A sequence of samples from a measuring device produces a time or spatial domain representation.
2) The main applications of DSP are audio signal processing and audio compression only.
3) It is obvious that DSP and analog signal processing are subfields of signal processing.
4) At first, engineers must convert the signal from an analog to a digital form.
5) DSP has never been used in analysis and control of industrial processes.
6) A microcontroller may be adequate enough for faster DSP applications.

7) Multidimensional signals are usually referred to the spatial domain.
8) DSP algorithms are not run on standard computers any more.
9) ASIC is the abbreviation for a field-programmable gate array.
10) If the required output signal is another analog output signal you have to use a digital-to-analog converter.

Exercise 2. Complete the sentences using the correct words from the text:
1) Today there are additional … used for digital signal … including more … general purpose microprocessors.
2) The … of DSP is usually to measure, filter and then … continuous …-… analog signals.
3) DSP is concerned with the … of signals by a … of numbers or symbols and the … of these signals.
4) A growing number of DSP … are now being implemented on … Systems using … PCs.
5) … is defined as the …-… of the signal with itself over varying … of time or space.
6) Specific examples of DSP are speech … and … in … mobile phones.
7) Some versions are … which use … point … and are more powerful.
8) Multicore … of DSPs have started to … from a range of … companies.

Vocabulary

Exercise 3. Give the Russian or English equivalents for the following word combinations:
Hi-fi loudspeaker crossovers and equalization; использование специализированных процессоров для обработки данных; application of computational power to digital signal processing; цифро-аналоговый преобразователь; time and spatial domain representation; распознавание многоядерного процессора; faster applications with vast usage; временна́я область с одномерными сигналами; field-programmable gate arrays, digital signal controllers and stream processors; настройка звука в закрытом помещении.

Exercise 4. Match the words with their meanings:

1) signal	a) working with numbers
2) recognition	b) an electronic circuit that can execute computer programs
3) processor	c) systematic arrangement of objects, usually in rows and columns
4) multicore	d) connected line of events
5) sequence	e) a type of microprocessor design in which multiple processors coexist on the same chip

6) array	f) identification of smth. already known or acknowledgement of smth. as valid
7) arithmetic	g) process of adjusting the strength of certain frequencies within a signal
8) equalization	h) a discrete part of a communication

Exercise 5. Translate from Russian into English:
1) Цифровая обработка сигналов – это процесс преобразования сигналов, представленных в цифровой форме. 2) Примером интегральной схемы, специализированной для решения конкретной задачи, может являться микросхема, разработанная только для управления мобильным телефоном. 3) Если бы алгоритмы цифровой обработки сигналов не были проверены на специальных процессорах, они бы не применялись в обычных персональных компьютерах. 4) Программируемая пользователем вентильная матрица (ППВМ) является полупроводниковым устройством, которое может быть сконфигурировано производителем или разработчиком после изготовления. 5) Особенностью ППВМ является то, что конфигурация соединений между её блоками может меняться с помощью специальных сигналов, посылаемых схеме. 6) Принципом магнитно-резонансной томографии (magnetic resonance tomography) является отображение магнитного резонанса, то есть метод измерения электромагнитной реакции ядер атомов водорода на их возбуждение электромагнитными волнами. 7) Раньше обработка аудио-сигналов была обязательна для радиовещания, поскольку в студиях возникали проблемы, связанные с установлением соединения при передаче. 8) Временна́я область описывает анализ математических функций или физических сигналов по отношению ко времени. 9) Арифметическая операция с фиксированной запятой широко применяется в цифровой обработке сигналов. 10) Электронное устройство, преобразующее напряжение в двоичный цифровой код, называется аналого-цифровым преобразователем.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) Could you interpret the term “DSP” and give its definition?
2) What is the general purpose of DSP?
3) Would you describe the initial stage of digital signal processing?
4) What is an ASIC?

5) What additional technologies are used for digital signal processing nowadays?
6) What domains of studying digital signals in DSP do you know?
7) How can you correlate a discrete Fourier transform with DSP?
8) Could you name the most important – from your point of view – applications of DSP?
9) What items may be used for faster DSP applications? And for slower ones?

LESSON 4
WHAT IS A SENSOR?

Lexical units:

touch-sensitive – сенсорный
to dim – гаснуть
output – выходной сигнал
microscopic scale – микроскопический уровень
MEMS technology – технология микроэлектромеханических систем
to merge into – переходить, превращаться во что-либо
to implement – выполнять, осуществлять
target device – конечный прибор
to obey the rule – соответствовать правилу
linear – линейный (применительно к функции)
deviation – отклонение, девиация
sensitivity error – ошибка чувствительности
dynamic error – динамическая ошибка
bode plot – представление амплитудно-фазовой частоты в логарифме
phase shift – сдвиг по фазе
to some extent – до некоторой степени
random error – случайная (несистематическая) ошибка
resolution – разрешающая способность
to fluctuate – колебаться
scanning tunneling probe – сканирующий туннельный микроскоп
fine – тонкий
tip – наконечник

TEXT

Sensors are used in everyday objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base. There are also innumerable applications for sensors of which most people are never aware.

Applications include cars, machines, aerospace, medicine, manufacturing and robotics.

A sensor is a device which receives and responds to a signal. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes, i.e. a sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C. Sensors that measure very small changes must have very high sensitivities. Sensors also have an impact on what they measure – a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured, making the sensor smaller often improves this and may introduce other advantages.

Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. MEMS (micro-electro-mechanical systems) is the technology of very small mechanical devices driven by electricity. It merges at the nano-scale into nanotechnology. MEMS technology can be implemented using a number of different materials and manufacturing techniques, depending on target device and market sector. The most common materials here are silicon, polymers, and metals.

A good sensor usually obeys the following rules: 1) it is sensitive to the measured property; 2) it is insensitive to any other property likely to be encountered in its application; 3) it does not influence the measured property. Ideal sensors are designed to be linear to some simple mathematical function of the measurement, typically logarithmic. The output signal of such a sensor is linearly proportional to the value or simple function of the measured property. The sensitivity is then defined as the ratio between output signal and measured property.

If the sensor is not ideal, several types of deviations can be observed. For example, the sensitivity may in practice differ from the value specified. This is called a sensitivity error, but the sensor is still linear. If the sensitivity is not constant over the range of the sensor, this is called nonlinearity. Usually this is defined by the amount the output differs from ideal behavior over the full range of the sensor. If the deviation is caused by a rapid change of the measured property over time, there is a dynamic error. Often, this behaviour is described with a bode plot showing sensitivity error and phase shift as function of the frequency of a periodic input signal. If the signal is monitored digitally, limitation of the sampling frequency also can cause a dynamic error. Noise is a random deviation of the signal that varies in time. And, surely, sensors may to some extent be sensitive to properties other than the property being measured. For instance, most sensors are influenced by the temperature of their environment.

These deviations can be classified as systematic errors or random errors. Systematic errors can sometimes be compensated for by means of some kind of calibration strategy. Noise is a random error that can be reduced by signal processing, such as filtering, usually at the expense of the dynamic behaviour of the sensor.

The last item to be considered about the sensor is its resolution. The resolution of a sensor is the smallest change it can detect in the quantity that it is measuring. Often in a digital display, the least significant digit will fluctuate indicating that changes of that magnitude are only just resolved. The resolution is related to the precision with which the measurement is made. Thus, a scanning tunneling probe (a fine tip near a surface collects an electron tunneling current) can resolve atoms and molecules.

Comprehension

Exercise 1. True or false?

1) Most sensors are influenced by the temperature of their environment.
2) When the sensitivity is not constant over the range of the sensor, we call it linearity.
3) Sensors are always sensitive to properties other than the property being measured.
4) An ideal sensor does not influence the measured property.
5) Sensors that measure very small changes must have very high sensitivities.
6) Sensor applications include cookery, forestry, soccer, and veterinary medicine.
7) A scanning tunneling probe collects an electron tunneling current.
8) If the sensor is ideal, several types of deviations can be observed.
9) MEMS technology is used to manufacture sensors on a microscopic scale.
10) The most common materials for MEMS technology are rubber, putty, and timber.

Exercise 2. Complete the sentences using the correct words from the text:

1) The … of a sensor is the … change it can detect in the … that it is measuring.
2) MEMS … merges at the …-… into ….
3) Sensors are used in everyday … such as touch-… elevator ….
4) … is a random … of the signal that … in time.
5) The sensitivity is … as the … between … signal and measured property.
6) A … temperature thermometer … into a hot cup of … cools the liquid.
7) If the … is not … over the range of the sensor, this is called ….

8) Systematic … can … be compensated for by means of some kind of … strategy.

Vocabulary

Exercise 3. Give the Russian or English equivalents for the following word combinations:
Ideal behavior over the full range of the sensor; отклонение, вызвавшее несистематическую ошибку; innumerable applications for sensors in robotics and manufacturing; разработка конечных приборов в соответствии с планом; using a number of different materials and manufacturing techniques; сенсорная панель управления для нового конвейера; limitation of the sampling frequency; колебания значений разрешающей способности; to be linearly proportional to the value; чувствительность тонкого наконечника сканирующего микроскопа.

Exercise 4. Match the words with their meanings:

1) manufacturing	a) variation from the common way or from a rule
2) deviation	b) the use of machines, tools and labour to produce goods
3) property	c) way of accomplishing a task that is not immediately obvious
4) surface	d) the study of or a collection of techniques
5) device	e) attribute which is characteristic of a class of objects
6) impact	f) the up-side of a flat object
7) technology	g) any piece of equipment made for a particular purpose
8) technique	h) significant or strong influence; effect

Exercise 5. Translate from Russian into English:
1) Датчиком является любой элемент измерительного, сигнального, регулирующего или управляющего устройства системы, который преобразует контролируемую величину в удобный для использования сигнал. 2) Сейчас различные датчики широко используют при построении систем автоматизированного управления. 3) Датчики преобразуют температуру, частоту, скорость или напряжение в электрический или оптический сигнал, который можно измерить, передать или преобразовать. 4) Если бы учёные средневековья не изобрели основные измерительные приборы, следующие поколения учёных не совершили бы свои открытия. 5) В сенсорах используется чувствительный элемент, который преобразует параметры среды в пригодный для технического использования сигнал. 6) Иногда датчиком называется часть измерительной или управляющей системы, представляющая собой совокупность измерительных преобразователей. 7) В последнее время часто применяются датчики со сложной обработкой сигналов,

возможностями настройки и регулирования параметров и стандартным интерфейсом системы управления. 8) Понятие датчика по практической направленности и деталям технической реализации близко к понятию «измерительный прибор», но показания приборов читаются человеком, а датчики обычно используются в автоматическом режиме. 9) Охранные службы многих стран предлагают инфракрасные сенсоры для защиты от воров и грабителей дорогих музейных экспонатов, а также частных коллекций. 10) Сенсором может называться сам чувствительный элемент любого датчика.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What is a sensor? Why do people use them in different spheres?
2) What do sensors usually have an impact on?
3) How can you describe the MEMS technology?
4) Could you name the rules a good sensor should obey?
5) When do we have an ideal sensor?
6) Could you give the examples of systematic errors and random ones?
7) What kind of error is noise and why?
8) What is a sensor resolution?
9) What is it related to?

LESSON 5
PRESSURE SENSORS

Lexical units:

transducer – преобразователь, приёмник
imposed – установленный
transmitter – передатчик
sender – датчик, передатчик
to capture – захватить, зафиксировать
combustion pressure – давление сгорания
traffic enforcement – дорожная полиция (в США)
pressure switch – реле давления
perfect vacuum – абсолютный вакуум
PSI (pounds per square inch) – фунт на квадратный дюйм

gauge pressure – манометрическое давление
to calibrate – градуировать, проверять
tire – шина
differential pressure – перепад давления, разность давлений
input – входной сигнал
pressure drop – потеря давления
sealed – запечатанный, опломбированный
drastically – значительно, кардинально
suitability – пригодность

TEXT

At first we should note that a pressure sensor measures pressure, typically of gases or liquids. The pressure here is taken as an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. So, a pressure sensor usually acts as a transducer. It generates a signal as a function of the pressure imposed. As the practice shows, such a signal is electrical in 80 cases of 100.

Pressure sensors are used for control and monitoring in thousands of everyday applications. They can also be used to indirectly measure other variables such as fluid or gas flow, speed, water level, and altitude. These devices can alternatively be called pressure transducers, pressure transmitters, pressure senders, pressure indicators or manometers among other names.

There is also a category of pressure sensors that are designed to measure in a dynamic mode for capturing very high speed changes in pressure. Example applications for this type of sensor would be in the measuring of combustion pressure in an engine cylinder or in a gas turbine. These sensors are commonly manufactured out of piezoelectric materials such as quartz.

Some pressure sensors, such as those found in some traffic enforcement cameras, function in a binary (on/off) manner, i.e., when pressure is applied to a pressure sensor, the sensor acts to complete or break an electrical circuit. These types of sensors are also known as a pressure switch.

Pressure sensors can be classified in terms of pressure ranges they measure, temperature ranges of operation, and most importantly the type of pressure they measure. Thus, in terms of pressure type, they can be divided into five categories.

The first category includes absolute pressure sensors. They measure the pressure relative to perfect vacuum pressure (0 PSI or no pressure). Atmospheric pressure, as compared, makes 14.7 PSI at sea level with reference to vacuum.

The category of gauge pressure sensors is used in different applications because its devices can be calibrated to measure the pressure relative to a given

atmospheric pressure at a given location. A tire pressure gauge is an example of gauge pressure indication. When the tire pressure gauge reads 0 PSI, there is really 14.7 PSI (atmospheric pressure) in the tire.

Specialists utilize a vacuum pressure sensor to measure pressure less than the atmospheric pressure at a given location. This item has the potential to cause some confusion as industry may refer to a vacuum sensor as one which is referenced to either atmospheric pressure (i.e. measure negative gauge pressure) or relative to absolute vacuum.

Differential pressure sensors measure the difference between two or more pressures introduced as inputs to the sensing unit, for instance, measuring the pressure drop across an oil filter. Differential pressure is also used to measure flow or level in pressurized vessels.

The fifth category includes sealed pressure sensors. The devices are the same as the gauge pressure sensors except that they are previously calibrated by manufacturers to measure pressure relative to sea level pressure.

It should be also noted that pressure sensors can vary drastically in technology, design, performance, application suitability and cost. A conservative estimate shows that there were over 50 technologies and at least 300 companies making pressure sensors worldwide at the end of 2010.

Comprehension

Exercise 1. True or false?

1) Some pressure sensors may function in a binary manner.
2) Differential pressure sensors measure pressure less than the atmospheric pressure at a given location.
3) All pressure sensors measure pressure of gases and liquids only.
4) No pressure means the same as the perfect vacuum pressure.
5) Pressure sensors can never be used to indirectly measure any other variables.
6) A pressure transducer is not the same as a pressure sender.
7) The pressure is usually stated in terms of force per unit area.
8) A pressure sensor generates a signal as a function of the pressure imposed.
9) There are over 15 technologies and at least 30 companies making pressure sensors worldwide nowadays.
10) Differential pressure is used to measure flow or level in pressurized vessels.

Exercise 2. Complete the sentences using the correct words from the text:

1) The pressure is taken as an … of the … required to stop a fluid from ….
2) Specialists utilize a … pressure sensor to measure pressure less than the … pressure at a … location.
3) A … pressure gauge is an example of … pressure indication.

4) Pressure sensors can vary … in technology, design, …, and application ….
5) In terms of … type, pressure … can be divided into … categories.
6) The … of gauge pressure … is used in different ….
7) Atmospheric pressure makes … PSI at … level with reference to ….
8) … sensors are used for control and … in thousands of … applications.

Vocabulary

Exercise 3. Give the English or Russian equivalents for the following word combinations:
Разность давлений; to measure flow or level in pressurized vessels; физические параметры, измеряющиеся в зависимости от давления окружающей среды; to measure pressure relative to sea level pressure; опломбированный датчик давления; force per unit area; уловить изменение очень высоких скоростей; relative to absolute vacuum; давление сгорания в цилиндре двигателя моторной лодки; the potential to cause some confusion.

Exercise 4. Match the words with their meanings:

1) pressure	a) to determine or correct the scale of a graduated instrument
2) gauge	b) used to close a thing tight to prevent leaks
3) to monitor	c) surface parallel to the horizon with reference to its height
4) to calibrate	d) force on or against or influence on something
5) perfect	e) space completely empty of substance or gases
6) sealed	f) any of a variety of measuring instruments
7) vacuum	g) complete with everything needed
8) level	h) to be aware of the state of a system

Exercise 5. Translate from Russian into English:
1) Датчик давления – это устройство, физические параметры которого изменяются в зависимости от давления измеряемой среды. 2) Основным отличием одних измерительных приборов от других является точность регистрации давления, которая зависит от преобразования давления в электрический сигнал. 3) В отличие от датчика давления, манометр – это прибор, предназначенный для измерения давления, а не для его преобразования. 4) Показания манометра, которые могут быть считаны с его шкалы или дисплея, зависят от давления. 5) Датчики давления в камерах дорожной полиции США и Канады основаны на принципе использования реле давления. 6) Чувствительные элементы датчиков базируются на принципе измерения деформации резисторов, припаянных к титановой мембране, которая деформируется под действием давления. 7) Если бы управление статистики не проводило различные промышленные исследования, у нас не было бы информации о количестве

и местоположении компаний, которые занимаются производством датчиков давления. 8) Датчики разности давлений могут помочь измерить давление в топливных насосах и масляных фильтрах. 9) Под вакуумом мы понимаем среду, которая содержит газ при давлениях значительно ниже атмосферного. 10) Датчики давления могут использоваться для непрямого измерения таких переменных величин, как уровень воды, скорость потока нефти или газа, а также высота полёта.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What are the functions of a pressure sensor?
2) Could you state all the names used instead of the term “pressure sensor?”
3) What is the goal of a dynamic mode measurement?
4) Could you give the definition of a pressure switch?
5) How many categories of pressure sensors do you know? Name them.
6) What is 0 PSI?
7) Where can specialists use a vacuum pressure sensor?
8) What is the difference between the first and the fifth categories of pressure sensors?
9) What was the world-wide volume of pressure sensors production at the end of 2010?

LESSON 6
MICROCONTROLLERS

Lexical units:

integrated circuit – интегральная схема
processor core – ядро процессора
embedded – встроенный
remote control – пульт дистанционного управления
appliances – электроприборы (бытовые)
pipe-line – конвейер
assembly shop – сборочный цех
instrument-making industry – приборостроение
clock rate – тактовая частота
consumption – расход, потребление

to retain – поддерживать, сохранять
interrupt – (здесь) сигнал прерывания
light-emitting diode – светоизлучающий диод
custom – обычный, стандартный
interrupt service routine = interrupt handler – обработчик прерывания
sequence – последовательность, ряд команд
overflow – переполнение
communication link – канал связи
to halt – останавливать
on-chip – встроенный в чип
compiler – компилирующее устройство или программа
assembler – транслятор
field-alterable – программируемый в полевых условиях
erasable – стираемый

TEXT

An item we know as a microcontroller is a small computer on a single integrated circuit containing a processor core, memory and programmable input/output peripherals. Sometimes, in technical literature, it may be abbreviated as μC, uC or MCU. Microcontrollers are designed for embedded applications, in contrast to microprocessors used in personal computers or other general purpose applications.

Microcontrollers are frequently used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys as well as in transporters, pipe-lines, assembly shops, etc. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers integrating analog components needed to control non-digital electronic systems, are common in the instrument-making industry.

Some microcontrollers may operate at clock rate frequencies as low as 4 kHz, for low power consumption (milliwatts or microwatts). Here, under the clock rate we understand the rate in cycles per second. Such microcontrollers generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt. Power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may need to act more like a digital signal processor, with higher clock speeds and power consumption.

The majority of microcontrollers in use today are embedded in other machinery, such as automobiles, telephones, appliances, and computer peripherals. These are called embedded systems. While some of them are very sophisticated, many have minimal requirements for memory and program length, with no operating system, and low software complexity. Typical input and output devices include switches, relays, solenoids, light-emitting diodes (LEDs), small or custom LCD displays, radio frequency devices, and sensors for data such as temperature, humidity, light level. Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a PC, and may use no human interaction devices.

Microcontrollers must provide real time (predictable, though not necessarily fast) response to events in the embedded system they are controlling. When certain events occur, an interrupt system can signal the processor to suspend processing the current instruction sequence and to begin an interrupt service routine (ISR, or "interrupt handler"). The ISR will perform any processing required based on the source of the interrupt before returning to the original instruction sequence. Possible interrupt sources are device dependent, and often include events such as an internal timer overflow, completing an analog to digital conversion, a logic level change on an input such as from a button being pressed, and data received on a communication link. Where power consumption is important as in battery operated devices, interrupts may also wake a microcontroller from a low power sleep state where the processor is halted until required to do something by a peripheral event.

Finally, we should mention microcontroller programs. They must fit in the available on-chip program memory, since it would be costly to provide a system with external memory. Compilers and assemblers are used to convert high-level language and assembler language codes into a compact machine code for storage in the microcontroller's memory. Depending on the device, the program memory may be permanent, read-only memory that can only be programmed at the factory, or program memory may be field-alterable flash or erasable read-only memory.

Comprehension

Exercise 1. True or false?

1) Typical input and output devices include switches, relays, solenoids, etc.
2) Interrupts must provide real time response to events in the embedded system they are controlling.
3) A number of microcontrollers may operate at clock rate frequencies as low as 14 kHz.
4) A microcontroller is a small microprocessor on a single integrated circuit.

5) Sometimes microcontrollers may need to act more like a digital signal processor.
6) Microcontrollers are rarely used in automatically controlled devices.
7) Compilers are used to convert high-level language codes into a compact machine code.
8) Many embedded systems have maximal requirements for their memory and program length.
9) Microprocessors are used in PCs and other general purpose applications.
10) A logic level change on an input may be caused by a button pressure.

Exercise 2. Complete the sentences using the correct words from the text:
1) The … of microcontrollers in use today are … in other ….
2) Mixed … microcontrollers integrating … components needed to control …-… electronic systems, are common in the …-… industry.
3) Interrupts may also wake a … from a … power … state.
4) Under the … rate we understand the … in cycles per ….
5) Embedded … usually have no …, screen, disks, printers, or other … input-output devices.
6) The … will perform any … required based on the source of the … before returning to the original … sequence.
7) … interrupt sources often include events such as an internal timer … and completing an … to … conversion.
8) … consumption while sleeping may be just …, making many of them well suited for long lasting … applications.

Vocabulary

Exercise 3. Give the Russian or English equivalents for the following word combinations:
Recognizable I/O devices; программируемый в полевых условиях микроконтроллер; ability to retain functionality; встроенная в чип компилирующая программа; logic level change; устройство со стираемой памятью; to signal the processor to suspend processing the current instruction sequence; микроконтроллер, использующийся как устройство для цифровой обработки сигнала; high-level language and assembler language codes; стандартные светоизлучающие диоды, используемые в приборостроении.

Exercise 4. Match the words with their meanings:

1) diode	a) electrochemical cell to produce electricity
2) memory	b) device that measures a physical quantity and converts it into a signal

3) compiler	c) set of interacting or independent components forming an integrated whole
4) button	d) device attached to a host computer, but not part of it
5) peripheral	e) switch to control a machine or a process
6) system	f) computer program to transform codes written in programming languages
7) sensor	g) ability to store, retain, and recall data
8) battery	h) two-terminal electronic component

Exercise 5. Translate from Russian into English:
1) Микроконтроллер – это микросхема, предназначенная для управления электронными устройствами. 2) В современных микроконтроллерах используются мощные вычислительные устройства с широкими возможностями, построенные на одной микросхеме вместо целого набора. 3) При проектировании микроконтроллеров приходится соблюдать баланс между размерами и стоимостью с одной стороны и гибкостью и производительностью с другой. 4) Существует огромное количество микроконтроллеров, которые отличаются размером и видом встроенной памяти, набором периферийных устройств, а также типом корпуса и материалом, из которого он изготовлен. 5) Если бы производители не принимали во внимание ограничения в цене и энергопотреблении, это способствовало бы тому, что тактовая частота микроконтроллеров стала бы чрезвычайно высокой. 6) Программирование контроллеров обычно осуществляется на языке ассемблера, хотя существуют компиляторы и для других языков. 7) Специальные программы для персональных компьютеров, имитирующие работу микроконтроллера, используются для обнаружения, локализации и устранения ошибок. 8) На современном этапе развития приборостроение сделало доступным использование микроконтроллеров в сборочных цехах и на конвейерах, оборудованных соответствующим программным обеспечением. 9) Упрощённый набор команд (reduced instruction set) позволяет микроконтроллерам выполнять большинство инструкций за один такт, что обеспечивает высокое быстродействие даже при низкой тактовой частоте. 10) Микроконтроллер может иметь встроенную энергонезависимую память для хранения программы и данных.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What is a microcontroller? How can it be abbreviated?
2) Where are they usually applied?
3) What type of microcontrollers is common in the instrument making?
4) Why is the clock rate important in microcontrollers industry?
5) What units are used to measure microcontrollers power consumption?
6) How can you characterize an embedded system?
7) What is the function of an interrupt service routine?
8) Could you describe the principle of interaction between an interrupt and a microcontroller?
9) What types of microcontroller programs do you know?

LESSON 7
THE SCIENCE OF MEASUREMENT

Lexical units:

ratio – отношение, коэффициент
traceability – возможность отслеживания
suitability – (здесь) допустимость
calibration – стандартизация
regulatory – регулирующий, нормативный
uncertainty – переменчивость, неопределённость
National Institute of Standards and Technology –
Национальный институт стандартов и технологий, Мэриленд, США
National Physical Laboratory –
Национальная лаборатория физики, Лондон, Англия
systematic bias – систематическая ошибка
leads – выводы, подводящие провода
to short – замыкать накоротко
qualifying conditions – определяющие условия
triple point – тройная точка
(равновесное нахождение вещества в трёх агрегатных состояниях)
potentiometer – делитель напряжения, потенциометр
influential – важный, имеющий влияние
to anticipate – предугадывать, упреждать
repeatability – сходимость результатов
reproducibility – воспроизводимость
to quantify – определять количество, измерять

TEXT

Under the science of measurement we know the metrology. It includes all theoretical and practical aspects of measurement. The word “metrology” comes from Greek “metron” (measure) and “logos” (study). In Ancient Greek the term “metrologia” meant “theory of ratios.”

Nowadays, metrology is a very broad field and it may be divided into three subfields. They are scientific (fundamental) metrology, applied (industrial) metrology, and legal metrology. The first one concerns the establishment of quantity systems, unit systems, units of measurement, the development of new measurement methods, realization of measurement standards and the transfer of traceability from these standards to users in society. Industrial metrology concerns the application of measurement science to manufacturing and other processes and their use in society, ensuring the suitability of measurement instruments, their calibration and quality control of measurements. Legal metrology concerns regulatory requirements of measurements and measuring instruments for the protection of health, public safety, the environment, enabling taxation, protection of consumers and fair trade.

A core concept in metrology is traceability defined as the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, all having stated uncertainties. The level of traceability establishes the level of comparability of the measurement: whether the result of a measurement can be compared to the previous one, a measurement result a year ago, or to the result of a measurement performed anywhere else in the world.

Traceability is most often obtained by calibration, i.e. establishing the relation between the indication of a measuring instrument and the value of a measurement standard. These standards are usually coordinated by such national laboratories as National Institute of Standards and Technology (USA), National Physical Laboratory, UK, etc. Traceability, accuracy, precision, systematic bias, evaluation of measurement uncertainty are critical parts of a quality management system.

Mistakes can make measurements and counts incorrect. Even if there are no mistakes, nearly all measurements are still inexact. The term “error” is reserved for that inexactness, also called measurement uncertainty. Among the few exact measurements are: 1) the absence of the quantity being measured, such as a voltmeter with its leads shorted together – the meter should read zero exactly; 2) measurement of an accepted constant under qualifying conditions, such as the triple point of pure water – the thermometer should read 273.16 Kelvin (0.01 degrees Celsius, 32.018 degrees Fahrenheit) when qualified

equipment is used correctly; 3) self-checking ratio metric measurements, such as a potentiometer – the ratio here is independently adjusted and verified to be beyond influential inexactness.

All other measurements either have to be checked to be sufficiently correct or left to chance. Basically, metrology is the science that establishes the correctness of specific measurement situations. This is done by anticipating and allowing for both mistakes and error. The precise distinction between measurement error and mistakes is not settled and varies by country. Repeatability (variation in measurements taken by a single person or instrument on the same item and under the same conditions) and reproducibility (ability of a test or experiment to be accurately reproduced by someone else working independently) studies help quantify the precision.

Comprehension

Exercise 1. True or false?

1) The term "error" is reserved for measurement exactness.
2) Metrology is the science that establishes the correctness of specific measurement situations.
3) Traceability is often obtained by reproducibility.
4) The level of traceability establishes the level of comparability of the measurement.
5) The word "metrology" comes from the Latin language.
6) National Physical Laboratory is situated in the USA.
7) 273.16 degrees Kelvin are the same as 0.01 degrees Fahrenheit.
8) Legal metrology concerns the establishment of quantity systems, unit systems, units of measurement, etc.
9) Nearly all measurements are still inexact.
10) A voltmeter has two leads shorted together.

Exercise 2. Complete the sentences using the correct words from the text:

1) … includes all … and practical … of measurement.
2) Reproducibility is the … of a test or … to be accurately reproduced by someone else working ….
3) … metrology concerns the … of measurement science to … and other processes.
4) The … distinction between measurement … and … is not settled and varies by country.
5) Metrology is a very … field and it may be … into three ….
6) Repeatability and … studies help … the ….

7) Traceability, …, precision, evaluation of measurement … are critical parts of a … … system.
8) Among the few … measurements are …-… ratio … measurements.

Vocabulary

Exercise 3. Give the Russian or English equivalents for the following word combinations:
Establishment of quantity systems; возможность отслеживания в условиях неопределённости; anticipating and allowing for both mistakes and error; допустимость стандартных коэффициентов; application of measurement science to manufacturing; систематические ошибки, появляющиеся при измерениях; development of new measurement methods; определяющие условия для подключения вольтметра; variation in measurements taken by a single person or instrument; предоставление возможности отслеживания современных измерительных стандартов.

Exercise 4. Match the words with their meanings:

1) error	a) unit of temperature measurement on any of several scales
2) laboratory	b) a number representing a comparison between two things
3) ratio	c) something used as a measure for comparative evaluations
4) application	d) accidental wrong action, a false statement not made deliberately
5) standard	e) partial change in the form, position, state, etc., of a thing
6) variation	f) room, building or institution equipped for scientific research or analysis
7) degree	g) ratifying or ordaining; settlement; confirmation
8) establishment	h) employment of means to accomplish an end; specific use

Exercise 5. Translate from Russian into English:
1) Метрология – это наука об измерениях физических величин, методах и средствах обеспечения их единства, а также о способах достижения требуемой точности. 2) Предметом метрологии является извлечение количественной информации о свойствах объектов с заданной точностью и достоверностью. 3) Теоретическая метрология рассматривает такие общие теоретические проблемы, как разработка теории и проблем измерений, физических величин, их единиц. 4) Если бы целью метрологии не было создание общей теории измерений, эта наука потеряла бы смысл. 5) Учёные ввели в обращение широкое понятие физической величины для одного из свойств физического объекта. 6) Мы знали, что измерение – это нахождение значения физической величины опытным путём с помощью технических средств. 7) Отечественная метрология развивалась под

контролем государства из-за потребности в повышении точности измерений в связи с ростом промышленного комплекса. 8) Зарубежная метрология также возникла из-за практических требований, но эти требования исходили, в основном, от частных фирм. 9) Средством метрологии является совокупность измерений и метрологических стандартов, которые обеспечивают необходимую точность. 10) В странах Западной Европы частная фирма может не пользоваться плохо зарекомендовавшим себя стандартом или прибором и договориться с партнёрами о другом варианте подтверждения измерений.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What does the term “metrology” mean? What is its origin?
2) What is fundamental metrology?
3) Could you give the definition of industrial metrology?
4) How can you describe legal metrology?
5) How does traceability correlate to metrology?
6) What institutions coordinate measurement standards?
7) What exact measurements do you know?
8) Is there any distinction between measurement error and mistakes in metrology?
9) What is the function of reproducibility and repeatability studies?

LESSON 8
LEVELING THE LEVEL

Lexical units:

dumpy level – нивелир, строительный уровень
surveying – геодезия
tripod – тренога, штатив
foot-screw = leveling screw – подъёмный винт
tape measure – рулетка, мерная лента
staff – нивелирная рейка
site survey – инженерно-геологические изыскания
benchmark – топографическая отметка уровня
arbitrary – произвольный, случайный

quadrant – четверть
traverse – пересечение
bubble level – пузырьковый уровень
tilting level – наклонный уровень
to flip – переворачивать
to hinge – подвешивать, устанавливать на шарнирах
to cancel out – уравновесить, сбалансировать
spirit level – ватерпас, уровень
swinging – качающийся
bar-coded – с нанесёнными отметками
graduation – деления на нивелирной рейке
to sweep – тянуть, проводить
level vial – ампула уровня
terrain – местность
to endure – продолжаться
despite – несмотря на

TEXT

A dumpy level, or a builder's auto level, or a leveling instrument, or – now – an automatic level – all these synonyms are used to name just an optical instrument used in surveying and building to transfer, measure, or set horizontal levels.

The general principle of operations is as follows. The level instrument is set up on a tripod (a device used to support any one of a number of surveying instruments) and, depending on the type, either roughly or accurately set to a leveled condition using foot-screws (leveling screws). The operator looks through the eyepiece of the telescope while an assistant holds a tape measure or graduated staff vertical at the point under measurement. The instrument and staff are used to gather and transfer elevations (levels) during site surveys or building construction. Measurement generally starts from a benchmark with known height determined by a previous survey, or an arbitrary point with an assumed height.

A dumpy level is an older-style instrument that requires skilled use to set accurately. The instrument requires the level to be set in each quadrant to ensure it is accurate through a full 360˚ traverse. Some dumpy levels will have a bubble level ensuring an accurate level.

A variation on the dumpy and one that was often used by surveyors, where greater accuracy and error checking was required, is a tilting level. This instrument allows the telescope to be effectively flipped through 180˚, without rotating the head. The telescope is hinged to one side of the instrument's axis. Flipping it involves lifting to the other side of the central axis (thereby inverting

the telescope). This action effectively cancels out any errors introduced by poor setup procedure or errors in the instrument's adjustment. As an example, the identical effect may be obtained with a standard builder's level by rotating it through 180° and comparing the difference between spirit level bubble positions.

An automatic level, self-leveling level or builder's auto level, includes an internal compensator mechanism (a swinging prism) that, when set close to level, automatically removes any remaining variation from level. This reduces the need to set the instrument truly level, as with a dumpy or tilting level. Self-leveling instruments are the very preferred instruments on building sites, construction and surveying due to ease of use and rapid setup time.

A digital electronic level is also set level on a tripod, and it reads a bar-coded staff using electronic laser methods. The height of the staff where the level beam crosses the staff is shown on a digital display. This type of level removes interpolation of graduation by a person, thus removing a source of error and increasing accuracy.

The very up-to-date laser level uses the laser beam projector that employs a rotating head with a mirror for sweeping the laser beam about a vertical axis. If the mirror is not self-leveling, it is provided with visually readable level vials and manually adjustable screws for orienting the projector. A staff carried by the operator is equipped with a movable sensor which can detect the laser beam and gives a signal when the sensor is in line with the beam – usually an audible beep. The position of the sensor on the graduated staff allows comparison of elevations between different points on the terrain.

In conclusion, it should be noted that the term "dumpy level" endures despite the evolution in its design.

Comprehension

Exercise 1. True or false?

1) An automatic level includes an internal compensator mechanism.
2) Scientists can't understand the general principle of operations of a dumpy level.
3) There is no need to set the instrument truly level for an auto level.
4) A leveling instrument is an optical device used in surveying and building.
5) A tilting level uses the laser beam projector.
6) Digital electronic levels remove interpolation of graduation by a person.
7) Basically, a level instrument needs two persons to be operated.
8) Foot-screws are not the same things as leveling screws.
9) The instrument and staff are used to gather and transfer elevations, or levels.

10) There has been no evolution in the design of a dumpy level since its invention.

Exercise 2. Complete the sentences using the correct words from the text:
1) A … carried by the operator is equipped with a … sensor which can … the laser beam.
2) A … level allows the … to be effectively … through 180˚, without rotating the head.
3) The height of the … where the level … crosses the staff is shown on a digital ….
4) The … of the sensor on the … staff allows comparison of … between different points on the ….
5) … generally starts from a … with known height determined by a … survey.
6) A … is a device used to … any one of a number of … instruments.
7) Dumpy levels are …-… instruments that … skilled use to set ….
8) A movable … gives an … beep when it is in … with the laser beam.

Vocabulary

Exercise 3. Give the English or Russian equivalents for the following word combinations:
Местность, предназначенная для инженерно-геологических изысканий; preferred instrument on building sites; произвольное время установки ватерпаса; a visually readable level vial; установленный на шарнирах наклонный уровень; difference between spirit level bubble positions; необходимость сбалансирования качающегося прибора; hinged to the left side of the instrument's axis; несмотря на продолжительные действия команды геодезистов; automatically adjustable screws for orienting the projector.

Exercise 4. Match the words with their meanings:

1) graduation	a) any means for the conversion or control of motion, or the transmission or control of power
2) mechanism	b) a state in which opposing forces harmonize
3) balance	c) a marking indicating a measurement
4) accuracy	d) equipment designed for a particular purpose
5) setup	e) freedom from mistakes; exact conformity to truth
6) projector	f) optical device that projects a beam of light
7) beam	g) the employees of a business or the workers of a plant
8) staff	h) a ray or collection of parallel rays from any luminous body

Exercise 5. Translate from Russian into English:
1) Нивелиром называется оптико-механический геодезический прибор для определения разности высот между несколькими точками. 2) У данного прибора есть зрительная труба, которая может вращаться в горизонтальной плоскости, и чувствительный уровень. 3) Современные оптические нивелиры оснащены автоматическим компенсатором, то есть устройством автоматической установки зрительной оси прибора в рабочее положение. 4) Если бы учёные не разработали лазерный нивелир, геодезические работы пришлось бы проводить как минимум двум специалистам. 5) Цифровые нивелиры обычно оборудованы запоминающим устройством, которое позволяет сохранять результаты наблюдений. 6) В промышленной геодезии метод геометрического нивелирования считается наиболее простым и точным. 7) Эффективность наклонного уровня при проведении измерений в гористой местности значительно снижается. 8) В лазерных уровнях используется принцип вращения лазерного луча, специально разработанный для этих электронно-механических приборов. 9) Как сообщили в новостях, высокоточный нивелир нового поколения сможет осуществлять измерения поверхностей различных планет, в первую очередь Луны и Марса. 10) С помощью элевационных винтов и подъёмного винта подставки можно быстро привести нивелир в рабочее положение.

Exercise 6. Make up the summary of the text and write its annotation.

Discussion

Exercise 7. Work in pairs or in small groups. Share in the discussion. Use the following questions as prompts:
1) What is a dumpy level? Give its analogous names.
2) Describe the general principle of its operation.
3) What are the main components of a level instrument?
4) What is the difference between a dumpy level and a tilting level?
5) Where can we find a swinging prism and what is it?
6) Why do specialists consider a digital electronic level to be the most dependable one?
7) How can you show the principle of work of a laser level?
8) What is the feature in the use of the term “dumpy level?”
9) What degree of precision can be obtained with the help of different types of level instruments?

FINAL TEST

Make the correct choice:

Variant 1

1. The precision of the laser rangefinder is determined by … .
a) the rise or fall time of the laser pulse b) the speed of the receiver
c) both of them d) sub-millimeter measurements

2. A digital electronic level always uses … .
a) a laser beam projector b) set level on a tripod
c) a bar-coded staff d) a telescope

3. A USB microscope is a … digital microscope.
a) multifunctional b) high-powered
c) transilluminating d) serviceable

4. The term “error” is used to describe … .
a) measurement uncertainty
b) measurement of an accepted constant
c) the absence of the quantity being measured
d) theoretical and practical aspects of measurement

5. Signal microcontrollers integrating analog components needed to control …, are common in the instrument-making industry.
a) industrial mechanical processes b) transporters and conveyers
c) digital computer systems d) non-digital electronic systems

6. Pressure sensors can be used to indirectly measure such variables as … .
a) intensity of a current b) time and date
c) speed, water level, and altitude d) sea depth and distances

7. The most common materials in sensors-making industry are … .
a) cast iron and aluminum b) polymers and metals
c) glass and silicon d) wood and plastics

8. In DSP, engineers study digital signals in one of the following domains: … .
a) time domain and frequency domain
b) spatial domain and autocorrelation domain
c) wavelet domains
d) in all of them

9. The integral part of each leveling instrument is a(n) … .
a) bubble level b) tripod
c) battery d) application-specific integrated circuit

10. Laser measuring tools usually include the ability … .
a) to produce some simple calculations
b) to calculate algebraic equations
c) to send the data obtained to the control station
d) to destroy themselves after their expiration date

11. The first microscope to be invented in the 16th century was the … microscope.
a) inverted b) optical
c) digital d) electromechanical

12. 1 degree Fahrenheit is the same as … .
a) 5/9 degrees Celsius b) 22 degrees Kelvin
c) 5 degrees Centigrade d) -243 degrees Kelvin

13. Microcontrollers must provide … response to events in the embedded system they are controlling.
a) very fast b) predictable
c) accurate d) logically grounded

14. The sensors used in a gas turbine are manufactured out of … materials.
a) bulletproof b) fusible
c) inflammable d) piezoelectric

15. A good sensor is … .
a) sensitive to the measured property only
b) sensitive to any other properties
c) designed to be non-linear to simple mathematical functions
d) able to react to any slight movement

16. Digital signal processing is often implemented … .
a) using special microcontrollers b) in many applied sciences
c) using specialised microprocessors d) as a part of nanotechnology

Variant 2

1. A laser rangefinder is a device which uses a … to determine the distance.
a) beam of electrons
b) telescope
c) laser beam
d) tape measure

2. USB and … are widely used by many modern manufacturing firms and labs.
a) stereo microscopes
b) comparison microscopes
c) optical rangefinders
d) digital microscopes

3. Today we can use … for digital signal processing.
a) general purpose microprocessors
b) different optical devices
c) modern stereo systems
d) industrial conveyors

4. A mirage may be caused by … .
a) the proximity to a desert
b) temperature gradients in the air
c) personal hallucinations
d) a powerful laser projector

5. The electron microscope is primarily used for … .
a) quality control
b) failure analysis
c) both of them
d) semiconductor device fabrication

6. Sometimes analog output signals require a(n) … .
a) analog-to-digital converter
b) purpose-built hardware
c) magnetic resonance imaging
d) digital-to-analog converter

7. We may find a visually readable … only in modern laser leveling instruments.
a) database
b) tilting level
c) level vial
d) magnet with specific qualities

8. Everybody may use a dumpy level in … and … to set horizontal levels.
a) outer space, vacuum
b) building, surveying
c) designing, engineering
d) fabrication, manufacturing

9. Metrology is the science that establishes the correctness of … .
a) specific measurement situations
b) practical aspects of measurement
c) different scientific theories
d) hard mechanical equipment

10. A … includes such parts as traceability, accuracy, precision, etc.
a) quality control system
b) measurement standards system
c) quality management system
d) governmental calibration committee

11. It is possible to convert … and … codes into a compact machine code.
a) English, Dutch
b) programming language, machine language
c) bar codes, digital
d) high-level language, assembler language

12. You may find … inside each tire.
a) the atmospheric pressure
b) a nipple
c) an air-pump
d) no pressure

13. A discrete Fourier transform produces the … information.
a) time and spatial
b) frequency domain
c) algebraically proven
d) frequency spectrum

14. All types of sensors have an impact on … .
a) living beings
b) industrial processes
c) what they measure
d) the environment

15. Microcontrollers are often used in … .
a) laser rangefinders
b) automatic levels
c) automobile engine control systems
d) optical microscopes

16. Pressure sensors are usually classified according to the … .
a) negative gauge pressure
b) application suitability and cost
c) difference between two or more pressures
d) temperature ranges of operation

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