Сontent

- Introduction p.6-7

- 1. Dimensions and surfaces p.8-9

- 2. Different colors p.10-12

- 3. Сapturing the height information, top and bottom surface features p.13-14

- 4. System uses Retina, a C/C++ library-based on artificial intelligence p.15-16

- 5. List of sources used p.17

- 6. Camera integration into the embedded world In the machine vision world p.18-19

- 7. Specialized embedded systems p.20

- 8. Special image data transfer A direct camera-to-SoC-connection for the image data transfer p.21-22

- 9. Camera configuration p.23

- 10. Conclusion Embedded vision p.24

-11. Robots and vision combine to speed up automation tasks. p.25

-12. Systems with one camera. p.26-27

-13.Smart add flexibility in lighting in robotic systems. p.28-29

-14.Stereo vision. p.30-31

-15. 3D imaging. p.32-33

-16.Add flexibility. p.34-35

-17. The multi-camera vision system checks the buckle assembly. p.36

-18. Fast motion systems improve image stability. p.37-38

-19. Image quality through motion control. p.39-40

-20. Piezo drives: speed and resolution. p.41-42

-21. Astronomy / microscopy. p.43-44

-22. Motion modeling. p.45-46

-23.Hexapod drive types and applications. p.47-48

-24. Robots in medicine p.49-57

-25. Occupational Safety and Emergency Safety p.58-72

- List of sources used p.73

Introduction

Although small parts such as washers, screws and bushings can be checked by operator operators, the task is tedious, time-consuming and repetitive. In addition, such checks are subject to human errors, and since such tasks can not be performed at high speed, machine vision systems are deployed to perform such tasks. In addition to performing such tasks more quickly, such machines can display several kinds of each part, ensuring that every aspect of the part has been made correctly. To achieve this goal, several visualization stages, often with different lighting, camera systems and lenses, should be used on such vision-based machines to accomplish this task. Understanding this, UTPVision has developed a rotational desktop monitoring system to perform this task (Figure 1). In operation, the parts are loaded from the turntable, where parts are inspected at several image processing stations for top-level defects, defects in bottom defects and internal and internal defects. The system presented at last year's VISION 2016 exhibition and conference in Stuttgart, Germany, uses several vision stations to test all aspects of small components such as washers, screws and gaskets. The exhibition showed a system for testing rubber gaskets at a speed of 100 parts per minute [1-2]

Figure 1: To develop a machine vision system to inspect small parts such as washers, screws and grommets, UTPVision uses a rotary table equipped with three vision stations.

1. Dimensions and surfaces

After the parts are fed by the vibrating bowl feeder (VBF) to the rotating plate of the system, they are indexed for visualization by the vision systems (Figure 2). As each part rotates, the displacement sensor from Keyence (Osaka, Japan, [www.keyence.com](http://www.keyence.com/)) is used to measure the height of the part and after a delay starts the camera at the first control station. At this station, the dimensions of the part are checked. To achieve this, Manta G-504, a GigE camera from Allied Vision (Stadtroda, Germany, [www.alliedvision.com](http://www.alliedvision.com/)) with a CCD sensor 2/3 inches 2452 × 2056, equipped with a telecentric lens from Opto Engineering (Mantua, Italy, www. opto-engineering.com) is mounted above the rotating plate. Color images from this camera are then transferred to the host computer of the system via the GigE interface of the camera. When a part is indexed to the next image processing station, images of the top surface of the part are captured. For this, the second camera Manta G-504, GigE is equipped with a 35 mm lens from Computar, Cary, NC, USA; Http: // Computar. com) and placed above the rotating plate. To accurately depict curved, often mirrored surfaces, angular, textured or topographic

functions are illuminated by a domed light, which is in the immediate vicinity of the sample that is displayed.

Figure 2: In operation, parts are loaded from a rotary table where the parts are inspected at imaging stations for (a) dimension (b) top defects, (c) bottom defects and (d) inside and perimeter defects.

2. Different colors

Because different parts are checked, they can reflect and / or absorb the wavelengths of light. Since the part includes a control station, the part is then scattered by both red and green light. Thus, by illuminating the part with red light, the colored signs of the red surface will be reflected, and the opposite colors of the surface, such as green, will be darkened.Mario.Similarly, highlighting the part with green light, the color properties of the green surface will be reflected, and the opposite surface colors, such as red, will be darkened. After the details are highlighted, at these two different wavelengths, two images are combined and transferred to the host computer of the system via the camera's GigE interface. While the camera / dome lighting system is used to capture images of the top surface of parts, another camera (not shown) configured in the same way is mounted under the roller when it is rotated. Thus, images of the lower surface of the computer can be captured and transferred to the host computer

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Figure 2.1.Laser line,micro focus,laser pattern generator

Figure 2.2 Line scan cameras

Figure 2.3Large area scan macroscope

3. Interior parts, as well as, as it were, the height of information, the top and bottom surfaces of the parts. In the case of rubber gaskets, for example, a dividing line on the outer circumference of the parts. While specialized pericentric and catadioptric lenses can be used to reduce the number of cameras and lenses for this task, in some cases. In such cases, several camera / lens solutions are needed. To accomplish this task, UTPVision developed a specialized image processing system in the verification system on the rotary table, in which at least 12 cameras are used to perform the task. As the parts are rotated under the imaging system, six user cameras based on 1600 x 1200 CCD images from Sony (Tokyo, Japan, [www.sony.com](http://www.sony.com/)), set horizontally 60 degrees, are triggered to represent the outer circumference of the part. At the same time, six cameras based on 1600 x 1200 CCD images from Sony are mounted vertically at an angle of 45 ° for the image of the inner diameter. Images from all 12 cameras are then transferred via the GigE interface to the host computer of the system. When images are captured by the system, they are displayed in the graphical user interface on a flat monitor (Figure 3). The interface, written using GTK +, and the C toolkit for creating graphical interfaces from the GTK + project ([www.gtk.org](http://www.gtk.org/)), allows the user to visualize (clockwise from top to bottom) the part size, the surface features, the outer edge of the part and its internal features. Thus, the operator can visualize the operation of various image processing stations.

Figure 3: In designing the system, UTPVision employed Retina library developed by Squeezebrains – UTPVision Department, a C/C++ library to analyze the images using supervised learning. Using a GUI, the operator can visualize (from top to bottom): the dimensions of the part, the surface characteristics, the outside rim and the inside surface.

4. Supervisory training Instead of using standard image processing algorithms such as function analysis to detect specific functions, color defects of each part, the system uses Retina, a C / C ++ library based on artificial intelligence developed by Squeezebrains. Unlike uncontrolled or semi-controlled learning algorithms, Retina analyzes images using a proprietary algorithm, requiring the operator to train the system using a set of images. Because of this configuration

Parameters are required, because parameters are images used for training. In such controlled learning systems, the input variables (in this case images) and the output variable (pass or fail) are used by the algorithm to study the mapping function from the input to the output. In the system developed by Squeezebrains - UTP Vision Department, the Retina software is used to process all images taken from different machine machine vision machines. This eliminates any pre-processing steps of the image, such as the image threshold, that are used when saving all the information on the captured images. To teach the system, the number of parts that need to be trained depends on the variability of the part being examined. For simple parts, this can be only five; for more complex objects the number of parts can be higher. In a typical scenario, approximately 100 object types are first captured. Then, good and bad parts are displayed, as well as operator input used to train the system by the operator.

Once the training is done, other details are presented to the system, and the system asks the operator for the condition of the part, reinforcing the controlled machine learning. After the details are classified, they are indexed around the turntable. To classify the parts according to their defects, the PLC, coupled to the host computer of the system, starts the purge valves from Festo (Esslingen, Germany, www. Festo.com) to segment the parts into different cells. By configuring the system in different ways, parts can be classified as good or bad or, alternatively, can be sorted into several boxes depending on the defects detected. In many cases, after sorting, defective parts can be recycled or altered. To date, UTPVision has deployed a number of such systems in Europe, Korea, China and the United States of America at a cost of about 100 thousand Euros. As a unit of UTP, Squeezebrains also offers Retina software for OEMs developing computer vision systems. Complete with a graphical interface, Retina software is estimated at about 8 thousand euros per license.

5. Integration of vision into embedded systems

Embedded vision architectures provide smaller, more efficient vision solutions optimized for price and performance.

Embedded computer systems usually come into play when space is limited and energy consumption must be low. Typical examples are mobile devices - from mobile test equipment in the factory to dental scanners. Built-in vision is also an excellent solution for robotics, especially when the camera needs to be integrated into the robot's arm. In addition, the built-in approach reduces system costs compared to the classic PC-based setting. Let's say you spent $ 1,700 on a system with a classic camera, lens, cable and PC. A built-in system with the same bandwidth will cost $ 300, since each piece of equipment is cheaper (Figure 4). So whether it's smart industrial stretchers, automated parking systems or people counting applications, there are several built-in system architectures available for integrating cameras into your built-in vision system.

Figure 4: Because embedded architectures require greater up-front development resources to result in lower unit cost, volume is a key factor to consider when deciding to launch an embedded machine vision or image processing project.

6. Integration with the camera in the built-in world In the world of machine vision, typical integration with the camera works with a GigE or USB interface,

which is more or less a plug-in connected to a PC (or IPC). Together with the manufacturer's software development kit (SDK) it is easy to access the camera, and this principle can be transferred to the embedded system (Figure 5). Using a single-board computer (SBC), this basic principle of integration remains unchanged (Figure 6). Low-cost and easily accessible SBCs contain all parts of the computer on a single SoC board, RAM, data storage slots, I / O ports (USB 3.0, Gig-E, etc.).

Popular single-board computers, such as Raspberry Pi or Odroid, have compatible interfaces (USB / Ethernet). There are also industrial single-board computers available from companies like Toradex (Horw, Switzerland, [www.toradex.com](http://www.toradex.com/)) or Advantech (Taipei, Taiwan, [www.advantech.com](http://www.advantech.com/)) that provide these standard interfaces. The main differences are the types of processors that these single-board computers are equipped with. Despite the availability of SBC, available with x86-based processors, most processors use ARM-type processors, because they usually consume less power. More and more camera manufacturers are providing their software development kit (SDK) also in a version running on the ARM platform so that users can integrate the camera in a familiar way, like on a Windows PC. In the best case, the SDK provides the same functionality and API (programmable application interfaces) for both platforms, so that even parts of the application software code can be reused. Therefore, with this installation, only a small additional integration effort should be performed compared to a standard PC-based vision system.

Figure 5: Components of a traditional general-purpose, pc-based, machine vision system (a) and components of a camera module (b) for a solution oriented, embedded machine vision or image processing system that is optimized for price/performance.

7. Specialized Embedded Systems Embedded systems can be specialized at an even higher level, where for some applications the processing technology needs to be further reduced. That's why many systems are based on the system on the module (SoM). These very compact on-board computer modules contain only a processor (more precisely: a system on a chip, SoC), microcontrollers, memory and other important components. Such a SoM must be installed on a carrier board, which, for example, carries the necessary connectors for certain interfaces. With such a relatively cheap carrier platform, the system can be easily individualized for a particular application and system requirements, but since

SoM is a finished product - the whole installation can be cheap. Typically, this setting can be equipped with a standard interface connector (for example, USB). In this case, the advantages of plug and play are used in the same way as for a single board computer or even a computer vision system on a PC. However, often this does not correspond to the idea of ​​a very specific and frugal system. In addition, due to space requirements, weight or power consumption, the USB interface may not be acceptable, and instead a more direct connection between the cameras and the processor is of interest. In addition, many embedded vision systems are based on (or include) the FPGA (FieldProgrammable Gate Array) module. These devices are ideal for the necessary computing work, for example, in stereovision devices or in face detection applications. All these aspects are the reasons for which a direct connection between the camera and the FPGA or camera may be required.

8. Special transfer of image data. Direct connection to the camera for data connection for image data transmission can be achieved by connecting on the basis of LVDS or MIPI standard CSI2. Both methods are not clearly standardized by the equipment. This means that no connectors are indicated, even the numbers of the strips in the cable. As a result, to connect a specific

camera, the corresponding connector should normally be designed on a carrier board and not available in a standardized form on the finished single-board computer. CSI2, a standard coming from the mobile device industry, describes signal transmission and the software standard. Some SoC have CSI interfaces, and there are available drivers for selected camera modules and dedicated SoCs. However, they do not work in a unified manner, and there are no common drivers. As a result, the driver may need to be individually modified, and data connection with the driver may require additional adaptation on the application software side to ensure the acquisition of image data. Thus, CSI2 is not a ready-to-use solution that works right after installation. Although LVDS is a widely used connection for high-speed data transmission, with certain signaling principles, there is no standardized software protocol for transferring image data. As a result, there are no standard drivers. Some manufacturers provide additional systems, that is, cameras with LVDS output based on the proprietary protocol and cards with the corresponding adapted drivers that work together directly. Advantage is a complete solution with low integration effort, but the user is limited to certain equipment. Other vendors provide open documentation based on the LVDS camera, which is free for any hardware integration. In this case, you need to create a driver. In practice, this signal processing can be performed on a FPGA. This type of image capture algorithm based on FPGA can be programmed from scratch, but there are also tools to reduce the amount of integration work. For example, such a FPGA uses preconfigured IP cores. For a camera with airborne levels with LVDS interface, the Dart Basler camera (Ahrensburg, Germany, [www.baslerweb.com](http://www.baslerweb.com/)) provides a development kit that includes a processing board with a reference implementation (FPGA programming) to provide a direct choice for integrating a prominent device.

9. Camera configuration Another aspect of these connections to the board is the camera configuration. Control signals can be exchanged between the SoC and the camera via various bus systems, for example. CAN, SPI or I²C. So far, there is no standard for this function. It depends on the camera manufacturer, with which you can control the image settings and how. Even the decision to support or not support GenICam depends on the manufacturer. But the good news is that all these bus systems are supported by most SoCs. Thus, with the help of the appropriate driver software, you can directly access the camera to adjust and change the image settings. In addition, it is important to have access to the camera configuration. Basler supports camera access via I²C (as part of the BCON interface for LVDS) from the Basler's pylon SDK and thus provides standardized APIs (such as C ++) that simplify configuration programming (Figure 7).

Figure 7: Possible interfaces for embedded vision include BCON for LVDS and USB 3.0.

10. Conclusion Built-in vision can be an interesting solution for certain applications; Several applications based on GigE or more typically on USB can be designed using single-board computers. Given that these types of equipment are popular and offer a wide range of prices, performance and compliance with quality standards (consumer and business), this is a reasonable option for many cases. For a more direct interface for image data transmission, LVDS or CSI2 is possible. However, there is no comprehensive industry standard, established for a wide variety of process requirements or for all platforms [3-5].

Consequently, both methods have their limitations when it comes to creating simple integration solutions. Adaptation and integration are required, but companies provide drivers, sample sets, SDKs, or other tools to make integration easier for the user. Both of these interfaces have advantages for one or the other application and use. The configuration of the camera that accompanies these interfaces is usually simpler, as standards and drivers already exist. With the SDK or other tools, integration and work can even be simplified. As a rule, for the best integration of cameras with direct connection to SoC, it is important to develop and widely implement standards. With the subsequent universal drivers and standardized data APIs, a real image processor that runs out of the box (without adaptive programming) can be achieved. This would make the integration of vision technologies even in the smallest and most compact embedded systems as easy as it already is for today's (I) computer vision on a PC

11. Robots and vision combine to speed up automation tasks.

In automation tasks, numerous types of camera systems and image sensors are used, which are now available.

Previously, robots were limited to performing repetitive tasks on similar parts that were fixed within known coordinates. Because of this, they were limited to large-scale applications, where, after programmed tasks, such tasks could be performed quickly, which reduced production costs. Today, by adding vision-based systems, integrators can offer more flexible systems that can address a wider range of applications that require less production. To solve these problems, developers can choose from a variety of different configurations of vision systems, each of which remains highly dependent on the application. When choosing a vision system for a particular system, many different types of technologies are available that use single, dual or multiple cameras, structured or projection systems and flight time sensors (see "Selecting a 3D vision system for automated applications for robotics." Systems Design, December 2014, <http://bit.ly/1BUQaFw>). In addition to considering the various types of image sensors that are available, developers need to consider the types of lighting needed to better illuminate the part that needs to be checked or selected. Depending on the detail, lighting configurations such as LED backlighting or off-axis lighting, dome lighting, back lighting or structured lighting may be required. After capturing images, they can be processed in various ways, using a number of different software packages, ranging from simple sets of vision and ending with advanced sets of OEM packages for their own packages.

12. Systems with one camera.

To perform a variety of selection and location tasks, only the use of single cameras is required. In the simplest configurations, the camera is placed in a fixed position above the object to be inspected and the object is analyzed outside the field and / or custom software. The robot located next to the vision system then performs the task of selecting the part and placing it in the corresponding box. Many examples of such systems were shown at the VISION exhibition this year in Stuttgart, Germany. For example, in Festo (Esslingen, Germany, [www.festo.com](http://www.festo.com/)) Gerhard Hölsch, product manager for Machine Vision, explained how EXPT Parallel Kinematic Robot EXPT is used by a large cookie manufacturer to accommodate various types of cookies in plastic containers. After the different types come out of several ovens and merge on the same conveyor, the cookies are displayed using a smart camera enclosed in a custom enclosure above the conveyor. The corrugated white dome lights up the biscuits. Intelligent software in the camera determines the quality and shape of the cookie, as well as its position on the conveyor. The results of this image processing are then transferred via the Ethernet camera interface to the Festo robot controller with tracking functions. Here, the coordinates of each cookie are then used to give

To accomplish this task effectively, Bosch uses shape-from-shading to highlight the defects present on the highly specular surfaces of the objects. In this method, the gradient and curvature of features within an image can be realized by capturing multiple features of an object by illuminating it in an uneven way to obtain a topographic map (see “Lighting system produces shape from shading,” Vision Systems Design, January 2008; <http://bit.ly/2g2QXMd>). Instead of using a commercially built system, such as that from SAC Sirius Advanced Cybernetics (Karlsruhe, Germany; [www.sacvision.de](http://www.sacvision.de/)), Bosch chose to light the part with four white LED panels from Vision and Control (Suhl, Germany; [www.vision-control.com](http://www.vision-control.com/)) placed around the part at roughtly 45o angles. To obtain a 360o map of the surface of the cylindrical part, the part is first positioned by a Fanuc industrial robot in a fixture that is

then moved into the field of view of a UI-3370CP CMOS camera from IDS Imaging Development Systems (Obersulm, Germany; https:// en.ids-imaging.com) equipped with a 25mm Fujinon lens from Fujifilm (Tokyo, Japan; [www.fujifilm.com](http://www.fujifilm.com/)).

13.Smart add flexibility in lighting in robotic systems.

For large complex parts, such as engine blocks, adding cameras to robotic systems provides the flexibility to view objects from different angles. In addition to reducing the number of cameras required to obtain multiple views, such systems do not require that the part be mounted and can be easily reconfigured for different objects of different sizes and shapes. As in any system of view, lighting plays a key role in ensuring that captured images are obtained with maximum contrast. However, in many cases, different surfaces of an object may require unique and specific types of lighting. In such cases, a dynamic change in the intensity of light and its gating may be required. As explained by David Dehov, the engineer staff of Fanuc Robotics (Rochester Hills, Michigan, USA, [www.fanucameria.com](http://www.fanucameria.com/)), this task can be simplified using the latest intelligent lighting controllers. In the demonstration shown at last year's Automate show in Chicago, Dekhov showed a robotic vision system capable of lighting various details with different lighting parameters. When configuring the system, a custom camera from Kowa (Aichi, Japan, www. [Www.www.kowa.co.jp](http://www.www.kowa.co.jp/)), created specifically for Fanuc, was posted on the industrial robot Fanuc LR MATE. To illuminate the detail, a 120 mm ring light from CCS America (Burlington, MA, USA, [www.ccsamerica.com](http://www.ccsamerica.com/)) was installed on the camera. To place image objects on different surfaces, it was necessary to control both the intensity and the duration of the light pulse, as it moved along the field of each object. To this end, Dechow connected the LED lighting controller from Gardasoft Vision (Cambridge, UK, [www.gardasoft.com](http://www.gardasoft.com/)) between the industrial robot LR MATE and the 120mm ring light. To program the robot, Dehow has programmed the robot controller to move the robot along several different paths around the various parts that will be displayed. When the robot reaches a certain point on the way, the program starts the camera to start the exposure. At the same time, the trigger is sent to the Gardasoft controller for the ring light pulses for a certain time and current (brightness) level. After capturing the image, the lighting controller is then updated by the program running on the robot controller with respect to the next pulse duration and brightness required at the next robot position. When the camera starts at the next position, the lighting is automatically adjusted for different pulse durations and brightness levels. Thus, one program running on the robot controller can dynamically change the lighting of several objects, as they are displayed by the camera. The video system in action can be found at http: // bit.ly/2fnNnv6.

14.Stereo vision.

One of the most common methods for determining the position of an object in the field of view of the camera is the use of stereo vision. In this method, depth is calculated by obtaining two images from two different points of view and extracting three-dimensional information by studying the relative positions of objects in two images and solving the so-called correspondence problem. For applications for which robotic vision-based systems must accurately determine the position of objects using stereovision techniques, system integrators must fully understand the nature of their application. This involves understanding the types of cameras used in the system, their resolution, the focal length of the used lenses and the minimum distance that the camera system places from the object. Knowing this, you can calculate the base distance between the cameras and calculate the error for certain values ​​of z (depth). Such mathematical calculations were simplified by companies such as Nerian Vision Technologies (Leinfelden-Echterdingen, Germany; [https://nerian.com](https://nerian.com/)), which developed an easy-to-use online calculator for this task. Available at http: // bit. ly / 2fZNY9O, the calculator allows you to enter parameters such as the properties of the image sensor, the focal length of the lenses and the camera's minimum distances, and calculates the stereo distance required by the stereo cameras. At the same time, a depth error is calculated at the depth of the image. Using this tool, system designers can properly set up stereophonic vision systems to meet their specific application. Many OEMs, such as FLIR Integrated Imaging Solutions (formerly Point Gray, Richmond, BC, Canada, [www.ptgrey.com](http://www.ptgrey.com/)) and IDS, offer integrated, pre-calibrated stereo cameras. Despite the fact that they allow system designers to accurately install, configure and calibrate systems with two cameras, they are somewhat limited in applications that they can run.

As a demonstration designed to highlight binpicking, the system uses two Mako G-125 PoE GigE cameras from Allied Vision (Stadtroda, Germany; [www.alliedvision.com](http://www.alliedvision.com/)) mounted on a UR-5 robot from Universal Robots (Odense S, Denmark; [www.universal-robots.com](http://www.universal-robots.com/)). “While many bin-picking systems use structured lighting or pattern projection to create a 3D point cloud of the object, such approaches may not be suitable for objects with specular shiny surfaces,” says Isaac Miko of Infaimon. Instead, stereo camera systems can be used. As the robot moves in a pre-defined trajectory within the 3D space, multiple images are taken creating a 3D model of the environment. Features within the parts such as holes are then determined using blob analysis. With the 3D model, the best candidate for picking is computed taking into account whether or not the robot will collide or be trapped with other parts or the bin. Positional coordinates and orientation are then computed on an industrial PC and used by the robot controller to pick the part from the bin.

15. 3D imaging.

While stereo vision systems can be used effectively for certain types of applications, they are unsuitable in systems that require the 3D models of the part to be created. In such systems, structured lighting, pattern projection systems or Time of Flight sensors can be used. Tasked with analyzing the Department of Transport (DOT) codes on tires for a large German automobile manufacturer, for example, Peter Scholz Software + Engineering GmbH (Weiden in der Oberpfalz, Germany; [www.scholzsue.de](http://www.scholzsue.de/)) developed a vision-based robotic system to perform the task (Figure 10).

Reading the DOT codes placed around the rim of the tire cannot be accomplished with traditional stereo techniques because the DOT codes are composed of black lettering on black rubber. Thus, rather than use stereo cameras, a LJ-V 7060 3D inline profilometer from Keyence (Elmwood Park, NJ, USA; [www.keyence.com](http://www.keyence.com/)) was mounted on a UR-5 robot from Universal Robots. As the tires progress along the production line, information such as the expected tire size code, tire plant code, tire brand and the week and year the tire was made are read by a PC from the manufacturer’s PLC. To check whether this information is consistent with the information on the tire, the laser scanner is rotated over 440o around the tire by the robot. Profile data of the tire is then sent from the scanner to the host PC where a 3D point cloud model of the surface of the tire is computed. Because the DOT codes are raised above the surface of the tire, the 3D point cloud is then sectioned and transformed into a 2D image. From this image, the DOT codes are read and compared with the information from the manufacturer’s database. For new DOMs (Date of Manufacturing) changing every week, two independent manual input stations allow operators to enter new DOMs inline into the database. Inputs must be identical in both stations. If incorrect, a robot, positioned further down the production line removes the tire for re-processing.

16.Add flexibility.

Choosing which type of 3D vision system is very dependent on the application. While laser rangefinders using Time of Flight (TOF) methods can be used to search for distant objects, stereo imaging systems may be better suited for visualizing high contrast objects. However, for the display of details, such as DOT codes on tires, more flexible systems may be required that use structured light systems mounted on robots. By installing such image sensors for robots, system integrators can reduce the cost of rendering large parts with single-chamber systems. Indeed, at last year's VISION show a number of companies, including SAC Sirius Advanced Cybernetics, demonstrated how, by installing the Trevista camera company on the robot UR-5 from Universal Robots, the camera based on the form can be used to image parts from several types (Fig. 11).

Perhaps more impressive, however, was a demonstration developed by David Dechow, Staff Engineer at Fanuc Robotics (Rochester Hills, MI; [www.fanucameria.com](http://www.fanucameria.com/)) that showed how different surfaces of an object can be illuminated differently using a single camera and lighting system with a smart controller (see “Smart controllers add lighting flexibility to robotic systems,” page 28, this issue).

17. The multi-camera vision system checks the buckle assembly.

When it comes to manufacturing automotive safety components, quality rigor is very extreme and there is little room for error. That is why leading car manufacturers and their suppliers rely on computer vision systems to ensure that only the highest quality components and components fall into vehicles that are sold to consumers. An example is the belt buckle. Each buckle has many components, the presence and position of which allows the buckle to snap securely and function as intended. Each component must be intact and have a place. Any error, such as an inappropriate spring or missing tab in the clip, can potentially lead to the buckle not snapping or, in rare cases, cause the passenger to think that the buckle is locked when it is missing.

18. Fast motion systems improve image stability.

Mechanical piezo and hexagonal systems provide an active imagestabilization and resolution improvements.

The desire to visualize with a higher resolution pushes optical designers and manufacturers of motion control equipment to overcome physical limitations. Although megapixel inflation still seems to be the main focus of the consumer camera market, scientific applications are different. There is a trade-off between sensitivity and resolution, and violations such as vibration or vibrations in the atmosphere or in liquids damage the image quality, especially in low light conditions. Methods of image smoothing and active image stabilization based on precision mechanisms and motion control are modern tools for improving the quality of digital images. Precision motion control is also becoming increasingly important in testing equipment where pre-recorded vibration sequences are "reproduced" as six-dimensional trajectories on hexagonal platforms simulating different environments, including vehicle vibration and camera shake caused by the human muscular system.

19. Image quality through motion control.

If the electrical noise did not cause problems with digital image sensors, such as chips with a complementary metallic oxide semiconductor (CMOS) or a charger (CCD), the image quality can be greatly improved at minimal cost. However, in the real world, counting low photons leads to an unfavorable signal-to-noise ratio, creating difficulties for imaging applications from astronomy to microscopy. High-sensitivity detectors often do not have the desired resolution, and detectors with the highest resolution do not have sensitivity. The result is either a lack of detail, or excessive blurring of the image with a long exposure time. Resolution of digital methods of recording images is mainly determined by the number of pixels on the sensor, and improvements either require an increase in the area (the size of the sensor) or reduce the size of the pixel. Unfortunately, for the first case, different optical imaging is required, and in the second case, the photosensitivity decreases with the pixel size, which leads to a decrease in the signal. Nevertheless, there are methods based on mechanical motion control systems that can easily increase the image resolution in various applications, including fluorescence microscopy, white light interferometry, optical coherence tomography (OCT) or surveillance cameras and aerial photography cameras (Figure 12).

Using both motion-control hardware and software algorithms, image resolution can be significantly improved with relatively little

effort. Furthermore, these mechanical methods can also simulate challenging environments with jitter or vibration to develop image stabilization techniques that improve imaging resolution and quality.

20. Piezo drives: speed and resolution.

A special form of electroceramics, piezoelectric (piezo for short) drives are widely used for applications where accuracy, speed and strength are required in a small package. Based on the reverse piezoelectric effect, the piezoceramic discs expand when an electric field is applied, causing the drive to move. To make these piezo systems more accessible to OEM designers, manufacturers complete the drives inside the bend device, providing precise guidance and enhanced motion along with a simple mounting interface. Bends are usually made of aluminum, steel or titanium. With flexible power amplifiers, travel ranges up to 2 mm can usually be achieved with resolutions up to the nanometer range. High dynamics - the ability to accelerate and stop quickly - due to the high rigidity of the active ceramic elements can lead to scanning frequencies up to several kilohertz. Piezo drives have no wear, do not require lubrication and are non-magnetic and compatible with vacuum. In the absence of friction and wear, they can provide cycle maintenance cycles without maintenance. Physik Instrumente (PI; Karlsruhe, Germany), ceramic encapsulated PICMA drives were tested for the life of NASA / JPL and survived 100 billion cycles without failures - they have been working in the Mars Rover Science Laboratory for almost four years. However, the additional movement provided by flexible piezo drives takes place at a price. With increasing gain, both stiffness and responsiveness decrease. Nevertheless, well-designed piezo transducers can still provide intermediate milliseconds and much faster than any other conventional drive. And when they are integrated into bending devices, piezo drives can provide multi-axis motion. For example, they can be integrated into high-end custom cameras to stabilize the image or improve resolution based on the sub pixel principle.

Step-by-step adjustment of pixels When an image sub-pixel is used in the image processing system, the sensor recording area moves along a certain path with a certain frequency in sub-pixel increments. This anti-aliasing, when the movement is smaller than the pixel size, causes the pixel to be exposed several times in the recording area, creating a virtual "pixel multiplier" that can significantly improve

(Figure 13).

With the help of data processing, the various images produced in this way are subsequently superimposed to form the final, high-resolution image—a process also known as super-resolution imaging. Since this method is based on motion, a mechanical drive is required that meets all the performance criteria for mechanical precision and lifetime. The drives differ with the application, but they all have crucial features in common: the motion of the sensor chips must be reproducible in two dimensions with sufficient linearity, and the travel is on the order of the pixel size—a few tens of micrometers or less. The dynamics required range from a few hertz for still images up to the kilohertz range for video recordings. The basic requirement for high-resolution biometric CCD/CMOS scanners used to identify persons by their fingerprints is, for example, a scanning frequency between 1 and 5 Hz with a response time <1 ms. The travel for the drives is between 5 and 15 µm, with precision >0.5 µm in the smallest possible mounting space.

21. Astronomy / microscopy.

Fast piezo-controlled scanning devices can also improve the image in astronomical and microscopic applications. For astronomy active mirrors (tilt / tilt movement) and adaptive mirrors (several actuators deforming the surface of the mirror) showed an improvement in spatial resolution by more than one order. Modern telescopes collect light with huge primary mirrors - the larger the mirror, the more photons are collected. The main mirror of the Subaru telescope on Mauna Kea, HI covers 8.3 m and sends light to several smaller mirrors, until it finally hits the image detector.

Earthly telescopes are affected by atmospheric turbulence, which distorts the wave front (what people perceive as a flicker of stars) and the wind that causes vibration in the telescope's structure. To counteract these limitations, fast, high-precision mechanisms are integrated into secondary and tertiary mirrors. Using these smaller and lighter lower mirrors, motion control components with submicron linear accuracy, submicroradian angular accuracy and bandwidth in hundreds of hertz can limit external disturbances. Piezoceramics are often used in these active and adaptive systems because they provide high strength, sub-millisecond responsiveness and atomic-scale resolution. For example, the goal of the adaptive optics project, through the cooperation between the Institute for Applied Optics and Precision Engineering Fraunhofer IOF (Jena, Germany, [www.iof.fraunhofer.de/en](http://www.iof.fraunhofer.de/en)) and PI in Karlsruhe, is the development of a new generation of extremely accurate adaptive optics (XAO) based on 11 000 multilayer PICMA piezo-receivers for the European extremely large telescope (E-ELT), which will be built in the Chilean Atacama Desert in 2024. To break the diffraction limit in light microscopy, several scanning methods are available using piezoelectric drives with nanometer resolution. In high-resolution microscopy, rapid scanning means faster imaging and less risk of photobleaching effects. The first optical microscopes, significantly destroying the diffraction limit about 30 years ago, were scanned by near-field optical microscopes (SNOMs) that rely on a small probe tip with a subwavelength aperture scanned over the surface, while maintaining the exact distance between the tip and the sample in the nanometer realm. SNOM requires nano-precision mechanisms for the scanning device and for controlling the distance from the vertex to the sample. Another method, called reduced-radiation microscopy (STED), was first investigated by Stefan Adh in 1994 when searching for ways to measure transparent three-dimensional photoresist microstructures for the semiconductor industry. In a STED microscope, a ring laser

The beam excites fluorescence only in the nanometer volume at a time. Scanning a beam with nanometer resolution mechanisms and comparing the exact position with the collected optical data, a high resolution image is possible. Today, many other methods of superresolution, including light microscopy and 4PI-microscopy, require some form of nanometer accurate scanning mechanism for probes, sam

1701VSD and optics, or to control structural and destructive interference. For example, multi-axis piezo scanners, such as the PInano stage, can create high-resolution 3D images quickly

Scanning a bio-sample in several planes separated by micron fractions. The data of each scanned plane is combined with software, creating a multi-dimensional highly detailed image.

22. Motion modeling.

The above mechanisms for improving image resolution rely on fast controllers and algorithms to make the most of their capabilities. To test overall efficiency and improve systems, motion simulation is critical. Here, precision multi-axis mechanisms with controllers and software are important, which ensure highly repeatable execution of pre-recorded or synthesized patterned motion. Today, motion modeling is used for a wide variety of applications, including vibration testing of vehicles or aircraft, as well as responses to accelerometers, gyroscopes and image sensors, such as those used in high-end cameras and smartphones (Figure 14).

Repeatable multi-axis motion simulation can help tweak advanced algorithms in image stabilization systems and verify the performance of optomechanical or electronic stabilizers. The Camera and Imaging Products Association (CIPA; Tokyo, Japan; [http://www.cipa](http://www.cipa/). jp/index\_e.html), an international alliance of camera manufacturers, establishes standards for the test and evaluation of image stabilization systems, with DC-011-2015 being its latest standard for motion simulation test conditions. For high-quality test results, motion simulators need to provide highly repeatable motion with precisely the same dynamics (vibration direction, acceleration, and magnitude) as the original motion they are trying to simulate. This involves running high-precision trajectories with the corresponding dynamics in multiple axes. Stewart platforms, commonly called hexapods, have become the standard for multi-axis simulation tasks when high precision is required. A hexapod is a parallel kinematics system consisting of six actuators arranged in parallel between a top and bottom platform. Hexapods have many advantages over serial kinematics stages, such as lower inertia, improved dynamics, smaller package size, and higher stiffness. In addition, hexapods are more flexible than conventional six-axis positioners, allowing a programmable, randomized center of rotation. Advanced hexapod controllers can also cast the hexapod coordinate system’s origin and orientation anywhere in space rather than being fixed by the mechanical configuration of the system.

23.Hexapod drive types and applications.

Several drive types are available for different load and frequency ranges. Hexapods with electromagnetic brushless servo motors and screw-type actuators can provide good balance of high load capacity, stiffness, and low power consumption. Load capacities of 100 lbs and more are feasible and, with the appropriate mechanical design of the drivetrain and sensor technology, can achieve accelerations to 2 g. They also provide an inherently stiff-drive mechanical design that can hold a position on power-off. Even higher performance is feasible with voice coil drives (based on the principle of a loudspeaker driver; see <https://youtu.be/BQJg7I-4620>) such as used in the H-860KMAG flexure-guided, direct-drive hexapod. Here, accelerations to 4 g with velocities of several hundred millimeters per second are possible. The frictionless flexure guides and joints enable zero-backlash motion without the vibrational noise caused by traditional mechanical bearings—that is, undesired frequency components coupledin from the mechanical system cannot influence the measurement. In addition to drone-camera stabilization testing with an H-840 hexapod (see <https://youtu.be/RPJpNSTX7wA>), a PI H-900KSCO hexapod was designed for industrial automation and stabilization of motion on moving vehicles and vessels, handling loads up to 130 lbs while providing motion ranges to 200 mm (in x, y, and z) and 66° (pitch, yaw, and roll) with velocities to 80 mm/s and 30°/s, respectively. And finally, using carbon fiber struts, the H-860 high-dynamics voice coil hexapod has frictionless flexures throughout its drivetrain to eliminate minute vibrations caused by rolling elements. Hexapod waveform generation The hexapod controller’s built-in waveform generation function is capable of internal generation of millions of target positions to run complex multi-axis motion profiles with sub-micrometer precision at speeds of up to thousands of points per second, addressing aliasing and motiongeneration artifacts—the closer the points, the smoother the motion and the lower the unwanted vibration. Rapid controller communication occurs through high-speed interfaces such as TCP/IP Ethernet, SPI, EtherCAT, and real-time TTL for synchronization with external events. For rapid application development of complex motion waveforms, software tools operating across Windows, OS X, and Linux operating systems are critical. Dynamic libraries make for quick and productive programming in any language, while a simple, mnemonic ASCII command set makes for quick work in terminals or any scripting environment. An extensive, well-wrung-out, cross-platform-compatible LabVIEW (National Instruments; Austin, TX, USA; [www.ni.com](http://www.ni.com/)) library facilitates development of detailed and intuitive user interfaces on that platform as well (Figure 15).

An example application offers multi-axis arbitrary waveform generation, including independently selectable sine, square, triangle, sawtooth, and swept-sine actuation, or the ability to import custom or proprietary position-vs.-time tables in spreadsheet format. With the variety of motion-control parameters such as physical size, load capacity, speed, precision, travel range, and cost, it is obvious that one piezo mechanism or multi-axis motion system cannot fit all applications. However, the large amount of standard systems offered today facilitates proof of concept—and custom solutions are available for OEM design engineers.

24. Robots in medicine

Robots-assistants The history of robotic assisted surgery has been more than twenty five years. The experience and technology used previously for military purposes resulted in the emergence of robotic assistants, which allowed the surgeon to perform the most specific manipulations with the utmost care.

In 1985, the first surgical system, PUMA 560, was used in neurosurgery. Later, the arsenal of surgeons was replenished with the PROBOT manipulator, and in 1992, the RoboDoc system was introduced, which was used in orthopedics in joint prosthetics.

All of these systems were highly specialized installations to provide the stages of surgical operations and were not full-fledged robotic systems. In 1993, the robotic system Aesop (Aesop) of Computer Motion Inc. appeared. - an automatic hand to hold and change the position of the camera during laparoscopic operations. In 1998, Computer Motion Inc. presented a more advanced system ZEUS (Zeus). However, "Aesop" and "Zeus" - remained only additions, the main instrument still remained the hands of the doctor. In the late 90s, a completely versatile robotic surgical system with remote control was created - the robot surgeon Da Vinci. In surgery, fine motor skills are very important, so accurately reproducing the actions of the hands of the surgeon is an extremely complex engineering task that the developers of the Da Vinci system - the company Intuitive Surgical Inc.

The Da Vinci surgical system

The past 20 years have caused revolutionary changes in surgical technology and technology. A new surgical approach was developed and the approach was called minimally invasive surgery (IIR).

Although IIR surprisingly reduces the operating injury and, accordingly, the length of hospitalization, it has significant technical drawbacks. The surgeon operates using a standard two-dimensional video monitor, instead of looking at his hands. The video makes the natural depth of the operating field flat, and the fixed wrists and instruments limit the motor abilities. Absence of three-dimensional visualization of the operating field, poor ergonomics and controllability are the main limits to further progress. As a result, endoscopic surgery, as a type of IIR, limits its use to a narrow range of surgical interventions.

The revolutionary milestone in the development of surgical techniques was achieved with the advent of the Da Vinci system. It is equipped with manipulators with artificial wrists, which have seven degrees of freedom (similar to the human hand) and three-dimensional intuitive visualization (3D monitor). These innovations have created the prerequisites for minimally invasive implementation of complex operations in various areas of surgery.

The Da Vinci system improves outcomes of surgical treatment, fundamentally changing surgery in three aspects:

1. Simplifying many of the already developed operations:

Many surgical operations performed today using standard techniques can be performed faster and easier with the help of the system, because Da Vinci creates a "survey and sensation" close to open surgery.

2. Making complex minimally invasive operations routine.

3. By making possible new minimally invasive procedures:

A number of operations that could not be performed with the help of traditional minimally invasive technologies can now be done using a surgical complex. A large set of EndoWrist tools allows surgeons to do more operations through small accesses.

The surgical system consists of an ergonomic surgeon's console, a rack with four interactive robotic arms at the operating table, a high-performance InSite review system and proprietary EndoWrist tools. Armed with modern robotic technology, the movements of the surgeon's arms are scaled, filtered and uniformly converted into precise movements of the EndoWrist tools. As a result, an intuitive interface with excellent surgical capabilities is created.

Components of the surgical system

1. Surgeon's console

Using Da Vinci, the surgeon operates, comfortably sitting at the console and seeing a three-dimensional image of the operating field.

The surgeon's fingers grab the handles beneath the display, and the wrists and wrists are naturally aligned with his eyes. The system evenly translates the movements of the fingers, hands and wrists of the surgeon into precise movements of surgical instruments inside the patient in real time.

2. Stand at the operating table

The system rack holds up to four electromechanical hands, manipulating tools. The instruments and camera easily attach to the hands and easily move from the console or assistant.

The first two arms of the robot, corresponding to the right and left hand of the surgeon, hold the EndoWrist tools. The third hand holds the endoscope, allowing the surgeon to easily change, move, zoom in, and rotate the field of view from the console. Such mobility eliminates the need for an assistant.

The fourth hand allows you to add a third EndoWrist tool and perform additional tasks, such as maintaining a continuous seam. This eliminates the need for another assistant.

The surgeon can simultaneously control any two hands with the help of pedals under the console.

3. EndoWrist Tools

Created on the model of the human wrist, EndoWrist instruments have even more movements than a human hand. They really allow the system to advance surgical accuracy and technique beyond the capabilities of the human hand. Similar to human tendons, EndoWrist's internal ropes provide the maximum response, enabling fast and accurate stitching, dissection and manipulation on tissues. A manipulator with a tool at its end has 7 degrees of mobility, like a human hand.

4. InSite review system

The InSite review system with a three-dimensional high resolution endoscope and an image processing system provides a natural image of the operating field. Managed robotic arm endoscope, coupled with two 3-chip cameras, transfers the surgeon "inside" the patient.

The Intuitive Surgical video system is equipped with two independent image transmission channels interfaced with two color high-resolution monitors. The system also has imaging equipment consisting of two video cameras, algorithms for loop amplification and noise reduction.

The resulting three-dimensional high-resolution image is bright, sharp and sharp, without tiring flicker and fading. Control of the camera, carried out through the handles and pedals, provides a smooth movement in the operating space. Moving the surgeon's head on the console does not affect the image quality.

Advantages of using the surgical system before open surgery

1. Improved skill, accuracy and controllability

Da Vinci can give the surgeon better visualization, skill, accuracy and control than in open surgery, when performing surgery in 1-2 cm sections.

2. Excellent ergonomics

Da Vinci is the only surgical system designed to work sitting, which is not only more comfortable, but can also give clinical benefits due to less fatigue of the surgeon. The system provides a natural equalization of the eyes and hands on the surgical console, which provides better ergonomics than traditional laparoscopy. Finally, since robotic arms provide additional mechanical strength, the surgeon can now operate patients with severe obesity.

3. Security

The Da Vinci system reduces the risk of infection of the surgical team with hepatitis, HIV, and the like.

Application of the Da Vinci system

Currently, Da Vinci systems operate in almost 500 surgical clinics around the world. In 2007 Ekaterinburg on the basis of the Sverdlovsk Regional Clinical Hospital N1 opened the first Russian surgical center using this system. Since 2008. The robotic surgical complex is used in the medical-surgical center of. Pirogov. It is planned to gradually equip such systems with state clinical hospitals and medical centers.

Robots are simulators of patients

The leader in the production of robots - the simulators of the patient, is the American company METI (Medical Education Technologies Inc.). Robots created by the company are designed to develop decision-making skills and practical medical interventions in the treatment of pathologies.

Robots-mannequins reproduce the functional features of the cardiovascular, respiratory, excretory systems, and also generate a response to the various actions of students, including. and the introduction of pharmacological drugs. This physiological response is involuntary (automatic) in response to clinical effects. The presence of human physiology in robots is a unique property of these robots, which has no analogues in the world and distinguishes them from all other phantoms and imitators.

So, for example, when IVL1 is performed through an improperly installed endotracheal tube, the stomach of the manikin swells, breathing in the lungs is not audible, cardiac contractions appear on the monitor near the bed, and a frequent pulse is felt on the wrist and at other typical points of arterial pulsation. As the progress of respiratory failure widens the pupils, gradually increases the symptomatology, the patient falls into a coma, death occurs.

Robot simulator HPS Simulator HPS (Human Patient Simulator) - the most functional model of the robot-simulator, possesses a number of unique features of design and functional characteristics that have no analogues in the world.

1. Monitoring

There is a connecting interface for the patient patient with the patient for patients with sick patients for displaying blood pressure, minute cardiac output, ECG and body temperature.

2. Gas exchange

The robot of this version is able to consume oxygen, release carbon dioxide, and also with the option "Anesthesia" to absorb or isolate nitrous oxide and other substances in accordance with the principles of absorption and distribution. The concentration of gases upon exhalation can be measured using a standard anesthetic device for artificial ventilation used in medical practice.

3. Artificial ventilation of lungs

Ventilation of the lungs under different regimes results in a corresponding exhalation of exhaled CO2, which will be displayed on external monitors. Spontaneous, auxiliary or mechanical ventilation can be combined with each other with a corresponding inverse physiological response of the patient, including airway pressure.

4. Eyes

The eyes of the robot are equipped with pupils that react to light. The eyelids open and close depending on the physiology and pharmacology, regardless of whether it is conscious or not. There is a student's reaction to light, which disappears during the "dying" of the patient.

5.Pulse

Pulse is examined on the carotid, humeral, femoral, radial popliteal arteries. The pulse varies automatically depending on the blood pressure.

Physiology. Patient profile

The HPS patient simulator has 30 patient profiles that differ in their physiological characteristics and have individual responses to medications and medical manipulations (a healthy man, a pregnant woman, an elderly patient's chronicle, a child, etc.)

1. Pharmacological Library

In the pharmacological library, more than 50 drugs, including gaseous anesthetics, the possibility of intravenous drugs, and then an automatic dose-response physiological response to the drug administered.

Editing a pharmacological library, adding new tools.

2. Clinical scenarios

The basis for simulation training is computer-based simulated clinical scenarios. They describe the location and condition of the patient, the purpose, the necessary equipment and medications, as well as comments for the instructor in a convenient electronic format.

A simulated clinical scenario is run on the control computer, and during the training the physiological status is automatically changed - depending on the medicine taken or the manipulations performed.

3. Wireless management

The HPS patient simulator comes with a full-featured wireless control computer that allows the instructor to manage all aspects of the learning process directly next to the trainee. The screen and control buttons of the wireless computer are identical in appearance and functionally on the host computer.

25.Occupational Safety and Emergency Safety

The conclusions are included in the general conclusions of the explanatory note of the diploma project.

In accordance with GOST 12.0.003-74, the potential hazardous production and operating factors, the action of which can lead to injury, is analyzed in detail; harmful production (operational) factors causing acute poisoning and occupational diseases in the performance of certain (basic) production operations, which are developed in the technological part of the project. To analyze the possibility of occurrence of emergency situations in man-made accidents, connected with the destruction or depressurization of systems, the reasons of which can be: external mechanical actions; aging of systems (decrease of mechanical strength); violation of the technological regime; mistakes of service personnel; design errors; change in the state of the sealed medium; malfunctions in control, control and safety devices, and the like. This can lead to the appearance of one or a series of shocking factors: a shock wave (the consequences - injuries, the destruction of equipment and structures carrying, etc.); flash of buildings, materials and the like (consequences - thermal burns, loss of strength of structures, etc.); chemical pollution of the environment (consequences - strangulation, poisoning, chemical burns, etc.).

If the task for graduation design is software, the analysis of potential hazardous and harmful production factors is performed for the machine, complex, system, which provides for the implementation of the program.

The unit should detail and fully address the issue of ensuring the safety of the personnel in the production, installation, operation of the design object.

Specific technical and organizational measures to prevent the risk to human beings should be developed on the basis of the analysis of potentially hazardous production factors described in the first subdivision. In this case, it is necessary to calculate the technical means of protecting the staff for the main dangerous factor of production, and also reasoned to prove the need for their use.

Methods to combat the latest potential hazards encountered in the production (operation) of the design object, described as recommendations for the use of certain or other means and methods of protection without calculating their effectiveness. It is necessary to consider norms, technical means and methods of maintenance of electrical safety of service personnel.

Based on the analysis of potentially harmful production factors set out in the first subdivision and, in accordance with the Sanitary norms (SN), the Building Regulations and Rules (SNiP), the System of Safety Standards (SSBT), to propose measures that exclude the action of harmful factors on human health. Describe the microclimate of the production premises, in accordance with GOST 12.1.005-88, indicate the source of "harmfulness", choose (calculate) the system of ventilation or air conditioning, according to SNIP 2.04.05-91. and organization of the workplace. Provide preventive and organizational measures to protect against noise (ultrasound, vibration, etc.) in accordance with GOST 12.1.003-83, GOST 12.1.001-83, GOST 12.1.012-90. Specify the sources of electromagnetic radiation (HF, microwave), as well as the rigid radiation of display screens, to evaluate their intensity, describe methods and means of protection against the action of electromagnetic fields GOST 12.1.006-84. To substantiate in accordance with SNiP Ii-4-79 the choice of lighting (natural, artificial, etc.), norms and lighting systems, types of light sources and used fixtures, ways of their placement.

The unit, it is necessary to characterize the design object in terms of danger in emergencies (fire hazard) in accordance with ONTP 24-86, GOST 12.1.044-89, GOST 12.1.011-78. Such a characteristic is carried out for one of the following cases:

- when making a projected device;

- when operating it (including in conjunction with other devices);

- when developing a new technological process. In this case, it is necessary to identify the potential causes of fire and fire in the technological processes or operation: the presence of combustible substances and materials, indicate indicators of their fire and explosion hazard GOST 12.1.044-89;

- formation (or introduction) of sources of ignition: sparks and arcs of short circuits, sparks at closing and opening of circuits, overheating from prolonged overload and presence of transient resistance, exits of electrical voltage on equipment and construction, heating by induction currents and from dielectric losses, discharges of statistical electricity , the action of atmospheric electricity, and others.

In accordance with the Rules of the device electrical installation (PUE) to classify production facilities and external installations for explosive and fire hazardous zones. According to GOST 12.1.004-91, GOST 12.1.010-76, to determine the systems, methods and means for reducing the fire hazard and explosion hazard. To choose fire extinguishing and fire alarm systems, appearance, quantity, location of primary fire extinguishing means according to GOST 12.4.009-83, taking into account the formation of highly toxic products

combustion with fire (fire) of computer facilities.

The conclusions indicate the main results obtained in the section "Occupational safety and security in emergencies."

1. In case of any accident or emergency, which can lead to an accident and an accident, immediately take all the measures depending on it, preventing the possibility of damage (destruction) of the facility and eliminating the danger to people's lives.

At the same time, report the incident to the master or the immediate supervisor of the work.

2. To avoid accidents, use only serviceable lifting gear.

3. Repair of electrical equipment must be carried out only with the voltage removed,

4. Every worker should be able to provide first aid. Such assistance is immediately, directly at the scene and in the following sequence: first you need to eliminate the source of injury. Assistance should start with the most significant, which threatens health or life: with severe bleeding, apply a tourniquet, and then bandage the wound, if a closed fracture is suspected, a tire is placed; with open fractures, the wound should first be bandaged, and then the tire should be applied; when burns, apply a dry bandage, with frostbite, the affected area should be carefully rubbed using soft or fluffy tissues; in case of electric shock it is necessary to immediately release the victim from the action of the current, namely: turn off the knife switch, cut the wire, pull it back or drop it with a dry stick, pole. Do not touch the victim while he is under the influence of current. If the victim is not breathing, then immediately proceed with heart massage and artificial respiration before the arrival of the doctor.

5. After providing the first pre-medical care, the victim must be sent or taken to the nearest medical institution.

Fire safety.

      Fires cause significant damage to both citizens' property and their health. On average, in Ukraine, 100 fires occur daily, which destroy material values ​​by almost 500 thousand UAH. Every day on fires, 4-6 people die, almost 30 buildings and 2-4 pieces of equipment are destroyed by fire.

The dominant cause of fires is careless handling of fire, almost 57 percent of people who died in a fire are killed for this reason.

The main causes of fires in production are:

careless handling of an open flame during the execution of technological operations - welding, forging and the like;

violation of safety requirements for painting;

violation of the rules of installation and operation of electrical equipment;

violation of the requirements for the storage of waste and chemicals that may spontaneously ignite.

In accordance with the requirements of the Fire Safety Rules in Ukraine, an appropriate fire fighting regime is established at the enterprise, taking into account its fire hazard.

According to the existing rules, workers should: smoke in designated areas, carry out fire-hazardous work in accordance with established procedures; store flammable and flammable substances in a special container; observe the established procedure for the cleaning and storage of combustible dust, waste, rags; be trained and instructed on fire safety.

It must be remembered that in the basement and ground floors the placement of explosive-hazardous production facilities, storage and use of flammable and combustible substances, explosives, gas cylinders, celluloid, combustible film, calcium carbide and other substances and materials that have an increased explosion and fire hazard .

It is not allowed to use lofts, technical floors and premises (including ventilation chambers, switchboards) for production sites, for storage of products.

It is forbidden to clean rooms and wash clothes using gasoline, kerosene and other flammable and combustible substances, scatter and leave untreated oily cleaning materials. They need to be cleaned in metal boxes.

Evacuation routes and exits should be kept free, not forced, doors on evacuation routes should open in the direction of exit from the premises. Staircases, ladders, corridors, walkways and other evacuation routes should have evacuation lighting. It should be remembered that many cases of fires are associated with the use of electrical appliances.

RULES FOR FIRE SAFETY NOT ALLOWED

the operation of cables and wires with damaged or lost protective properties during the operation of insulation;

the use of self-made electrical extension cords;

suspension of lamps directly to conductive wires, wrapping lamps and lamps with paper, cloth or other combustible materials;

storage of combustible materials at a distance of less than 1 meter from electrical equipment;

use of household electric heaters (irons, kettles, boilers and the like) without heat-resistant supports and in places where their use is not provided for by the technological process.

FIRE EXTINGUISHING IS CARRIED OUT:

strong cooling of burning materials with substances that have a high thermal capacity;

isolation of burning materials from atmospheric air (from oxygen of air);

the isolation of burning materials from radiant heat and the direct influence of fire through water curtains, carbon dioxide and the like.

      To extinguish the fire, you can use water, steam, foam, carbon dioxide and inert gases, special powder, sand and bedspreads. To ensure greater efficiency in the extinguishing of fire, various fire extinguishing agents are used. These include simple means - buckets and water-pumps for water, boxes with sand and shovels, various blankets (from asbestos, felt and the like); chemical methods - fire extinguishers; technical methods - special fire engines. Fire panels (stands) are installed on the territory of the facility at the rate of one shield (stand) per area up to 5000 m2.

Such boards should be equipped with:

a box of sand - 1 pc.

a cover made of non-flammable thermal insulation material or felt of 2 m х 2 m - 1 pc;

shovels - 2 pieces;

with crowbars - 2 pcs .;

axes - 2 pieces;

fire extinguishers - 3 pcs.

The choice of the type of fire extinguisher depends on the fire-extinguishing ability, the maximum area, the class of fire of combustible substances and materials.

ACTION IN THE CASE OF FIRE.

In case of detection of a fire (signs of burning) it is necessary:

immediately inform about this by telephone number 01 in the fire department. At the same time, it is necessary to name the place of occurrence of a fire, the situation on the fire, the presence of people, and also to report their surname;

report it to the head or relevant competent officer or duty officer for the facility;

THIS PERSON SHOULD:

in case of need, call other emergency services (medical, gas emergency and the like);

in the event of a threat to the lives of people, immediately organize their rescue (evacuation), using the available forces and means for this;

remove outside the danger zone of all workers not related to the liquidation of the fire;

stop work in the building (if this is allowed by the technological process of production), except for works connected with the liquidation of a fire;

disconnect, if necessary, electricity (with the exception of fire protection systems), stop transporting devices, units, apparatus, cut off raw gas, steam and water communications, disconnect ventilation systems in emergency and adjacent rooms (with the exception of smoke protection devices) and perform other activities that will help prevent the development of fire and smoke building;

check the inclusion of a system to alert people about a fire, fire extinguishing systems, anti-smoke protection;

organize a meeting of fire protection units, provide them with assistance in choosing the shortest road for access to the site of a fire and for an installation to connect to water sources;

synchronously with the fire extinguishing to organize evacuation and protection of material values;

To ensure the observance of safety measures by workers who take part in extinguishing a fire.

First aid to the victims.

1. AT POISONINGS

      In severe cases, cramps and loss of consciousness are possible. In this condition, the victim must ensure free access to fresh air, unfasten clothing that hampers breathing, and if unconscious, call a doctor. It is necessary to know that loss of consciousness occurs as a result of a sudden outflow of blood from the head. Therefore, to the arrival of the doctor of the victim put so that the head was below the trunk - thus creating a flow of blood to the head. During the loss of consciousness, they give a sniff of ammonia, but in no case put a cold compress on your head.

Do not allow the victim to drink water, because in this state, the ability to swallow is broken, and water can get into the respiratory tract.

When breathing is stopped, artificial respiration should be given immediately.

2. BURNS

      A burn is tissue damage caused by the action of a flame, steam, boiling liquids, hot or molten metals, concentrated acids, alkalis, radioactive irradiation, etc., on the body. Burns are divided into: thermal, chemical, alkaline.

There are burns of four degrees. The 1st degree burn is accompanied by redness and swelling of the skin, burning pain on the damaged area. Burn 2 degrees - is characterized by the appearance on the reddened skin of blisters of various sizes, filled with a clear or slightly turbid liquid, intense pain. With burns of 3 degrees there is a deep damage to the skin, the patient feels a sharp pain. On the skin a solid scab forms, which covers the area of ​​dead tissue.

The most severe are burns of the 4th degree, in which the skin, muscles, tendons are damaged. Sometimes they are charred.

Burns that occupy more than 10% of the body surface are usually accompanied by a violation of the general condition of the victim - shock. The patient is restless, complains of severe pain, asks to drink. Pulse is accelerated (up to 100 - 120 beats per minute), rapid breathing, rapid. As a result of absorption of the decomposition products of damaged tissues, poisoning of the body quickly occurs, which is characterized by apathy, despondency, vomiting, and acceleration of the pulse.

The victim first of all needs to be quickly removed from the danger zone, put out his clothes with a fire extinguisher, water or cloth - a cover, a tarpaulin, a blanket, a coat and the like. The flame from clothes can be brought down, having pressed the victim to the ground, a road surface. Clothes that smolder, you need to carefully remove, pre-cut or torn. Parts of clothes that are stuck to the surface of the burn can not be torn off, because it can cause severe pain and worsen the condition of the victim. With limited burns of 1 degree, the burned area is wiped off with alcohol or cologne, and then a sterile bandage is applied on it.

Blisters that appeared on the skin can not be ripped apart, it is enough to treat them with alcohol and apply a sterile bandage to the affected area. If the area of ​​damage is large, you need to wrap the victim in a clean sheet, wrap up a blanket or other warm things. On the face of a bandage to impose it is not necessary, it is enough to cover it from a dust a sterile napkin.

Do not touch the hands or dirty objects of the wound, as it will fester after the contamination and slowly heal.

For burns of the first degree, the burnt skin should be cleaned with clean cold water and moisten the affected area with alcohol, vodka, cologne or a weak solution of potassium permanganate, and then apply a dry sterile bandage. In case of eye burns caused by exposure to an electric arc, cold lotions (2% boric acid solution) should be applied to the eyes and immediately consult a doctor.

If the burn is caused by chemicals, the burned areas of the body should be filled with cold water. With a burn caused by acids, apply a bandage soaked in a solution of baking soda (1 teaspoon per 1 glass of water). In case of alkali burns, apply a bandage impregnated with a solution of vinegar or boric acid (1 teaspoon per 1 glass of water).

Second-degree burns require the use of a dry sterile bandage. You can cover the damaged area with a bandage and send the victim to the hospital.

In the case of third and fourth degree burns, the victim must be rushed to a medical facility.

3. WITH THERMAL CURRENT

Thermal shock is a serious, sometimes life-threatening condition caused by overheating of the body. Its characteristic signs: headache, fainting, nausea, sudden weakness, vomiting, tinnitus, confusion, weak pulse, rapid acceleration of breathing, palpitation, drowsiness, hot skin, and sometimes sudden loss of consciousness and convulsions. In case of a sudden heat stroke, the victim must be dragged to fresh air, put in a shade, unfastened clothing, which prevents breathing, drink salted cold water, cool the body, moisturize the head and chest and create air around it.

To stimulate the victim's breathing, they slap on the face with a damp towel and allow them to inhale ammonia.

4. When the ligaments are stretched, accompanied by sharp pain in the joint and the appearance of the tumor, it is necessary to tightly tie the joint and create peace of mind for the victim.

5. UNDER STR.

The blows are also accompanied by pain. To reduce it and reduce hemorrhage, you should immediately use cold; replace the affected area under a stream of cold water or attach ice, snow, etc. In case of severe impacts, consult a doctor.

LEVEL LEVELS

A cold compress is used on the vyvorennom joint. Movement of the injured limb should be limited by the use of a fixative bandage or a tire. If there are wounds or bruises, apply a bandage. Dislocation does not send, but call a doctor.

7. WITH PROCESSING.

Signs of fracture - acute pain when pressing a damaged limb at one or another point, impairing mobility and changing the shape of the damaged part of the body at the site of the fracture, the impossibility of moving the injured limb. If the ribs are broken, it is a pain with a deep breath or a cough. Fractures are divided into open and closed. With an open fracture, the skin around the wound is smeared with iodine tincture, and a sterile cotton-gauze bandage is applied to the wound. You can not try to correct fractures on your own. It is necessary to ensure complete peace, the property of the damaged bone.

On the surface of the broken limb, put on a tire of solid material (flat plywood, poles, boards, etc.). The length of the tire should be such that it passes through these two joints of the limb, between which a fracture occurred. The tire is tied to a broken limb with a bandage, rope or belt. Carry the victim on a stretcher.

8. INSTITUTIONS.

In the event of injury, first of all, it is necessary to stop bleeding. If the wound is small, then enough bandages. If a large artery of the limb is damaged (blood from the wound follows an intermittent flow or fountain), then a rubber flagella is placed over the wound, which is wound around the limbus two, three times and tied. The turnstile is applied no more than 1.5 hours. If the vein is damaged (blood flows and has a dark red color), an embossed antiseptic dressing should be applied to the bleeding site, and if this does not help, the tourniquet is under the wound.

9. IN ELECTRIC SHOCK.

      First of all, free the victim from the effects of current. Unplug the switch or unscrew the fuses. If this is not possible, pull the wire with a dry wooden stick or pull the victim off, using dielectric gloves or improvised insulating means: dry rope, stick, board, etc.

If the victim has just come to consciousness, he must be laid before the arrival of the doctor to ensure complete peace without interruption observing the breathing and pulse. You can not let him move, because the absence of severe symptoms after an electric shock does not exclude the possibility of subsequent deterioration of health. If the victim is unconscious, but has even breathing and pulse, he should be put to unbutton his clothes, create an influx of fresh air, give sniffs of ammonia, and sprinkle with water. If the victim is unconscious, and his breathing is rare and convulsive, or he does not breathe at all and he can not feel the pulse, it is necessary immediately to proceed to artificial respiration and massage of the heart, removing the interfering clothing before it. Artificial respiration continues until it becomes clear that death has occurred. In all cases of electric shock it is necessary to urgently call a doctor or deliver the victim, after first aid, to a medical institution.

Artificial respiration is recommended only if the victim is not breathing or breathing is rare, convulsive, and also if breathing gradually deteriorates.

If the victim has no pulse, it is necessary to carry out an external massage of the heart synchronously with artificial respiration.

10. INJURY BY THE FRONT AND AMMONIA.

When poisoning with ammonia or freon vapor, the victim should be taken to fresh air or to a clean warm room. If necessary, immediately apply artificial respiration.

It is necessary to release the victim from the shortness of breath clothes, change contaminated clothing and give him complete peace. Carry out inhalation with a warm steam containing 1-2% citric acid solution (from a kettle through a paper tube).

Give a drink strong sweet tea, coffee, lemonade or 3% lactic acid solution.

It is recommended in all cases of poisoning inhalation of oxygen for 30-45 minutes, warming of the victim (cover with heaters).

Care should be taken in case of deep sleep and possible reduction of pain sensitivity, so as not to cause burns.

In the presence of the phenomena of irritation it is necessary to rinse the nose, pharynx with 2% solution of soda or water. Regardless of the condition of the victim, he must be referred to the doctor.

List of sources used

1.Vision sistem desing

2.www.visionsistems.com.

3.www.alysium.com

4.www.qut.com

5. www. fotonation.com

6. [www.pi-usa.us](http://www.pi-usa.us/)

7. [www.opto-engineering.com](http://www.opto-engineering.com/)

8. [www.keyence.com](http://www.keyence.com/)

9. [www.alliedvision.com](http://www.alliedvision.com/)

10. [www.gtk.org](http://www.gtk.org/)

11. [www.sony](http://www.sony/). com

12. [www.baslerweb.com](http://www.baslerweb.com/)

13. [www.toradex.com](http://www.toradex.com/)

14. [www.baslerweb.com](http://www.baslerweb.com/)

15. [www.bosch-apas.com](http://www.bosch-apas.com/)