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## **Machine Vision Enables to Increase Effectiveness of Technical Equipment**

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### **Abstract**

The article deals with possibilities of machine vision used mostly at production process. It calls attention to possibilities how to increase essentially an effectiveness and a productivity at many fields of production process and possibilities of cooperation between production facilities and a human or by complete substitution of human.

**Keywords:** machine vision, camera, production process, automation

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### **Introduction**

At present, a production is continuously increasing even though absence of manpower at lot of spheres. This trend will be enlarged under authority of worse prognosis of demography of population. This is reason why machine vision has to be developed. Machine vision is using different principles, various systems for alternative exploitations. This is the way how can be ensured so that machines were able to “see” components with which machines are working, as well as to brighten visual picture for people who realize different kind of production activities.

### **A digital camera – visual sensor**

A digital camera is electronic device able to create snapshots of selected object with high speed one after another. People are using eyes for visual sense, but visual sensor of technical systems is a digital camera on the present. A frequency of camera sensing depends on speed of sensed action. A specification of speed of sensing is important from point of view of technical quality of pictures but also of a price that increases rapidly with frequency of sensing. Important parts of a camera that have impact on quality of resulting picture are: a picture sensor, an optical system and output ports. An optical system provides that light illuminates light sensitive surface of image sensor with required quality. A light reflected from objects in field of vision of a camera is transformed into electrical signal into picture sensor.

Most used technologies of visual sensors are CCD and CMOS, on the present. It is surface semiconductor structure that accumulates electrical charge which is proportional to incident radiation – incident radiation originates electrical charge into each cell of sensor. An intensity of a charge into separate cells is adequate to distribution of optical radiation of scanned area.

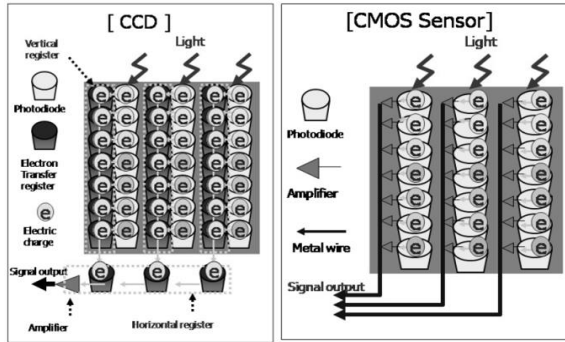


Figure 1. A principle of CCD and CMOS sensors

Source: Internet 1.

Video metric systems are divided:

- Camera system with processing of visual information by PC – external camera is connected with PC by communication interface.
- Compact video metric system – it consists from unit of visual information processing (independent from PC) and externally connected camera. Visual information is processed in external cell (multichip processor is used in case of data-intensive application).
- Intelligent camera – interconnection of camera and processor of video processing into one unit. Systems are computing less powerful in comparison with compact systems of machine vision, but its advantage is simpler solution by application aspect.



Figure 2. Examples of camera systems

Source: Internet 2, 3.

From point of view of visual information processing is the most powerful topology with parallel processing – it consists from multiple in parallel working Digital Signal Processor (DSP) and Central Processor Unit (CPU). Such connection is processing one problem complexly, if necessary it process more separate computations of visual characteristics.



**Figure 3. Visual sensor and compact type of camera construction for industrial production**

Source: Internet 4, 5.

Except high quality of video processing in real time, important are: proportions, weight, compactness, robustness of cameras as well. The reason is – using of cameras in production process with vibes, dustiness, air pollutants, and other negative conditions during proceeding.

### **A lightning system**

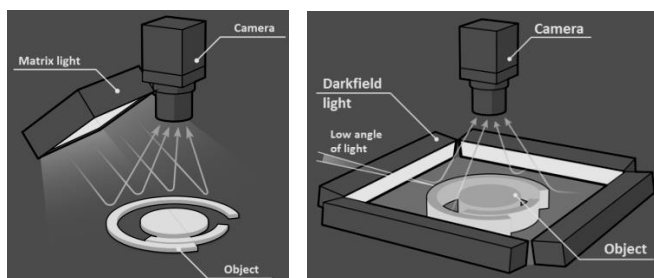
A lightning system is important part of camera system, its main role is to obtain maximal contrast of parts of measured object that are required in opposite to parts that are not in interest of measurement. A contrast of required part of measured object is possible to originate by two ways:

- Exploitation of different absorption.
- Exploitation of brightness difference.

A light that illuminates examined object is divided into some parts:

- Part of light is glanced off.
- Part of light originates emission of secondary radiation in material of examined object.
- Part of light goes through object.

Each part of light can be used in machine vision. Interaction of light with examined object depends on colour of object and wave-length of light. Different kinds of illumination shown in Figure 4 are used because of it. There are different disturbing sources of light in real industrial area that influence scanning of measured objects. This is reason why systems for optical measurement have adapted input – output ports because of to synchronize lightning with snapshot.



**Figure 4. Examples of illumination of scanned objects**

Source: Internet 6.

Illuminating systems that are more times powerful are used to eliminate disturbing source of light. Illuminating system is switched on synchronously only during time of scanning. High quality hardware of visual system has to cooperate with powerful software.

Software of camera systems can be divided into two basic groups:

- Intelligent camera – it has internally implemented software.
- Software that enables creation of custom applications in PC, for machine vision.

Different algorithms are used to process scans, for example: Fourier analysis, brightness image transformations, filtrations, arithmetic operations with image information, comparison of scan with paradigm, comparison of coordinates, detection of edges, etc.

Visual scanning systems find use at different spheres of production process on the present and their applications are continuously expanded by other methods of processing and using, hardly imaginable until now. Inspection camera systems are used for inspection of products at production process. Major task of these systems is to produce record by which will be determined qualitative parameters of measured object by optimal algorithms. For example: in electrical and electronic industry, machine vision serves in production process of printed circuits and their embed by electronic components:

- Inspected conductive paths on printed circuit have to satisfy required parameters that are verified by parameters predetermined by software.
- In the process of printed circuit embed by electronic component are verified their position, rotation, quality of soldered surface.

2D systems were used initially. 3D systems, used on the present, enable to receive many more information and by this way more exact picture about state of inspected object. Looking at object is possible to rotate and enlarge at real time on the present. 3D inspection, by its attributes, classifies detected error – this is important information for service personnel and enables to make optimal problem solving to personnel.

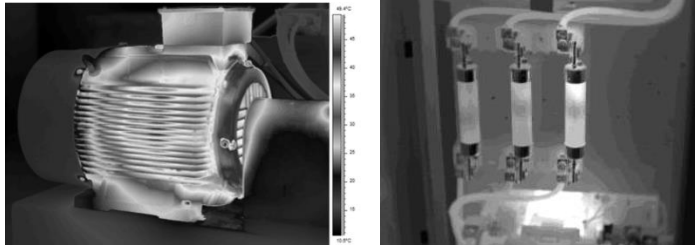
## **A machine vision**

A machine vision is preferred by industrial systems that process visual information from camera automatically – on the basis of that information system can for example: to eliminate incorrect piece, to signalize to operating personnel, to review quantity, etc. A machine vision enables massive application of automation systems which increase effectiveness and savings in production processes on the base of early detected of incorrect products. The system is able to communicate with other systems, with control system of production process and by this to react to disagreement in production process. The machine vision system is more unfailing and precise then human eye. A measurement is contactless – there is not needed intervention into a product to evaluate it. Standard tasks of machine vision are for example:

- Measurement and inspection of dimensions of products on base of required dimensions and permitted tolerance.
- Inspection of surface defects of product is frequently realized inside inspection of quality of the product – detection of splits, holes, different contaminations and surface modifications. Errors that have to be detected by machine vision system inspection are often indistinct and on the border of visibility for human eye – this is reason why quality of image is very important.
- Identification of components on assembling lines, each component separately before mounting – their correct position and orientation. Colour components can be identified by colour camera. Completeness of product and number of all components can be inspected after mounting.
- Localization of object in 2D and 3D space and consecutive guidance of operating robot for proper gripping of component and its fitting to appropriate position inside produced product.
- After production process – defects incurred in production process, incorrect mounting of components or incompleteness of product are inspected.

An automobile industry features by mass production, high requirements to quality and sensitiveness to production costs. This is reason why machine vision is one of key technologies for an automobile industry – a machine vision can be used to optimize processes as production process and assurance of quality. It is exploited to high speed and definite detection of objects, so it is assumption of full automation for complete acceleration of production processes. Number of robots that use their own camera system is increasing continuously, because machine vision enables optimization of processes. A technology of machine vision enables to identify exact location of objects, their orientation and velocity in space. The camera system can be situated on arm of the robot, what opens possibility of interaction between peoples and machines in automated production processes.

Thermo vision helps in many situations – it enables non-destructive diagnostics from point of view of object temperature without interfere into continuousness of process, with precise  $\pm 1^{\circ}\text{C}$  at big scale of temperature. Real picture of scanned object can be observed visually and simultaneously processed as analysis of infra red energy emit by measured object. Thermal radiation can be scanned by big amount of sensors in viewing field of detector of thermo vision camera by which is created temperature image of the object – the thermo gram (Figure 5).



**Figure 5. Examples of thermo gram using to recognize the thermal state of objects**

Source: Internet 7, 8.

Different intensity of infra red radiation, that is adequate to different temperature of separate parts of object, has its colour for temperature imaging.

## Conclusion

The development of production process and automation depends on exploiting of visual sensors and complex software processing of visual information in real time. The exploitation of different kind of sensors that use different principles enables to substitute workers and to increase quality of optical information evaluation when human vision is not able to do it. This is reason why it is necessary further to study and to develop sphere of machine vision as integral part of automation within the frame of Industry 4.0.

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