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OVERVIEW OF COMPUTER VISION AREAS APPLICATION FOR INSPECTION AND QUALITY CONTROL

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In today's world, computer vision is becoming integral part of production processes. It provides the ability to automate inspection and quality control, which increases productivity, reduces scrap and minimizes human factor. For specialists in field of automation and computer-integrated technologies and robotics, research and implementation of computer vision is promising area.

Modern production requires not only high speed of production, but also impeccable quality [1-7]. The use of computer vision to control quality of parts on production assembly lines makes it possible to automate inspections, ensure consistent quality and reduce manual labor costs (Fig. 1). Such system allows you to inspect parts in real time and identify defects at initial stages of production cycle.

The computer vision system on assembly line consists of high-resolution cameras, light sources, and image processing software. When part passes in front of camera, system receives image, processes it and analyzes it according to specified quality parameters. If defect is detected, system can send signal to stop conveyor, sort defect or reject it.

Surface defect detection is integral function of computer vision, which allows you to detect scratches, cracks, stains and other defects on surface of part. The system analyzes texture, color, and shape, comparing them with reference parameters. For example, scratches can be recognized by analyzing surface structure, and color changes by comparing them with basic color references.

Some parts have strict dimensional and geometric parameters. Cameras can capture deviations from set dimensions in real time by measuring length, width,

thickness, or angle of part. For example, computer vision system can measure hole diameters or distance between individual parts of part with micron accuracy.



Figure 1 – Computer-Aided Manufacturing

At stages where parts have to be assembled into one module, computer vision can control correct assembly. This is important when parts are made up of numerous elements, and their proper placement is crucial. For example, system can determine whether all components are in place and whether their location matches the drawings.

Computer vision can perform an analysis of shape of part, detecting any deviations in symmetry or contours. This is important for parts that must have strictly symmetrical shape or certain contours. For example, to detect axis curvature or deformation of rims on parts (Fig. 2).

To implement quality control on production conveyors using computer vision, number of technical solutions and algorithms are used to achieve high accuracy and reliability when checking parts [8]. Among main methods, pattern comparison methods stand out, when image of the part is compared with reference pattern, which makes it possible to quickly detect deviations from norm. Color and texture analysis algorithms are also widely used, which are able to recognize even small changes in structure or shades of surface of part, which may indicate presence of defects.



Figure 2 – Example of computer vision in manufacturing

In cases where shape and geometry control is critical, 3D scanning is used, which involves creating three-dimensional model of object using stereo cameras or laser scanning, so that shape of parts can be accurately checked. In addition, one of promising areas is use of machine learning algorithms, in particular neural networks, which can be trained to recognize certain types of defects [9]. These algorithms allow system to adapt to changes in production process and find even those defects that have not been encountered before. Thanks to combination of these technologies, computer vision becomes universal tool that significantly improves quality and efficiency of control in production.

The use of computer vision on conveyor lines ensures high accuracy and speed of part inspection, which is especially important for high-speed production. The system allows you to consistently maintain same level of product quality, avoiding influence of human factor, fatigue or subjective assessments, which makes quality control more reliable and predictable. Computer vision detects defects at early stage, which reduces the amount of defects and saves resources due to rapid rejection of mismatched parts. In addition, system integrates seamlessly with other manufacturing solutions such as ERP and MES, allowing quality data to be automatically transferred to databases for further analysis or reporting. Overall, computer vision on assembly line helps to improve production efficiency, reduce quality control costs, and increase the reliability of all manufacturing processes.

The use of artificial intelligence (AI) and machine learning in computer vision systems significantly increases their accuracy and adaptability: self-learning and adaptability, deep learning, image segmentation and classification, big data analysis. The relevance of Big Data is growing in modern production due to need to process and analyze large amounts of information coming from various sources – sensors, cameras, IoT devices, etc. [10].

Thus, in today's manufacturing environment, where every part must meet high quality standards, computer vision technologies open up new possibilities for automation and control. The computer vision system on assembly line allows you to quickly and accurately inspect products without interruption, ensuring that every part meets established quality criteria. This reduces production costs, as number of defects is reduced, and at same time optimizes inspection time. Continuous quality control ensures company's competitiveness in market and increases customer confidence in products. That is why computer vision technologies are increasingly becoming key element of modern production processes and are important area for further research and improvement.

Computer vision on assembly lines is powerful quality control tool that allows manufacturers to achieve high levels of reliability and accuracy. The implementation of this technology promotes automation, reduces production costs, and increases overall production efficiency. For specialists in automation and computer-integrated technologies, development and application of computer vision systems opens up new opportunities in professional growth and research.

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