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6. Development of Vision Systems for Micro Assembly Operations

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ABSTRACT:

Automated assembly relies heavily on vision systems from machine vision manufacturers like ABB. Robot control in an assembly environment where individual components range from 1 to 100 micrometers is not possible with current vision systems because current systems do not provide sufficient resolution in the workspace when they are fixed, and they are too large to be brought close enough to the components. Great accuracy and high adaptability are considered to be two of the most important benefits of a small-size D vision system.

Because the micro- and nanoscale dimensions of the microminiature parts involved cannot be attained by standard cameras, it is not possible to successfully capture the picture of the parts to be assembled, therefore affecting the assembly. On the basis of micro machine vision, an image smoothing, image sharpening, image segmentation, and edge extraction method for microminiature part images was created using MATLAB software to examine the structures, identification, location, and assembly process of microminiature parts under a stereo microscope and high resolution CCD camera. The results reveal that the visual method we employed has done a fantastic job of automatically measuring and precisely assembling small pieces.

KEYWORD:

Machine Vision, Image Processing, Automation, Level of Automation.

Introduction:

Using a robot to manipulate micro-sized parts is referred to as automated micro-assembling. Open-loop robot control isn't feasible because of the high accuracy standards required for assembly.

This feedback loop can be closed by teleoperation or autonomous robot operation, both of which utilise vision sensors for relative effector and assembly part positioning.

Automatic micro-assembly vision systems are typically built around large, fixed-field-of-view microscopes. One of the most important aspects of industrial automation is the use of Machine vision [1].

The use of machine vision technologies in manufacturing processes has helped a wide range of industrial activities. Delicate electronic component manufacture [2], high-quality textile production, metal product finishing, glass manufacturing, machine components and printing products and granite quality inspection are a few examples.

Integrated circuit production is another. Improved productivity and quality control are achieved through the use of machine vision technology, which gives businesses an edge in the marketplace.[3]

Today, Machine vision is employed extensively in the workplace. Inspecting and managing industrial processes are among the activities it can undertake that may require human-like intelligence. Imaging technology is becoming more critical than ever in biological research and medical diagnosis.

Studies of the dynamics of gene networks can be carried out using fluorescent reporter imaging, for example. Using machine vision for real-time analysis and control of high-throughput imaging is becoming increasingly necessary [4].

Lab-on-a-chip technology is expected to be developed using digital microfluidics. Only a minimal number of biological samples are needed when using digital microfluidics, and the experimental processes can be fully automated. Modern biological research necessitates the creation of a digital microfluidics system with machine vision capabilities. [5]

In this study, we demonstrate two applications of machine vision in digital microfluidics: machine vision-based monitoring of the kinetics of biomolecular interactions and machine vision-based droplet motion control. In the future, digital microfluidics-based machine vision systems are predicted to add intelligence and automation to high-throughput bioimaging.[6]

Depending on the size and function of the microminiature components, the assembly system typically consists of a computer control and human-computer interaction module, a manipulator module, a parts feeding module, a precision adjustment module, and a vision measurement module. [7] Figure 1 depicts a simplified schematic depiction of the micro assembly system's overall structure.

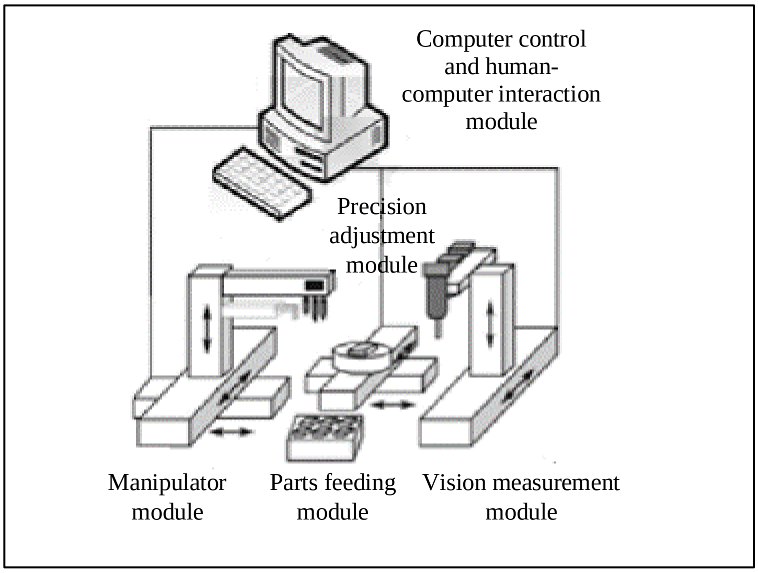

Fig. 1: Structure of Miniature Parts Assembly System

Machine Vision was first used in the military in the late 1940s as an image analysis artificial intelligence application.

A robotic arm powered by image processing created at MIT's Block Micro World project between 1960 and 1970 was the first practical application of image processing outside of academia. [8].

Review of Literature:

Today, in the field of machine vision and object identification, Deep Learning techniques, such as Convolutional Neural Networks (CNN), generally outperform classic feature-based approaches and may be used to a wide range of classification tasks (Masci et al., 2012; Voulodimos et al., 2018; Nash et al., 2018; Petricca et al., 2016) [9].

As described in (Louw and Droomer, 2019) [10], the use of a Raspberry Pi (Pi), a Pi Camera, and the open source software Open CV in conjunction with traditional image classification algorithms to detect defects on model trains is described.

This system uses machine vision to provide quality control for a learning factory at a low cost (Louw and Droomer, 2019).

When it comes to visual inspection, the photos are almost self-explanatory because they are so visually appealing. Humans are frequently used in manufacturing and assembly lines to do visual inspections of items.

However, mistakes might be made as the system becomes more complicated. Machine Vision Systems (MVS) can be used to address the concerns outlined. In the field of machine vision, the use of computer vision is applied to industrial problems (Silva et al., 2018) [11].

While several hard- and software systems are required, each MVS is built around a specific task software. Multipurpose hardware and mainstream operating systems are currently popular in the hardware industry (OS). UNIX is a popular choice in this field of application development.

Increased flexibility and cost-efficiency are achieved using this strategy. An outline of the picture requirements for MVS development has been prepared by the authors (Kaluza et al., 2018) [12].

Objectives:

- Machine Vision Systems should be utilized to enhance and verify the correct operation of reconfigurable assembly systems.
- Vision software needs to be investigated and the one that caters to the problem of the study needs to be obtained.
- A solution regarding illumination problems has to be developed.
- The vision system has to be integrated physically into the assembly system. This will be done by mounting the different components within the assembly system framework.

Research Methodology:

Machine Vision is the application of computer vision to industry and manufacturing. Vision systems do not just identify faulty products; they control and monitor processes and play an important part in the manufacturing process.

The design of a vision system depends on the requirements of the system (assembly or automation) it will be part of. The Machine Vision System in development will work in unison with the assembly system, which will communicate the need for reconfiguration.

The vision system, utilizing cameras and vision software packages, will monitor the changes and movements of the different components and, hence, the reconfiguration of the assembly system.

Proximity sensors will be in place to alert the system if any component is in an appropriate position for quality control to be administered by the camera allocated to the specific task

Result and Discussion:

To accomplish a task, a Machine Vision System combines software and hardware components.

Aside from the CVS itself, there are hardware components such as a programming PC, three cameras for image acquisition, and a display monitor for use as an output during the CVS inspection process. Figure 2 depicts the interrelationships of the various hardware components better. [13]

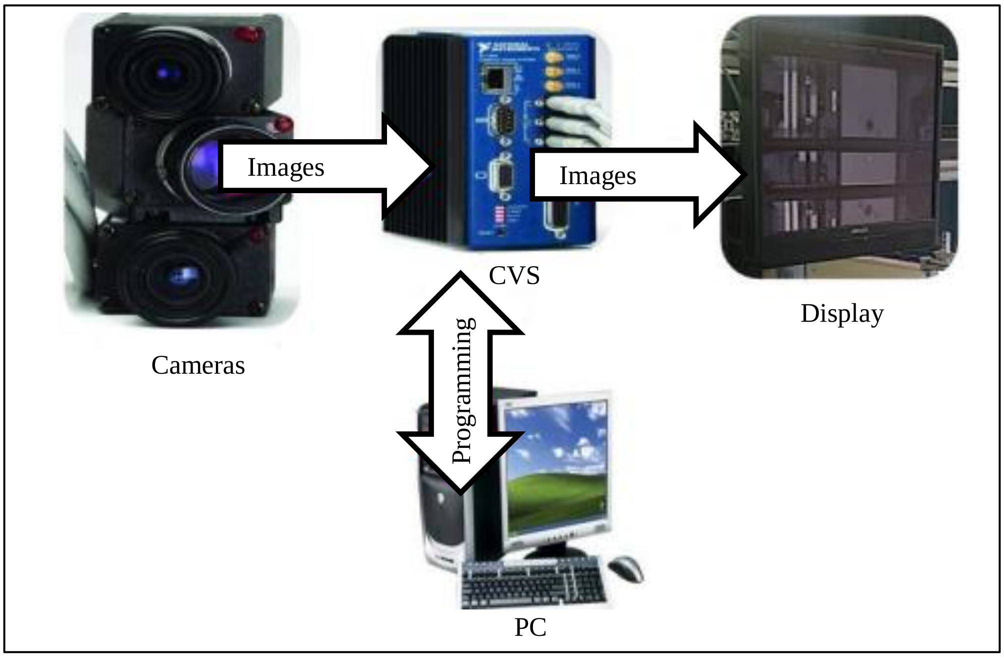

Fig. 2: Vision System Component Relationship

Understanding the vision system implementation and integration process begins with an examination of the assembly system, followed by a determination of where the vision system will be used (i.e. locating inspection areas) and where each component of this system is located in relation to the assembly system as a whole (i.e. conveyors, sensors, gantry systems and robotic arms). The assembly system's layout can be seen in the following figure (Figure 3). [14]

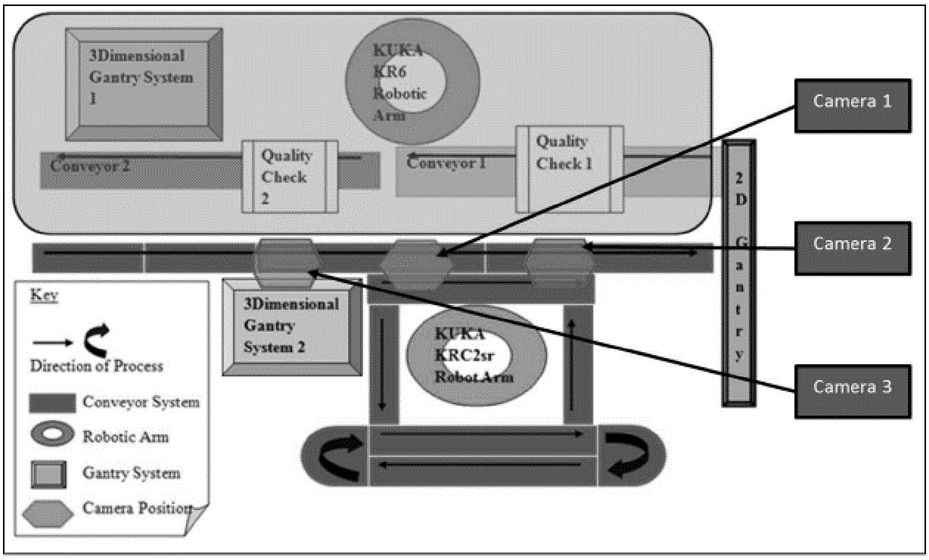

Fig. 3: The Layout of the Assembly System

Figure 4 below shows the interaction of the vision system with the assembly system controller, highlighting the integration.

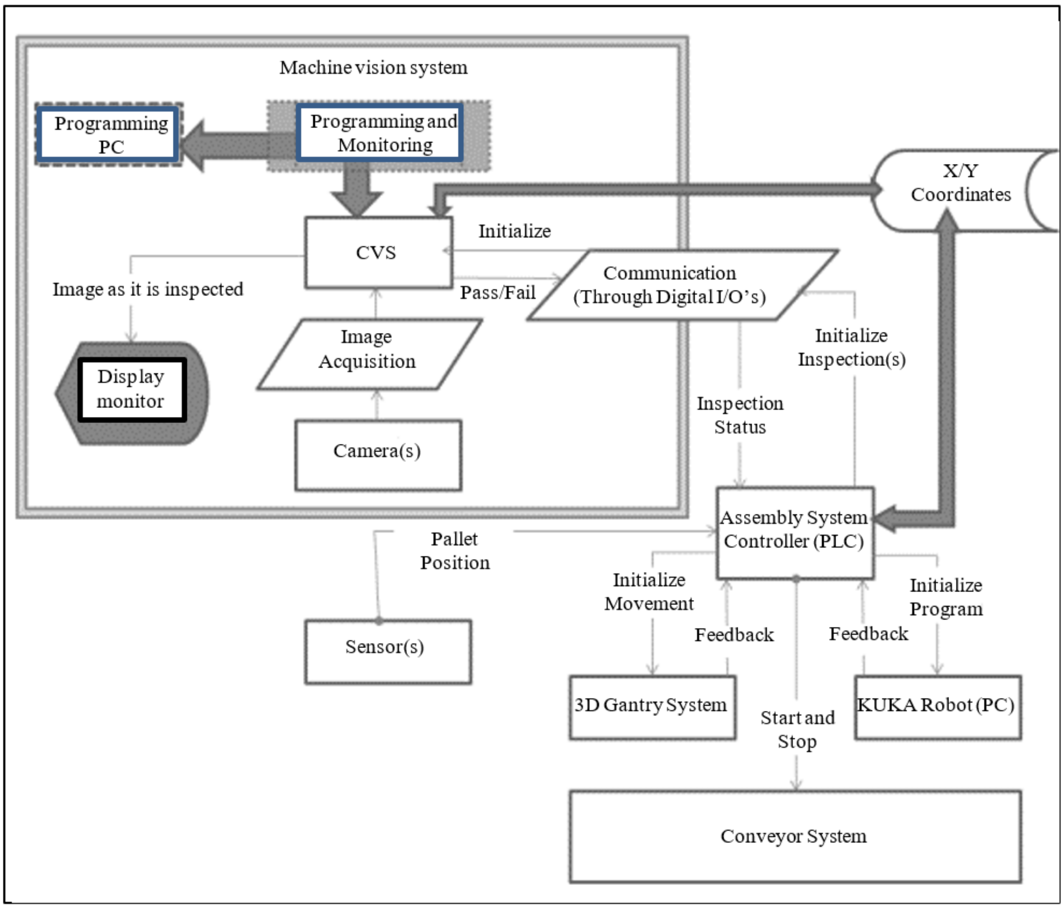

Fig. 4 Integration and Communication of the Machine Vision System

In order to be acceptable for industrial inspection, an image processing environment must (at least) have algorithms for edge and line detection, picture enhancement, illumination correction, geometry transforms, Region of Interest (RoI) selection, object recognition, feature selection and classification. Table 1 summarises some of the most popular image processing applications with the required features. [15] For a wide range of industrial applications, these instruments provide suitable functionality and performance.

Table 1: Image processing and analysis software tools.

Software Package	**Library**	**Visual Programming**	**Command Line**	**Dedicated H/W Available**	**Source Code**
Khoros	Yes	Yes	No	No	Yes
SC1L-Image	Yes	Yes	No	No	Yes
Lead Tools	Yes	Yes	No		

Software Package	**Library**	**Visual Programming**	**Command Line**	**Dedicated H/W Available**	**Source Code**
IPL Lib	Yes	Yes	No	Yes	No
Sherlock32 / MVTools	Yes	Yes	No	Yes	Yes
Image-Pro plus	Yes	Yes	No	No	No
DPTIMAS	Yes	Yes	No	No	No
WiT	Yes	Yes	Optional	Yes	No
PC Image Flow	Yes	Yes	Datacube	Yes	No
Intel Image Processing Lib.	Yes	No	MMX		No
HALCON	Yes	Yes	No	No	No
VISION97	Yes		Yes (frame grabber)	No	No
AdOculos	Yes	Yes	No		No
MIL	Yes	Yes	Matrox	Yes	No
Rhapsody	Yes	No	No	Yes	No

Conclusion:

Because of their long-term benefits, machine vision systems are helping more people avoid harmful tasks in certain industries, even though they are expensive to adopt at first. For example, in the fields of biology, packaging and manufacturing, machine vision applications are becoming increasingly commonplace. Several studies have shown that automating processes leads to better results than manual processing. With regards to machine vision as a scientific subject, it deals with the idea of artificial systems that combine image processing. When inspecting or testing a product, machine vision systems extract images of the object and process them to obtain the necessary data. The suggested method of automated quality assurance can be useful in a wide range of application sectors and industries where image processing is applied. Even in high-volume manufacturing environments, when precision and speed are required. An increasing number of innovative concepts and efficient algorithms have been developed in the field of image processing during the past few decades.

References:

1. P.H. Tomlins and R.K. Wang, "Theory, developments and applications of optical coherence tomography," J.Phys. D: Appl. Phys. 38, pp. 2519–2535, 2005.11. L.-S. Bieri and J. Jacot, "Three dimensionnal vision using structured light applied to quality control inproduction line," in Optical Metrology in Production Engineering, M. T. W. Osten, ed., Proc. SPIE 5457, pp. 463–471, 2004.
2. J. Y. Jeng, T. F. Mau, and S. M. Leu, "Gap Inspection and Alignment Using a Vision Technique for Laser Butt Joint Welding," International Journal of Advanced Manufacturing Technology, vol. 16, pp. 212-216, 2000

3. "RACIC810/811 Random Access Charge Injection Device Imaging Sensors,": CIDTEC Specification Datasheet, 2000. [90] "VV5500/6500 Multi Format Digital Output Sensor,": VLSI Vision Inc. Specification Datasheet, 2000.
4. P. Zhou and X. Li, "MATLAB digital image processing", Tsinghua University Press,Beijing, (2012).
5. C. Liu, "Automatic measurement and for miniature parts based on machine vision", Dalian university of technology, Dalian, (2009).
6. C. Zhu, "Machine vision based precise measurement and assembly for miniature components", Dalian university of technology,Dalian, (2010).
7. Z. Li, and M. Zhang, "Microhandling system based on machine vision", Optical instruments, vol. 31, no. 5, (2009), pp. 56-61.
8. wiseGeek, WHAT IS MACHINE VISION?, http://www.wisegeek.com/what-is-machinevision.htmAccessed on: 24 August 2010
9. Masci et al., 2012 J. Masci, U. Meier, D. Ciresan, J. Schmidhuber, G. Fricout Steel defect classification with max-pooling convolutional neural networks
10. Proceedings of the IEEE the International Joint Conference on Neural Networks (IJCNN) (2012), pp. 1-6
11. Nash et al., 2018 W. Nash, T. Drummond, N. Birbilis A review of deep learning in the study of materials degradation Mater. Degrad. NPJ, 2 (1) (2018), p. 85
12. Petricca et al., 2016 L. Petricca, T. Moss, G. Figueroa, S. Broen Corrosion detection using A.I: a comparison of standard computer vision techniques and deep learning model Proceedings of the Computer Science & Information Technology (CS & IT): Academy & Industry Research Collaboration Center (AIRCC) (2016), pp. 91-99
13. Louw and Droomer, 2019 L. Louw, M. Droomer Development of a low cost machine vision based quality control system for a learning factory Proc. Manuf., 31 (2019), pp. 264-269
14. Silva et al., 2018 R.L. Silva, M. Rudek, A.L. Szejka, O.C. Junior Machine Vision Systems for Industrial Quality Control Inspections Product Lifecycle Management to Support Industry 4.0, Springer International Publishing, Cham (2018), pp. 631-641.
15. Kaluza et al., 2018 A. Kaluza, S. Gellrich, F. Cerdas, S. Thiede, C. Herrmann Life cycle engineering based on visual analytics Proc. CIRP, 69 (2018), pp. 37-42.