RME 3102: Machine Vision

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- Machine/Computer vision is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images.
- Machine vision is the substitution of the human visual sense and judgment capabilities with a video camera and computer to perform an inspection task.
- It involves the development of a theoretical and algorithmic basis to achieve automatic visual understanding.
- It is the automatic acquisition and analysis of images to obtain desired data for controlling or evaluating a specific part or activity.

- Image (pre-)processing deals with the low-level features of images.
- Feature detection provides refined representation of images.
- Segmentation detects the parts of images.
- 3D reconstruction creates 3D models of objects from 2D images.
- Object recognition labels what appears in images.
- Motion analysis deals with moving objects in videos.

Manufacturing Goal	Machine Vision Applications
Improved product quality	Inspection, measurement, gauging, and assembly verification
Increased productivity	Repetitive tasks done manually are automated with machine vision
Production flexibility and less machine downtime	Automatic product changeovers
Increased manufacturing throughput	High-speed inspection keeps up with the fastest production lines
Reduce manufacturing waste	Detecting defects earlier in the process prevents adding value to defective products

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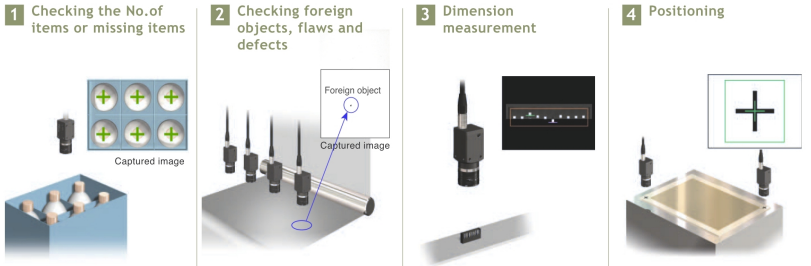
Machine Vision Applications



Counting the No. of bottles in a carton

Detecting pinholes and foreign objects on a sheet

Measuring the coplanarity of connector pins

Positioning of LCD glass substrates

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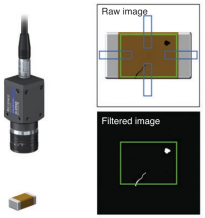
Flaw inspection of a chip capacitor



Stable inspection of minute flaws is necessary because the workpieces are small and production output is large.

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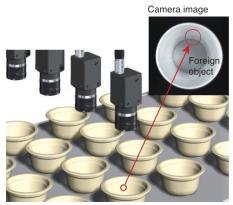
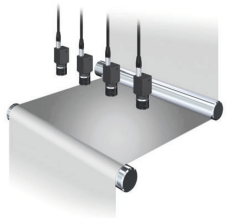
Detecting dirt / foreign objects inside of a cup



Flexibility is necessary to simultaneously inspect multiple locations with varying surface conditions such as the bottom and inner sides.

Inspecting dirt / foreign objects on a sheet or film



High processing speed is required to inspect fast-moving workpieces without omission.

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Checking print quality of best-before dates (right), and monitoring level to which bottles are filled (right).

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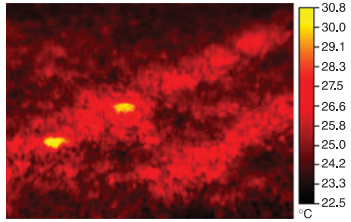


Buried landmines in an infrared image (left). Handprint recognition system (right).

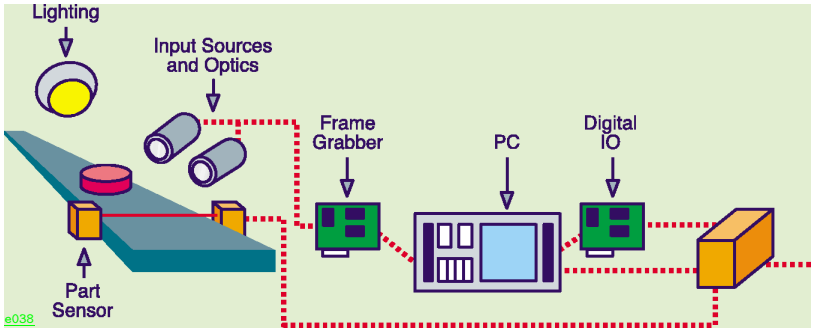
Industrial users of machine vision

Agriculture, Automotive, Biometrics/Security, Container, Cosmetic, Electronics/Electrical, Entertainment, Fabricated Metal, Fastener, Food/Beverage, Glass, Lab Automation, Lumber/Wood, Medical Devices, Medical Imaging, Military/Aerospace, Miscellaneous Mfg., Nanotechnology, Paper, Pharmaceutical, Plastics, Primary Metal, Printing, Rubber, Scientific Imaging, Semiconductor, Telecommunications, Textile/Apparel, Tobacco, Transportation etc.

Machine vision application categories

- Defect detection
- Gauging
- Guidance and part tracking
- Identification
- OCR
- Packaging inspection
- Pattern Recognition
- Product Inspection
- Surface Inspection
- Web Inspection

Machine Vision: Key Components



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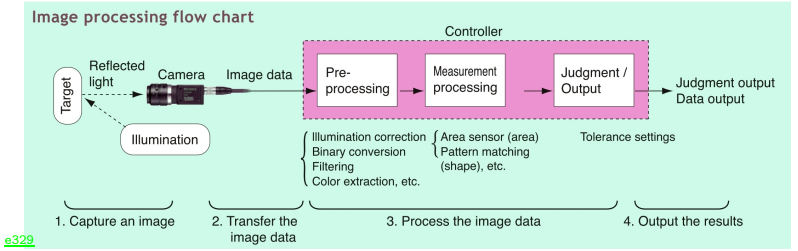

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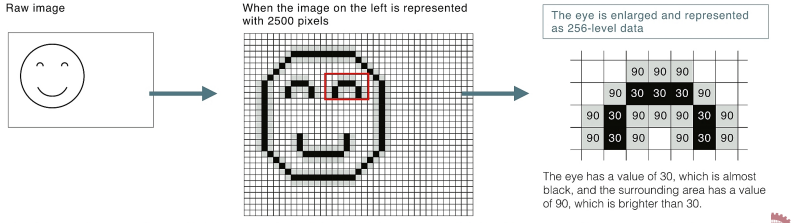


As in the example above, image data is represented with values between 0 and 255 levels per pixel. Image processing is processing that finds features on an image by calculating the numerical data per pixel with a variety of calculation methods as shown below.

e330

67	67	66	68	66	67	64	65	65	63	63	69	61	64	63	66	61	60
69	68	63	68	65	62	65	61	50	26	32	65	61	67	64	65	66	63
72	71	70	87	67	60	28	21	17	18	13	15	20	59	61	65	66	64
75	73	76	78	67	26	20	19	16	18	16	13	18	21	50	61	69	70
74	75	78	74	39	31	31	30	46	37	69	66	64	43	18	63	69	60
73	75	77	64	41	20	18	22	63	92	99	88	78	73	39	40	59	65
74	75	71	42	19	12	14	28	79	102	107	96	87	79	57	29	68	66
75	75	66	43	12	11	16	62	87	84	84	108	83	84	59	39	70	66
76	74	49	42	37	10	34	78	90	99	68	94	97	51	40	69	72	65
76	63	40	57	123	88	60	83	95	88	80	71	67	69	32	67	73	73
78	50	32	33	90	121	66	86	100	116	87	85	80	74	71	56	58	48
80	40	33	16	63	107	57	86	103	113	113	104	94	86	77	48	47	45
88	41	35	10	15	94	67	96	98	91	86	105	81	77	71	35	45	47
87	51	35	15	15	17	51	92	104	101	72	74	87	100	27	31	44	46
86	42	47	11	13	16	71	76	89	95	116	91	67	87	12	25	43	51
96	67	20	12	17	17	86	89	90	101	96	89	62	13	11	19	40	51
99	88	19	15	15	18	32	107	99	86	95	92	26	13	13	16	49	52
99	77	16	14	14	16	35	115	111	109	91	79	17	16	13	46	48	51

T1898

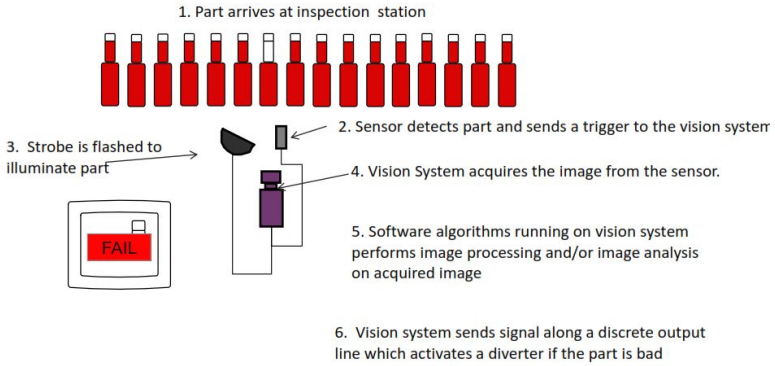
Different versions of an image. An array of numbers (left) which are the values of the grey scales in the low resolution image of a face (top right). The task of computer vision is most like understanding the array of numbers.

1. Front-end optics:- includes the camera, lens and the lighting.
2. Frame grabber:- or video capture card, interfaces the imaging units to the host computer. It takes the image data provided by the camera(s) in either analog or digital form and convert it for use by the host computer.
3. Computer and software:- A computer forms a necessary part of the machine vision system. Softwares processes the incoming image data and makes decisions such as pass or fail.

Machine Vision: Process steps

1. Image acquisition:- system gathers images to be converted into digital format and placed into computer memory.
2. Image processing:- various algorithms are used to enhance elements of the image that are of specific importance to the process.
3. Feature extraction:- processor identifies and quantifies critical features in the image and sends data to control programs.
4. Decision and control:- control program make decision based upon the data. Are the holes within specifications? Is a pin missing? How must a robot move to pick up the component?

How the system works



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