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# MACHINE VISION IN ROBOTICS

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## ABSTRACT
*This paper is the an overview of the actual use and importance of machine vision in robotics generally. Robotics poses important place in today industry, space exploration, services, medicine, etc. Presenting relevant attainable information of machine vision in use, we will show in this overview a tendency of increasing use, applicability, and importance of machine vision in robotics. This is especially obvious in different industries, starting from automotive industry where machine vision is having the most havyiest use. "Blind" robot manipulators in automotive industry are beeing rapidly changed to robot manipulator with vision, assuring time savings, better precision and positioning that outcome to higher productivity. Machine vision has also very important place in mobile robotics, with the practice use in transportation systems, manipulation in storage and manipulation phases in production. Machine vision will continue to have even harder use in production, services and space expolation.*
**Keywords:** maschine vision, robotics, robot manipulator

## 1. VISION
If a robot is to interact with its environment, then the robot must be able to sense its environment. Computer vision is one of the most powerful sensing modalities that currently exist [1]. Vision is the ability to see and recognize objects by collecting the light reflected off those objectsinto an image and processing that image. Robot vision makes use of computers or other electronic hardware to analyse visual images and recognize objects of importance in robot application [2].
An electronic image is an array of pixels that has been digitalized into the memory of a computer. A pixel or a picture element is the smallest element in that image. A binary number is stored in each pixel to represent the intensity and possibly the wavelength of the light falling on that part of the image. In a binary image, a pixel can have a value of 0 or 1 representing black and white. In a grey scale image, a binary number represents an intensity level between black and white. In a colour image, information about colour is stored as well as intensity information.
The spatial resolution of an image is the area represented by each pixel, usually specified as the number of pixels per line of an image. It is a function of the distance from the camera to the scene, the focal length of the lens, and the number of pixels per rowin the image array. A lens with focal length $\lambda$ is used to focus light onto the sensing array, which is often composed of CCD (charge-coupled device) sensors. The lens and sensing array are packaged together in a camera, which is connected to a digitizer of frame grabber. In the case of analog cameras, the digitizer converts the analog video signal that is output by the camera into discrete values that are then transferred to the pixel array by

the frame grabber. In the case of digital cameras, a frame grabber merely transfers the digital data from the camera to the pixel array.

### 1.1. Vision systems

Quality assurance and high-precision position detection systems for component handling applications are essential items in the automation engineering toolkit. Intelligent vision systems provide the key to higher productivity, greater efficiency and total quality assurance. They ensure that the required precision and speed are achieved during robotic assembly and production, and they offer significant potential enhancing the efficiency of automotive manufacturing. Vision systems must deliver 100% availability and reliability. They also have to be user friendly and suitable for environments. [3]

### 1.2. Industrial Robots Statistics

Following information gives us the overview of robot presence in today's industry.
After the record numbers recorded in 2005, sales of industrial robots were 11% lower in 2006, at 112,200 units. Nevertheless, this was the second highest result ever recorded. Although the automotive and the electrical/electronics industries, which in 2005 were still the main engines of the rapid growth that had been experienced, reduced their investment in robotics by 17% and 34% respectively, all other industrial sectors increased robot purchases by 25%.
The IFR Statistical Department estimates that there are now over 951,000 robots in operation worldwide. Almost 50% of these are in Asia, a third in Europe, and 16% in North America. Australia and Africa each share about 1% of the total.
The IFR Statistical Department forecasts that in 2007, around 10% more industrial robots was sold worldwide than in 2006. In Europe, rising demand has already been registered, particularly in Central and Eastern Europe, Germany and Italy. [4]

### 1.3. Acceptance rate statistics for publications in graphics/interaction/vision

Following information presented in Table 1 and Table 2 show number of submitted, accepted papers, and acceptance ratio for the papers published in IEEE Computer Vision and Pattern Recognition and IEEE International Conference on Computer Vision / European Conference on Computer Vision respectively, with the theme Computer Vision. We see constant research interest for computer vision in recent period. It shows the number of published works and papers for the last ten years, and we can see constant interest for computer vision [3,6].
The numbers were collected from many sources - conference proceedings prefaces, journal reports on conferences, Google search, and so on. There is no guarantee of correctness, yet, when possible, I was trying to double check the numbers from different sources. In cases of different sources claiming different rates, you can see different numbers in brackets. The difference can come e.g. from including or not of short papers.
When assessing acceptance rates, bear in mind that the numbers are skewed by self-selection - the authors will usually submit their work to more selective venues only if they think that they can have some chance of being accepted.

*Table 1. CVPR (IEEE Computer Vision and Pattern Recognition) [5]*
*http://vrlab.epfl.ch/~ulicny/statistics/*

| Name & year | Accepted | Submitted | Acceptance |
|---|---|---|---|
| CVPR 2004 | ~200 | ~1200 | ~17 % |
| CVPR 2003 | 209 (149 poster + 60 oral) | 905 | 23.1% (16.5 % posters + 6.6 % oral presentations) |
| CVPR 2001 | 273 (195 poster + 78 oral) | 920 | 30 % (22 % posters + 8% oral presentations) |
| CVPR 2000 | 220 (154 poster + 66 oral) | 466 | 47% (33 % posters + 14.2 % oral presentations) |
| CVPR 1998 | (42 oral) | 453 | (9 % oral presentations) |
| CVPR 1997 | (62 oral) | 544 | (11.4 % oral presentations) |

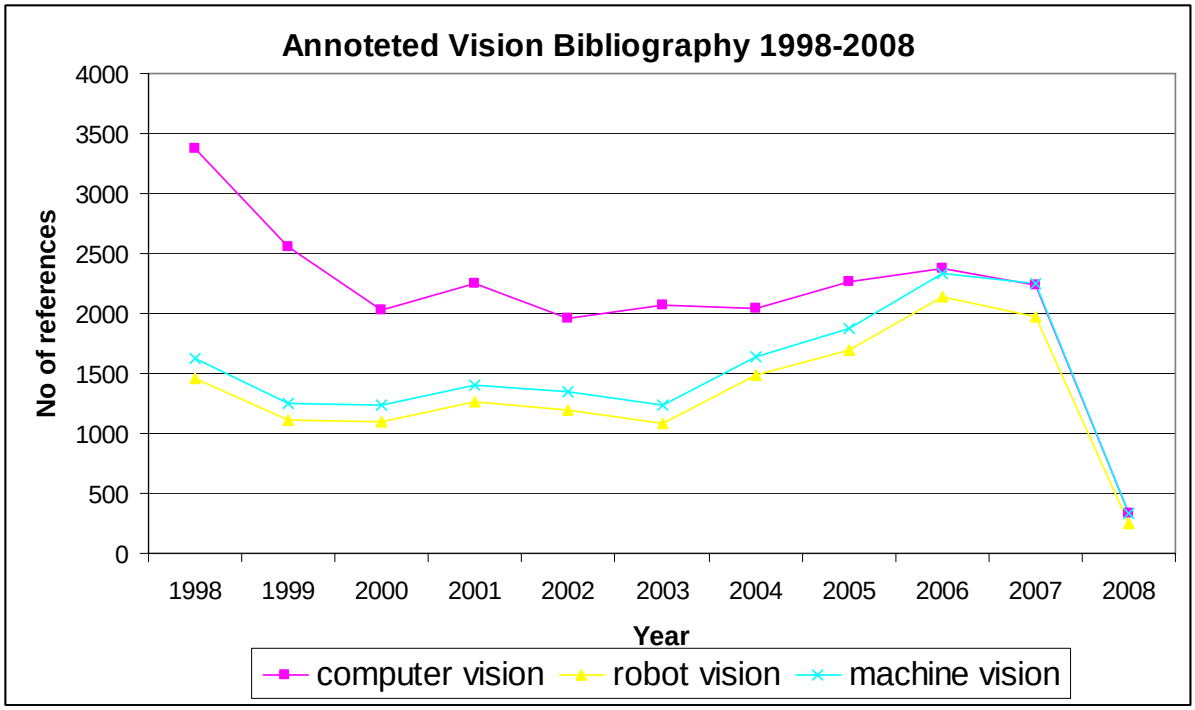
*Table 2. ICCV/ECCV (IEEE International Conference on Computer Vision / European Conference on Computer Vision) [5] http://vrlab.epfl.ch/~ulicny/statistics/*

| Name & year | Accepted | Submitted | Acceptance |
|---|---|---|---|
| ECCV 2004 | 190 (149 poster + 41 oral) | 555 | 34.2 % (26.8% posters + 7.4 % oral presentations) |
| ICCV 2003 | 199 (156 poster + 43 oral) | 960 | 20.7 % (16.2 % posters + 4.5 % oral presentations) |
| ECCV 2002 | 226 (181 poster + 45 oral) | ~600 | ~37.7 % (30.2 % posters + 7.5 % oral presentations) |
| ICCV 2001 | | | 34 % |
| ECCV 2000 | 116 | 266 | 43.6 % |
| ICCV 1999 | | | 31 % |
| ECCV 1998 | 112 (70 poster + 42 oral) | 223 | 50 % (31 % posters + 19 % oral presentations) |
| ICCV 1995 | | | 26 % |

Following information presented in Table 3 and pictured in Picture 1 shows the constant research interest for computer vision in recent period. It shows the number of published works and papers for the last ten years, and we can see constant interest for computer vision [5].

*Table 3: Overview of published vision papers in last 10 years [5] http://vrlab.epfl.ch/~ulicny/statistics/*

| Year | No of published computer vision papers | No of published robot vision papers | No of published machine vision papers |
|---|---|---|---|
| 1998 | 3379 | 1452 | 1626 |
| 1999 | 2555 | 1109 | 1247 |
| 2000 | 2023 | 1100 | 1238 |
| 2001 | 2254 | 1263 | 1401 |
| 2002 | 1961 | 1194 | 1351 |
| 2003 | 2066 | 1079 | 1238 |
| 2004 | 2044 | 1480 | 1633 |
| 2005 | 2269 | 1688 | 1872 |
| 2006 | 2377 | 2135 | 2332 |
| 2007 | 2231 | 1975 | 2255 |
| 2008 | 333 | 250 | 327 |
| TOTAL | 23.492 | 14.725 | 16.520 |




*Picture 1. Overview of published vision papers in last 10 years [5] http://vrlab.epfl.ch/~ulicny/statistics/*

## 2. CONCLUSION

We clearly showed and pointed to actual use and importance of machine vision in robotics generally and a tendency of increasing use, applicability, and importance of machine vision in robotics. Different industries today strongly relay and lean to machine vision, especially automotive industry where machine vision is having the most havyiest use. Machine vision is the area of really high interest for studying and exploration and that trend will remain for at least one decade in future. Machine vision will continue to have even harder use in production, services and space exploration.

## 3. REFERENCES

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