**VSD:** What sort of vision systems or services does ImagingLab provide? What is the origin of your company?  

**Piacentini:** ImagingLab is a small high-tech company whose mission is to offer its know-how to system integrators, machine builders, and end users with the need to adopt innovative technologies in the field of machine vision and robotics, minimizing their investments and shortening their learning curve.  

Our core business is machine vision for industrial robotics, with what I consider a difference from most robotics companies: We have arrived at robotics from vision. Therefore, the design of our systems is vision centric with a very tight integration of the robotics and vision software, essentially leading to a single programming/configuration platform.

We are an atypical integrator, more akin to a design/engineering bureau. We work in close partnership with other companies (typically much larger) from the early design phase to a validation prototype. The actual construction of “machines” is remanded to our partners, but we follow closely the final engineering phase, the deployment of the machines to the factory floor, and the introduction of improvements arising from the everyday operation of the end users. We also provide the necessary technology transfer to facilitate the adoption of robotics and vision to both the machine manufacturers and to the end user.

I had the first glimpse of machine vision in the early 1980s, while working at the JET Project (Culham Laboratories, Abingdon, UK), a large thermonuclear fusion experiment. The personal computer revolution had not yet occurred and the vision algorithms were running slowly—an oxymoron?—on a PDP 11. In 1991 I left the research community and moved to machine vision. In 1995–96 I was directing Graftek Italy and took part in the discussion and negotiation between Graftek France and National Instruments (Austin, TX, USA; www.ni.com) for the acquisition of a LabVIEW-based image-processing library, which led to the development of the machine-vision products line in the following years. After a spell with NI as a European business development manager for machine vision, in 2004 I left to start ImagingLab.

**VSD:** What technologies and components do you use in machine-vision-related applications? How often do you evaluate competing technologies?  

**Piacentini:** Software plays the largest role in our system development and is obviously based on LabVIEW and the related vision library. With a company start in 2004, the choice was to go fully digital with the adoption of IEEE 1394 (FireWire) high-resolution cameras, while Camera Link has been used for a few high-end applications. In terms of CPUs, LabVIEW and its Real Time version allow us to develop conveniently under Windows [XP Pro since we are not great fans of Vista], while deploying the application software on a number of different targets from industrial-panel PCs running XP embedded to a number of RTOS boxes and smart cameras.

GigE has slowly trickled into our applications but has not yet significantly offset FireWire. The communication with the robots and machine interface is based on a variety of standard protocols ranging from TCP/IP over Ethernet to Modbus. Ether-CAT will facilitate the use of remote deterministic I/Os.

3-D vision is becoming increasingly important, especially in conjunction with robotics, and we have very recently developed a LabVIEW tool-kit, under contract with SICK-IVP (Linköping, Sweden; www.sickivp.com), for their Ranger series of laser-scanning cameras.

Concerning competing technologies, we keep a vigilant eye on all the novelties appearing on the machine-vision market, often evaluating new products with hands-on trial, while we are rather cautious in their immediate deployment.

**VSD:** In which areas of the industry do you see the most growth? What are users demanding from you in the design of new systems?
Piacentini: We are heavily biased towards machine vision for robotics. Roughly 100,000 robots are sold around the world every year. This number is increasing steadily. The percentage of robots making use of vision is also increasing. European manufacturing companies are facing strong competition from China and India and can only compete by adopting more and more concepts of flexible manufacturing, which in turn leads to more advanced automation based on robotics and machine vision.

Our systems are targeted to the manufacturers of machines that perform some kind of automated production or assembly cycle. Culturally, these companies have a strong mechanical background, which has to move towards the more recent world of mechatronics. The success of our applications/systems is linked to the overall performance of the machines in terms of cycle time but also in the ease of use of the technologies we are offering. “Ease of use” encompasses a number of issues: simple end-user interface, tools to facilitate the commissioning and startup of the machine, self-calibration tools [there is a need to correlate the “looseness” of pixels deriving from optical distortion of various kinds to the more rigid space of robot coordinates], and remote diagnostics and maintenance.

VSD: How will OEM components targeted towards machine-vision applications have to change to meet future needs?

Piacentini: I would like to see some attempt to standardize the data sheets of all the components that are part of the acquisition chain, from sensors and cameras to illumination devices and optics. Comparing the merits/quality of individual components is today rather difficult and can hardly be done based on the published data. Think about, for instance, how to compare the sensitivity and noise level of two cameras from different vendors or how to evaluate the uniformity and intensity of illumination of an array of LEDs at a given distance.

VSD: Could you discuss the machine-vision market in Italy and compare the machine-vision markets in different industry segments in Europe?

Piacentini: In the contest of the European Union, Italy is fourth in terms of gross domestic product, but is second after Germany in the production of “manufacturing machines.” Seventy percent of these machines are exported. This obviously has an influence on the machine-vision market, machine vision being used to automate the production
cycle as well as a quality control instrument. There are also other market segments like food production and packaging that represent a potentially large market share of the machine-vision market.

An historical challenge for machine-vision companies active in the Italian market is the fragmentation of the market itself and the inherent small size of the machine-vision system integrators, which fall well below the European average of 38 people per company. ImagingLab has a team of only eight people, yet is considered a medium-sized integrator!

More information on the peculiarities of the Italian machine vision market can be found on a presentation I gave during the 2008 EMVA conference in Berlin.

**VSD:** What machine-vision algorithms and specific software developments do you see emerging in the next five years?

**Piacentini:** Algorithms for 2-D imaging have reached a reasonable level of maturity and completeness, and the fairly recent addition of geometric pattern matching to the more conventional one based on normalized cross-correlation has vastly improved robotized pick-and-place operations. The machine-vision libraries available from various vendors offer more than just the pure algorithmic content—they also offer a very good level of user interface, simplifying the understanding and the interpretation of the results.

With the advent of 3-D cameras capable of generating spatially calibrated 3-D images (either as a cloud of points or correlating the $z$ dimension to the grayscale level), there is a lot to be done to reach the same level with a 3-D vision library. It is sufficient to think of the increase in complexity required for the reliable detection of a specific pattern once perspective and different 3-D positionings in space have been taken into account.

Processing speed will also benefit from the increased availability of multicore CPUs, though some rethinking will be required at the algorithmic level to be able to distribute data processing on these new hardware architectures.

**VSD:** What kinds of new applications and industry trends do you expect to emerge in the future?

**Piacentini:** I can think of many, but solving and generalizing bin-picking as opposed to palletizing parts is one of the current dreams of many companies involved with flexible manufacturing: an application that can most likely be solved with a careful combination of 3-D and 2-D imaging. I also see machine vision becoming an integral part of robotics and no longer an external add-on, with the possibility of using vision-derived information in the kinematics control loop to improve speed and positional accuracy.

As the price/performance of machine-vision systems continues to improve, more and more systems will be deployed, with quality control becoming distributed during the whole process rather than being confined to the end of the production line.