

How to make Business with Computer Vision Technology

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- Business Development by Technology Innovation
- Technology Transfer Projects
- Product Development methodology
- Key components of the Innovation process
- A success story: AUTO-DETECTOR
 - Marketing context
 - Main technology challenge
- Lessons learned
- An example of failure: ROBOLIFT
- Open problems and conclusions

Business Development by Technology Innovation

- ❑ Technology innovation as a key to economic growth
- ❑ The objective to technology transfer to Business and product innovation is not only a priority of industrial research but is a must also for academic departments
- ❑ Time until returns is usually quite long; (> 20 y until economic gain); much shorter time horizons are considered as useful in the industry
- ❑ The role of R&D function: a technology incubator (in the past); more linked to the business process (today) by creating leading-edge products and processes.
- ❑ R&D objectives are more directly linked to business objectives than in the past.

How to measure the success of R&D technology innovation

Traditional metrics based on the number of publications and patents are no more sufficient.

Much more emphasis is given on measurable value added solutions of technical and operational problems (product and process innovation).

Technology Transfer

- Promoting technology transfer from basic research to product development
- Traditional university structures are primarily designed for research and education activities
- Main challenges to move
 - from fixed budget to more competitive markets,
 - from scientific curiosity to concrete market needs,
 - from continuity to improved flexibility,
 - from bureaucracy to management efficiency,
 - from science to international competition.
- Linear model of Technology Transfer is not quite appropriate
- Actually, research results and ideas are used at all stages of the innovation process and not only in the early phase and the relationship between basic research and commercialization is too complex to be described as a linear function and requires a series of feedback loops and changing actions to succeed.
- Linear models tend to underestimate the contributions of people involved in the innovation process, including users whose ideas are often a push to innovation.

Computer Vision Market

- ❑ Image quality inspection for industrial applications (industrial automation, pharmaceutical and manufacturing, etc.) represents a mature market field with many dedicated Exhibition and Conferences.
- ❑ OCR (Optical Character Recognition) in postal automation and document processing represents still one of the most important business success of Image Processing and Recognition technologies.
- ❑ Biomedical Image Processing for Diagnostic systems and surgical systems is an essential component of all new advanced devices in the medical field.
- ❑ Robotics, Automation in different areas (Space, applications, service robotics and Logistic automation)
- ❑ Image Processing and CV is a a key-technology in Telecommunications and Multimedia for intelligent data compression and scene segmentation
- ❑ Security and Surveillance Applications is the emerging area with Computer Vision applications of scene understanding, video-surveillance, biometric control and face-recognition, human motion and behavior analysis.

Product Development and Innovation

Sectors and functions involved

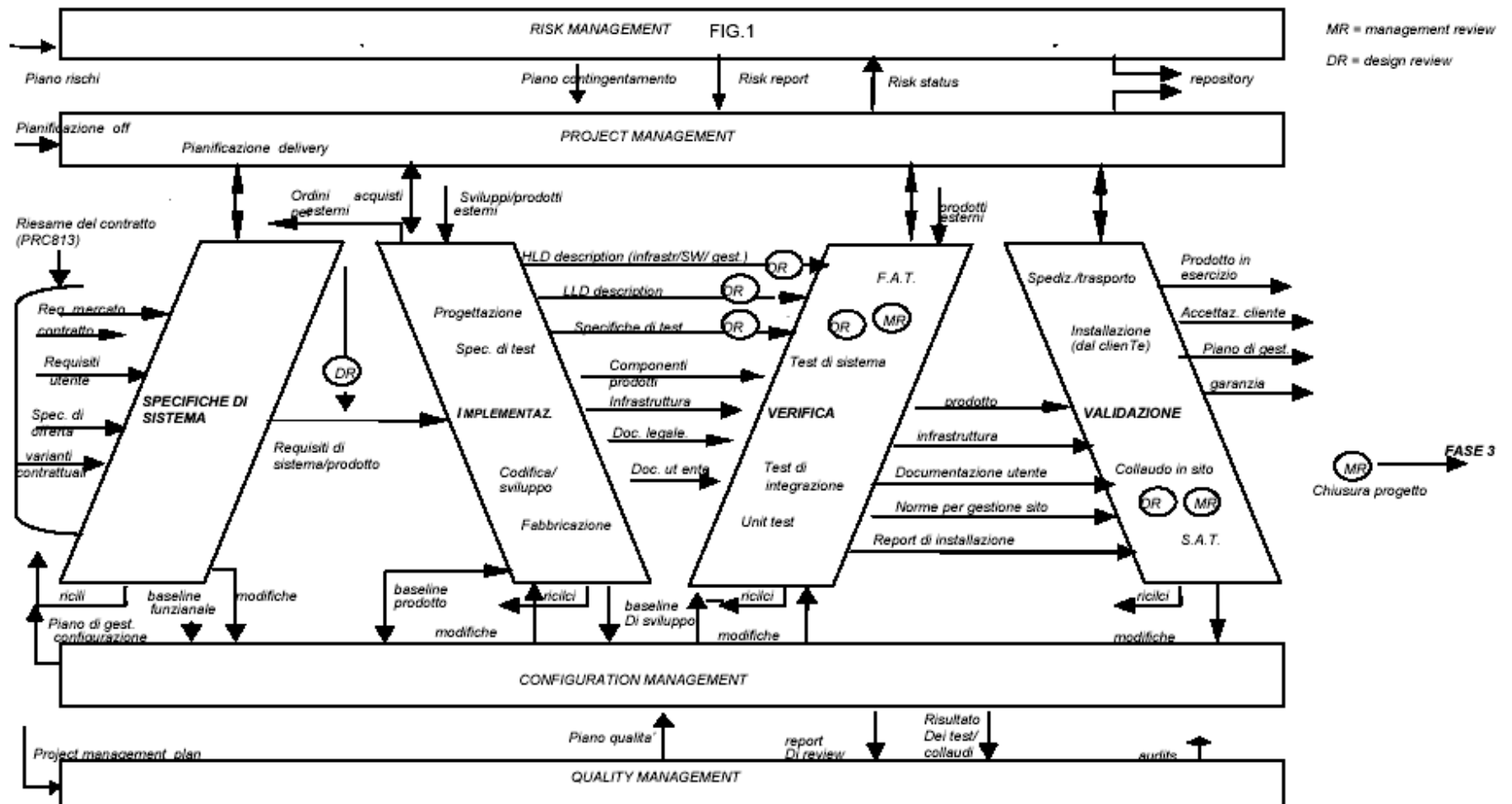
- | | |
|---|--|
| <input type="checkbox"/> MKT: marketing deptm strategic: | => competition analysis |
| <input type="checkbox"/> PD: Product development manager: | => investments and priorities |
| <input type="checkbox"/> R&D deptm: | => technolgy road-map, patenting, technolgy partnership |
| <input type="checkbox"/> PM: Project Management | => customer mgmt, EVA value chain |
| <input type="checkbox"/> Business department | => strategic partnership |
| <input type="checkbox"/> Legal dptm: | => IP Intellectual property, patents and trade-marks |

The source of new ideas

- Technology push from the R&D
- From specific project requirements (user specs)
- Product development strategy & evolution (driver approach)
- From the competition analysis (follower approach)

For those interested in marketing tools and principles: <http://www.marketingteacher.com/>

Project management scheme



Key components of the Innovation process

User requirement analysis: to focus on real and concrete objectives

Competition analysis to focus on strength & weakness of the current available solution and missing features

Understand the really perceived value by the user: how to solve a practical problem

Good and complementary partnership to fill the missing competence:

Fully compliance with customer standards and operational procedures

A success Story: Auto-Detector

2001: the status of the security mkt of ANPR

Statement (ACPO): ANPR technology is a core business for all police institutions for “Denying criminals the use of the roads”...

Available product classification:

- Fixed installation at gateways, at highway, city centers, parking access control (usually triggered systems) for traffic control
- Security fixed installations at road-side (city centers and along highways), self-triggered systems
- Transportable systems (on tripod at road-side), mainly for speed enforcement
- Videorecording systems on board of a patrol car (speed enforcement) and selected car LPR
- Parking inventory (dedicated cars with camera system) low-speed constraints



LPR: License Plate Recognition

ANPR: Automatic Number Plate Recognition

2001: the status of the security mkt of ANPR

USA – border control and highway control; growing market of security

UK – the widest number of installations of fixed control cameras in London and major UK cities, including patrol-car VCR and speed enforcement

Other European countries (France, Germany, Italy) – fixed & transportable system (speed enforcement and security)

ASIA (Singapore and far-east) – fixed installations for traffic control and security applications

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2001: Elsag background situation

Since '91 many fixed installations in different configurations:

- ❑ Triggered gate control (Italian Autostrade)
- ❑ ZTL access control to downtown city centers
- ❑ Parking access control (applications in Italy and Spain)
- ❑ Security application (23 service stations along the southern highway (Salerno-Reggio Calabria) for the Ministry of the Interior)
- ❑ Transportable system for security apps

R&D competence:

- ❑ Background technology developed in national projects (MURST 1999-2002) and EEC-IST (Visor-Base 2000-2001)
- ❑ Continuous reading capabilities from the video flow
- ❑ No need of external trigger for transit detection



MOBILE ANPR Project:

Everything is moving: both sensor and target

Feasibility project by May 2001



Italian Security Forces: Carabinieri Army

Responsible for security control in all Italian cities and neighbourhood

In 2001 they were looking for a mobile ANPR system to be installed in their patrol fleet

Actual candidate: PROVIDA 2000

Strength:

- Mobile unit installed on-car
- Combined close-up and far reading (by human driven zoom control)

Weakness:

- LPR on-demand
- Too much involvement of the human operator
- Low-performance of recognition (a few ten's of LP's per shift)
- Encumbrance of the sensor and processor
- Old ineffective technology of VCR (tape recording)



<http://www.carabinieri.it/>



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Mobile ANPR for the Carabinieri Army: new additional requirements

- User friendly solution – no impact on normal patrol duties
- Compact solution (to be integrated into existing cars)
- Minimum power drain
- Smooth integration with existing devices already installed into patrol cars
- Day & night operation in all environmental conditions

Main technology challenge:

- Digital Image acquisition (resolution and sensitivity)
- Fast processing rate (25 fps) low-power consumption processing unit
- Accurate plate detection & location from the video flow
- Character segmentation and OCR of a noisy scene
- Contextual processing (multi-national applications)
- Alarm detection and management
- Friendly User interface
- Central supervisory station and system architecture



Performances

Night and day continuous reading also in sudden light condition transitions (tunnels, rain, etc.)

Can be optimized for any country car plates.
In Italy error is less than 1%

International applications

More than 3.000 car plates per hour per vehicle

Parked vehicles: at cruise speed of 50 km/h

- Car plates read > 95% of readable plates
- Parallel parking, perpendicular parking

Moving Vehicles; differential speed up to 150 km/h



Lessons learned

- ❑ Importance of technology innovation, the identification of all relevant added values to the market, as well as a solution to real concrete problems.
- ❑ R&D technology investment are profitable when are oriented to problem solving.
- ❑ Robustness and reliability and high quality of the results are also fundamental issues (product engineering and system configuration management) as well as the subjective quality as perceived by the user).
- ❑ The solution must be effectively integrated within existing operational procedure and particular care must be devoted to all services of maintenance and user assistance.
- ❑ The technology development team must exhibit a high flexibility to adapt the proposed solution to user requirements along the development of the product, with the involvement of the user in the development phase.
- ❑ The company qualification and certification is extremely important. Credibility and reputation are difficult to achieve but they are very easy to lose.
- ❑ IPR activity (patents & publications) as well as licensing strategy must be well defined and supported.
- ❑ Partnership relationships are extremely critical in the development of a new business based on R&D innovation, as technical partnership (to complement internal competence and “core” technology) as well as commercial (to support introduction especially in the international market).

An example of failure: 1995-1998 ROBOLIFT

Objective: Autonomous visual guidance and pallet loading-uploading for a standard fork-lift

Report: G.Garibotto, "ROBOLIFT: vision guided autonomous forklift", Service Robot: An International Journal, Vol. 2 n.3, 1996, pp.31-36, MCB Un. Press.

Partners:

Elsag:technology provider, Logistic Automation and System integratio

Fiat-OM carrelli elevatori: Fork-lift manufacturer and

Main events:

- 1996 – CEBIT Exhibition Hannover
- 1997 – Hannover Fair Exhibition
- 1998 – Pilot installation Ceramics – Sassuolo (Italy)
- 1998 – project stopped

- | | |
|---|---|
| <ul style="list-style-type: none"> • CV technology • Robustness & reliability • Processing unit • User interface • Partnership | <ul style="list-style-type: none"> • Not enough mature for the application (a similar approach has been proposed in 2003 by a USA company) • Not fully proven with a sufficient testing phase (only a few pilot systems) • Std PC an advantage in terms of costs but a limitation for the processing power • Need of a particular skill for installation and reconfiguration (layout modification) • Elsag was leaving the Factory Automation market • Fiat-OM absorbed within a multinational firm (LINDE) |
|---|---|



Conclusions

- ❑ Not always a good technical idea become a business success
- ❑ It is necessary a favorable combination of a series of components, including:
 - ❑ A careful understanding of the customer requirements and customer satisfaction
 - ❑ An effective and complementary technical and commercial partnership
 - ❑ Continuous product innovation
- ❑ Computer Vision and Pattern Recognition are mature technologies and represent key components of most relevant industrial applications.
- ❑ The successful solution must be simple, robust and user friendly and must be conceived to solve real problems and provide a measurable added value to the specific field and the customer needs.
- ❑ The approach to a new problem must be carried out with open mind with the objective to improve your knowledge of that area (become an expert of the field)
- ❑ The continuous improvement of technology and facilities in the sensory domain open a wide range of opportunities for the creativity of IT and CV researchers

My best wishes for your own business success with Computer Vision technology