



IAC-13-E1.7.10
26 September 2013, Beijing

**Experience in Integrating Robots Designed for Planetary
Exploration and an Environment initially Designed for
Cooperating Robots on Planet Earth**

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heig-vd

Haute Ecole d'Ingénieurs et de Gestion
du Canton de Vaud



Hes·so
Haute Ecole Spécialisée
de Suisse occidentale

Content

- 1. Introduction**
- 2. Past space-related hands-on experiments in our lab**
- 3. HEIG-VD expertise in cooperating robots**
- 4. OP12-Y, a versatile, Piaget-driven platform and robot**
- 5. Space constraints and opportunities**
- 6. Conclusion**

1. Introduction

- **Humans attempt to extend the reach of our civilization to extra-terrestrial grounds [1].**
- **Robots can be helpful,**
 - **not only as scouting elements**
 - **but also for human assistance.**
- **Hands-on experiments good to learn more about space matters and to contribute. E.g. SpaceBot Cup (re. DLR and BWMi) and SEAR (Small Exploration Assistant Rover) [2].**
- **Our lab did a lot in cognitive aspects (e.g. clip IJCAI 2013 [3]), in particular for smart cooperating robots in domestic and industrial domain.**
- **Hands-on project in space matter, with cooperating robots on Earth to be now transposed to the extra-terrestrial world.**

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3. HEIG-VD expertise in cooperating robots

III.1 Examples of sensors, computing circuits, and actuators, which need be appropriately integrated for the design of smart systems



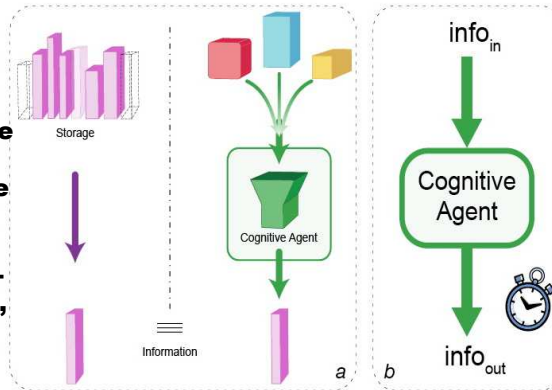
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Figure 64 : Représentation du processus cognitif avec les éléments de l'institut LaRA composant la chaîne cognitive.

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3. HEIG-VD expertise in cooperating robots

III.2 – Schematic view of cognition. (a) Cognition and, effectively, cognitive systems, generate information. (b) Cognitive properties can be quantitatively estimated on the basis of the input-output information flows, and time.



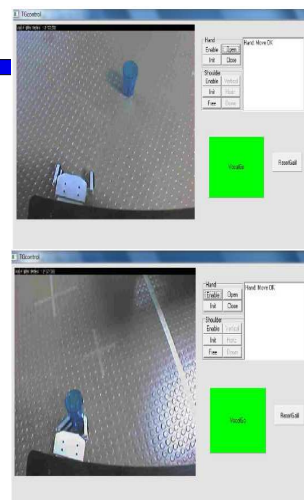
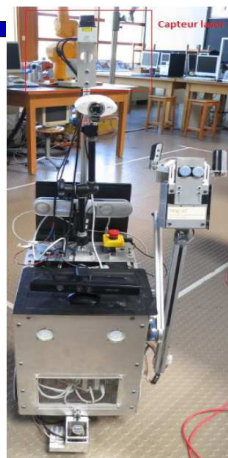
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3. HEIG-VD expertise in cooperating robots

III.III – Our RH-Y robot, on the left, includes various sensors (rangars, camera, Kinect, microphone, etc.) and actuators (wheel joints, arm, gripper, etc.). On the right, within the « Telegrab » task, the robot can autonomously fetch and carry the blue glass

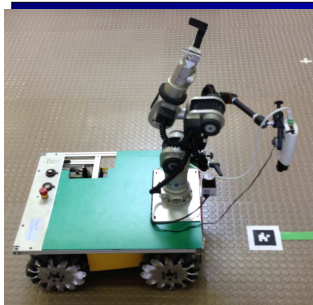


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3. HEIG-VD expertise in cooperating robots



III.IV – OP-Y, left (photo HEIG-VD - Emilien Kobi) is ready to address tasks of the Robocup@Work league . On the right, the NAO-typed humanoid Nono-Y has been integrated to our Piaget environment and is useful as a mediator between humans and other robots and machines.

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4. OP12-Y, a versatile, Piaget-driven platform and robot

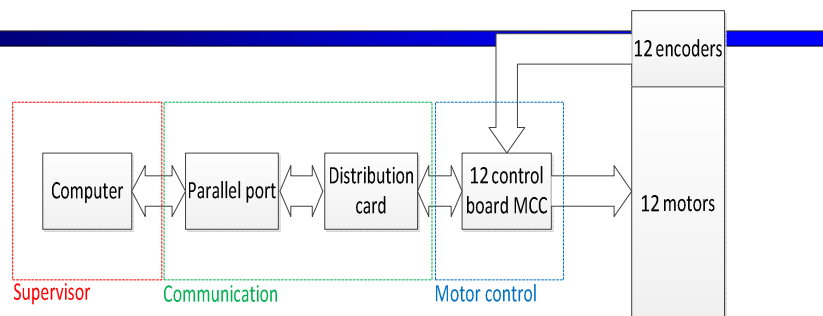
- 4.1. Six wheel and 12 motor platform with control via parallel port
- 4.2 New architecture
- 4.3 Integration with "Piaget"
- 4.4 Locomotion

14.10.2009

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4.1. Six wheel and 12 motor platform with control via parallel port



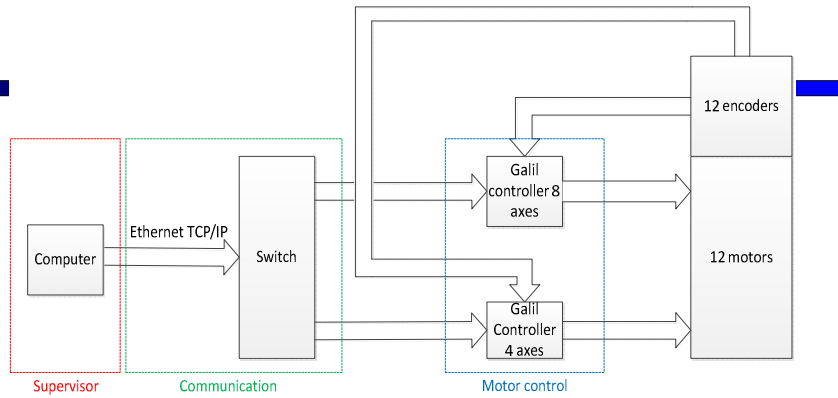
IV.I: Architecture initially adopted to implement a fully computer-based motor control

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4.2. New architecture



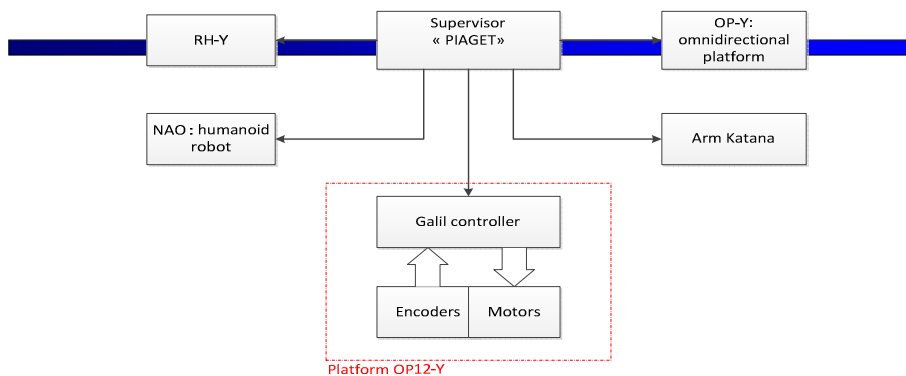
IV.II: New architecture for joint control

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4.3. Integration with "Piaget"



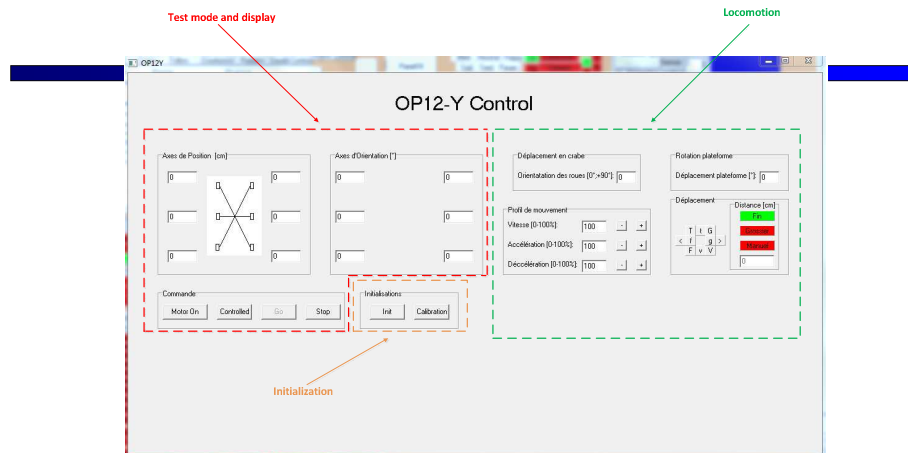
IV.III: Integration in "Piaget"

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4.4. Locomotion



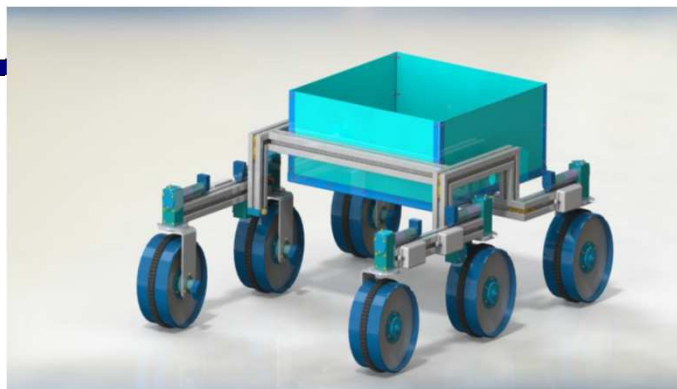
IV.IV: Form in “Piaget” for OP12-Y

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4.4. Locomotion



IV.V: The new version of OP12-Y has various improvements in mechanical terms as well. It is shown here in a configuration for straight motions.

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5. Space constraints and opportunities

	Earth	Moon	Mars	Titan	Asteroids
Important changes in parameters depending on specific contexts					
M/M_E	1	0.012	0.11	0.023	0
G (m/s²)	9.81	1.622	3.71	1.352	0
v_e (km/s)	11.19	2.38	5.03	2.639	0
R (AU)	0	0,00257	1.52	9.54	TBD
T_{mean} (K)	288.15	196	210	93.7	n.a.

Table 1: Different parameters of the Moon, Mars and Titan, compared to Earth's. Data from [15].

5. Space constraints and opportunities

- **Some constraints**
 - **Pressure, temperature, cosmic rays, microgravity (sometimes totally new rover principles to adopt for locomotion), distance from human support...**
 - **Distance from immediate/short-term social needs**
- **Some opportunities**
 - **Microgravity (ease of access and depart), materials rare on earth, "infinite" space size, energy**
 - **Attractive goal for knowledge acquisition and support for dreaming/envisioning an inspiring future**

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6. Conclusion

- **Hands-on projects have always been useful for raising the interest of students in space matters and technologies**
- **Progress on Earth has recently changed the paradigm of deploying cognition in automated ways**
- **Smart robots for effective cooperation with humans also have their missions in space for the future**
- **The reported project in this line has proved , though of course in its limited statistical and time-related, available basis, to be very inspirational for the involved students.**

Acknowledgments

The author wishes to acknowledge here numerous contributions from engineers, foreign interns (re. exchange programs), students at HEIG-VD, as well as from our technical services and workshops.

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Appendix – Swiss Space Days p2 to p4



Vendredi 4 octobre 2013

MATIN, écoles primaires et secondaires pour les écoles

10h *Visite de Claude Nicollier* *
avec éventuelle présentation de travaux et/ou réponses aux questions

APRÈS-MIDI, HEIG-VD pour l'économie, les écoles et le public

13h Ouverture de l'exposition

13h30 Accueil et bienvenue
Roland Peflaz-Droux, directeur adjoint HEIG-VD / Daniel von Siebenthal, syndic Yverdon-les-Bains / Jean-Daniel Dessimoz, prof. HEIG-VD et président Swiss Space Association

13h50 *"La Suisse - une nation active dans l'espace aujourd'hui et demain"*
Rokun Richard, Secrétaire d'Etat à la formation, à la recherche et à l'innovation, Division Affaires spatiales

14h15 *"CubeSat et Science"*
Federico Belloni, Swiss Space Center

14h35 *"Un cluster aérospatial pour l'économie et la société suisse"*
Alain Geiger, Prof. ETHZ et vice-président du Swiss Aerospace Cluster

15h00 Pause café et visite de l'exposition

15h20 *"Rexus - des étudiants suisses réussissent leur lancement dans l'espace"*
Roberto Putzu, prof. HESSO-HEPIA

15h40 *"Contrôles non-destructifs au service de l'industrie spatiale"*
Jean-Pascal Reymondin, prof. HEIG-VD

16h00 *Apports de l'industrie suisse au spatial*
Frédéric Boden, APCO-Technologies, Vice-président du Swiss Space Industry Group

16h20 *"Nacette suisse pour petits satellites et l'aviation du futur"*
Pascal Jausi, Swiss Space Systems

16h40 *"Questions-réponses en matière spatiale"*
avec l'astronaute Claude Nicollier

17h00 *"Concours des gymnasiens"*
Georgios Bouban, Swiss Space Center

SOIRÉE, Maison d'Allieurs pour le public

19h30 Bienvenue des autorités et des organisateurs

19h45 *"Quelques aspects de la science perçus par un artiste"*
Claude Ecken, écrivain de science-fiction et critique littéraire

19h55 *"Quelques commentaires d'un scientifique face à certaines conjectures artistiques en matière spatiale"*
Claude Nicollier, astronaute

20h05 *"Science et Fiction"*
Débat avec l'astronaute Claude Nicollier et l'écrivain Claude Ecken, modération Marc Atallah, directeur Maison d'Allieurs

21h00 Apéro et discussions en groupes

* matin ou après-midi; sans réserve, notamment selon contraintes de vols Hunter
** à confirmer

Samedi 5 octobre 2013 Journée principalement en allemand / Tagung vor allem deutsche

VORMITTAGSPROGRAMM, HEIG-VD, E03 für SRV-SSA-Mitglieder / membres

9h45 Empfang der Teilnehmer (Kaffee & Gipfeli) / accueil (Café-croissants)

10h15 SRV, Generalversammlung / assemblée générale

12h30 Lunch für Mitglieder / repas pour les membres

NACHMITTAGSPROGRAMM, HEIG-VD, F01 Öffentlicher Anlass / public

14h00 Accueil et bienvenue
Roland Peflaz-Droux, directeur adjoint HEIG-VD / Daniel von Siebenthal, syndic Yverdon-les-Bains / Jean-Daniel Dessimoz, prof. HEIG-VD et président Swiss Space Association

14h15 *"Die Schweiz - eine aktive Nation im Weltraum, heute und morgen"*
Oliver Botta, Staatssekretariat für Bildung, Forschung und Innovation, Abteilung Raumfahrt

14h30 *"CubeSat et Science"*
Federico Belloni, Swiss Space Center

14h45 *"Raumfahrt, neue Resultate, neue Projekte"*
Claude Nicollier

15h15 Fragen und Antworten - Réponse aux questions mit Claude Nicollier

15h25 Kaffeepause und Anstellungsbesuch - pause café et visite de l'exposition

15h40 *"Rexus - des étudiants suisses réussissent leur lancement dans l'espace"*
Roberto Putzu, prof. HESSO-HEPIA

15h55 *"Die Zerstörungsfreie Prüfungen in der Raumfahrtindustrie"*
Jean-Pascal Reymondin, prof. HEIG-VD


16h10 *"Beiträge der Schweizer Industrie in den Weltraum"*
Frédéric Boden, APCO-Technologies, Vice-président du Swiss Space Industry Group

16h25 *"Schweizerisches Pendelflugzeug für Satelliten und die Luftfahrt der Zukunft"*
Pascal Jausi, Swiss Space Systems

16h45 *"Futures activités relatives au spatial chez Swiss-Engineering"*
Josef Horvath, président STV Space Group

17h Apéro und Ende der Swiss Space Days - Apéritif et fin des Swiss Space Days

Les 2 jours, exposition dans le Hall de la HEIG-VD

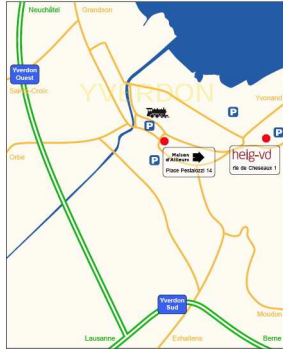


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SWISS ! Appendix – Swiss Space Days p2 to p4



Associazione Svizzerai partners et exposants



Samedi, bus gratuit "Swiss Space Days" de la gare d'Yverdon-les-Bains à la HEIG-VD. Départ : 10h

Am Samstag kostenloser Shuttle-Bus "Swiss Space Days" vom Bahnhof zur HEIG-VD. Abfahrt: 10h

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