Mesure et analyse des paramètres physiques de la poignée de main entre deux personnes dans de simples contextes sociaux

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What is Handshaking?

For human

- Physical and rhythmic interaction :
  - Physical coupling (force, frequency, posture)
- Social Interaction :
  - Context of handshaking (posture)
- Emotional coupling
- Communication (gaze)

For humanoid Robot

- Controller ? (rhythmic movements, external forces)
- How to take into account the social context ?
- How to take into account “an emotional state” of the human?

Handshaking = Physical and Social multimodal interaction

Past

Today

Future?

Outline

I. STATE OF THE ART

- Role of handshake in social interaction between humans
- Handshaking studies in robotics

II. HUMAN-HUMAN PHYSICAL INTERACTION MODELING

- Previous Works
- Measurement system
- Experimental results and discussions

CONCLUSIONS

State of the art : handshake between humans

Schiffrin, 1974 → HS regulates et maintains human interactions

Hall and Hall, 1983 → HS initiates and built social interactions

Astrom, 1994, 1996 → correlations to personality traits

Chaplin et al, 2000 → link between personality and HS characteristics : gaze, strength, vigor, grip, durations..

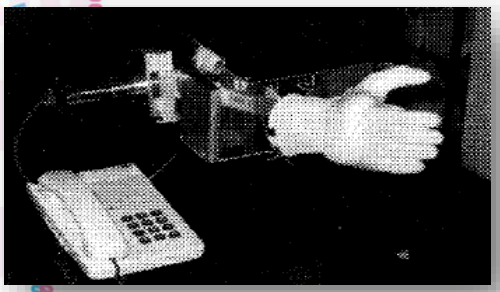
Stewart et al, 2008 → HS in interview assessment: correlation to Extraversion, gender, professional dress,

Bernieri et al., 2011 → conscientiousness in HS

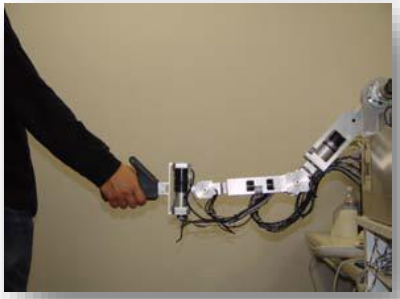
Golubchik, et al., 2012 → HS = diagnostic tools in medicine

- HANDSHAKE IS STUDIED IN PSYCHOLOGY
- BUT WITHOUT QUANTITATIVE MEASUREMENT OF HANDSHAKE PARAMETERS (PHYSICAL AND PSYCHOLOGICAL)

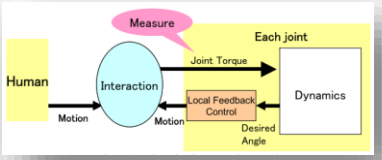
Handshaking in robotics



Hashimoto, Ouchi and Manarotkul, (1996, 1997)
Frequency : 1 Hz, 10 N

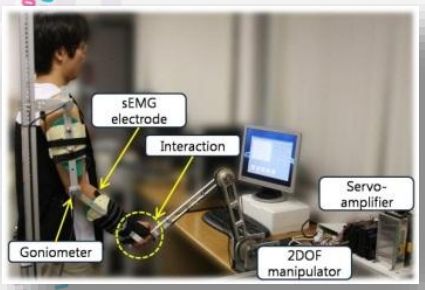


Kasuga and Hashimoto, (2005)
Frequency: 1,48 Hz

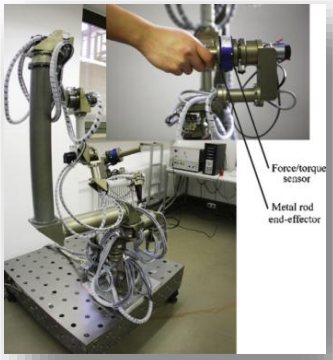


Sato, (2007)
Frequency: 6.5-7 Hz

Jindai et al. (2006 – 2012)
Frequency : 2 Hz,
Duration: 2.5 s

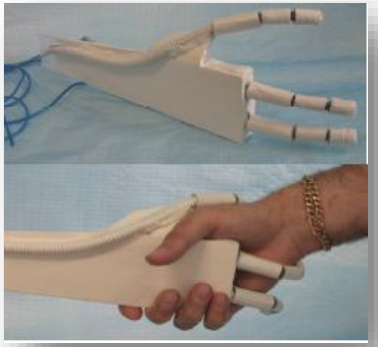


Kwon and Kim, (2009)
Frequency : No information



Giannopoulos et al, (2011)
Wang, et al., (2011)
- Frequency :1,5 Hz

Bainbridge et al, (2011)
Frequency: No information



Vanello et al, (2011)
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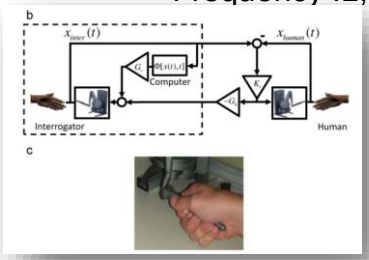
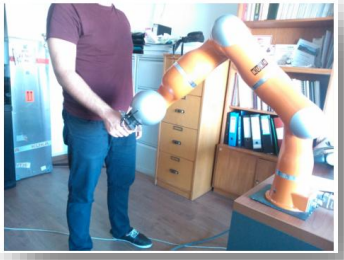


Avraham et al. 2012
Frequency : 2.5 Hz

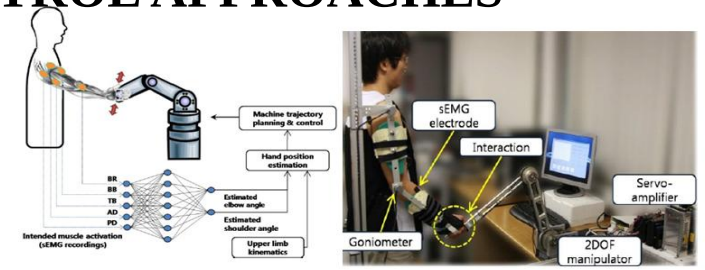


Papageorgiou et al. 2015
Frequency : 1.5 Hz
Duration : 2 s

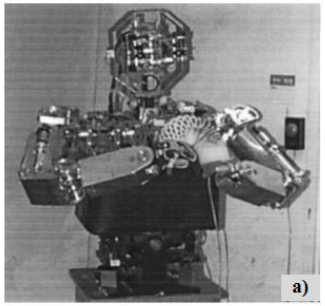
Handshaking in robotics:

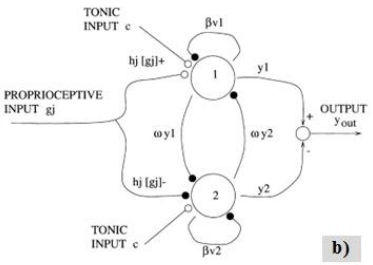
BIO-INSPIRED CONTROL APPROACHES

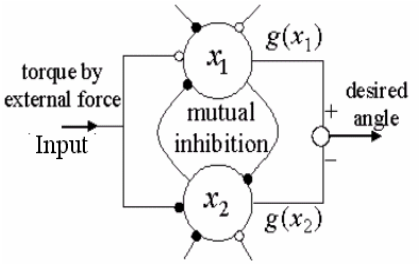
Kwon & Kim, 2009, 2011
→NN for Prediction of intention from EMG et EEG.



Williamson, 1998;
Kasuga & Hashimoto, 2005
Sato, et al., 2007
→ Neuronal oscillator (Matsuoka model)



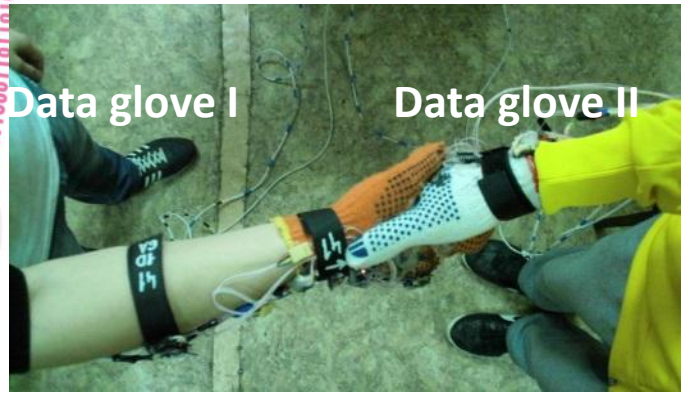




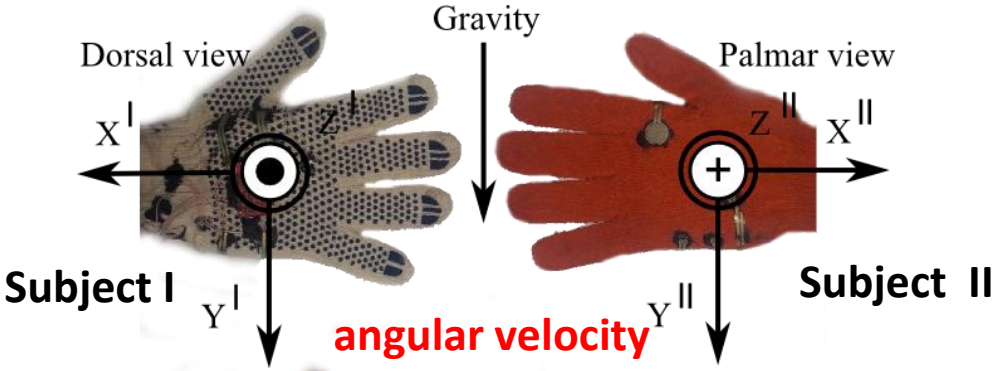
- WITHOUT MODELING OF THE INTERACTION
- WITHOUT SOCIAL CONTEXT

Human-human physical interaction modeling

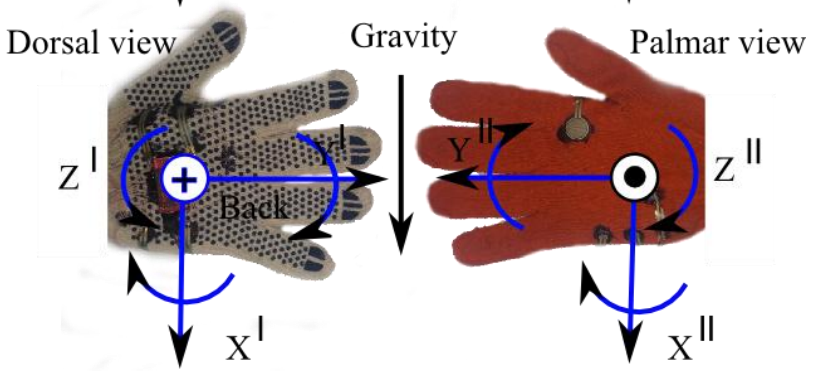
Previous works (Melnyk et al. 2014)

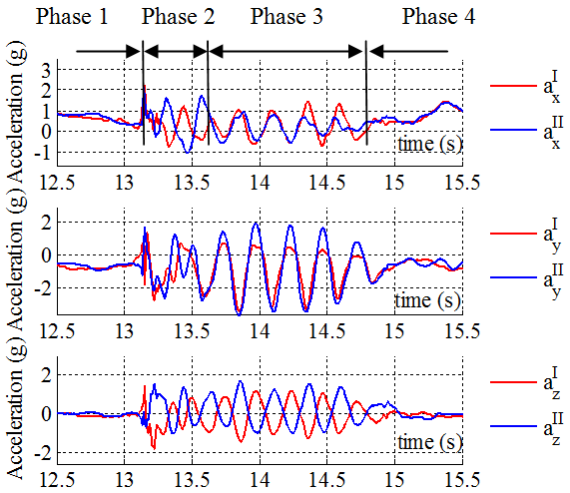


Accelerometers



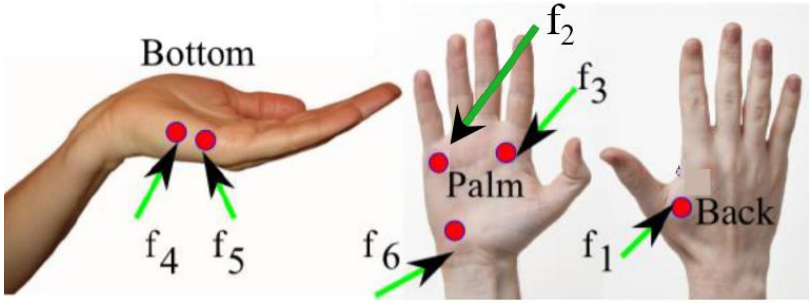
angular velocity





- **Four phases**
- **Synchrony (PLV)**

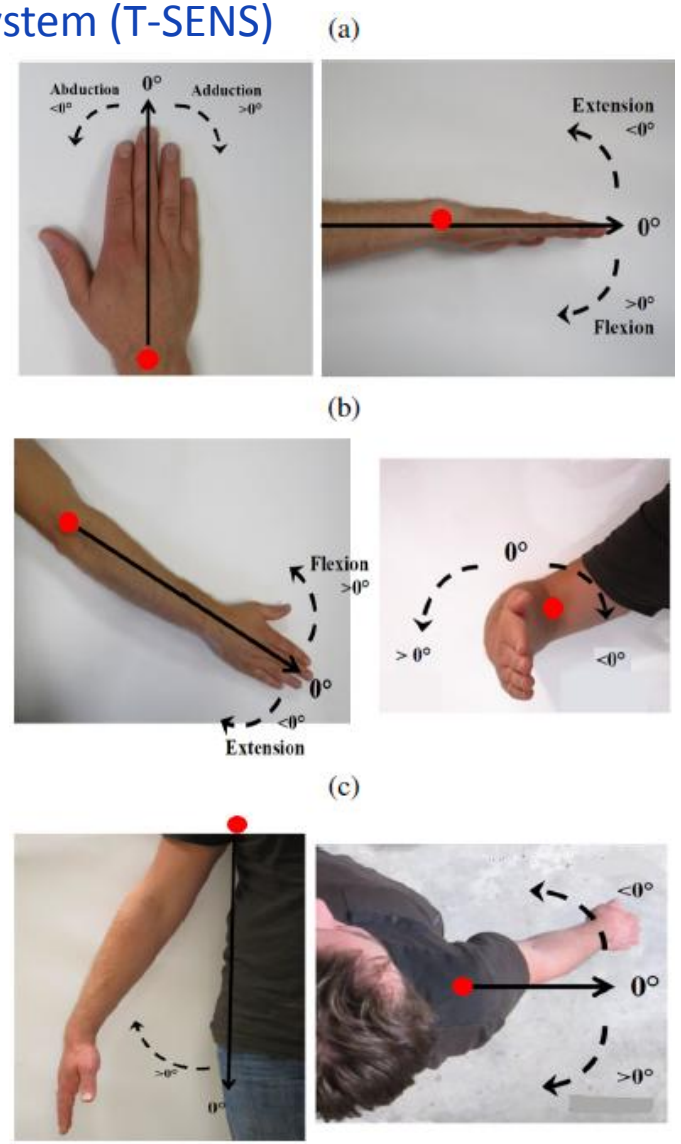
6 Forces sensors (FSR)



Measurement system

Physical parameters measuring system (T-SENS)

Inertial Measurement Unit (IMU) positions



Elementary movements of joints: (a) Wrist, (b) Elbow, (c) Shoulder

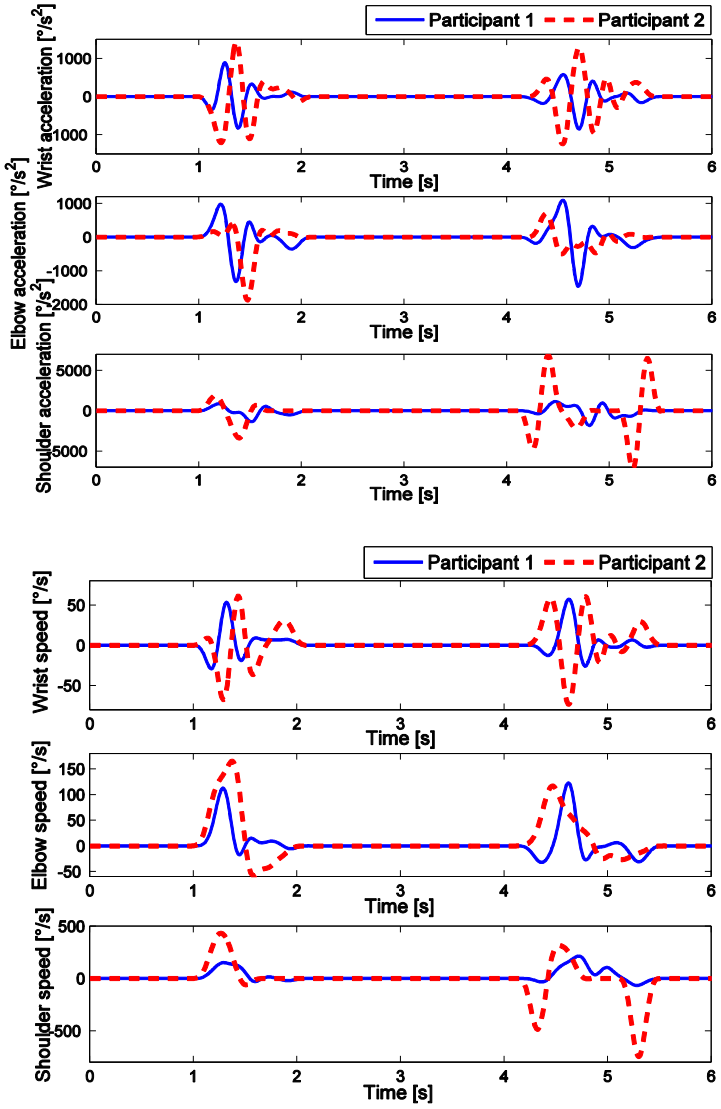
Experimental results
(Data collection methodology)

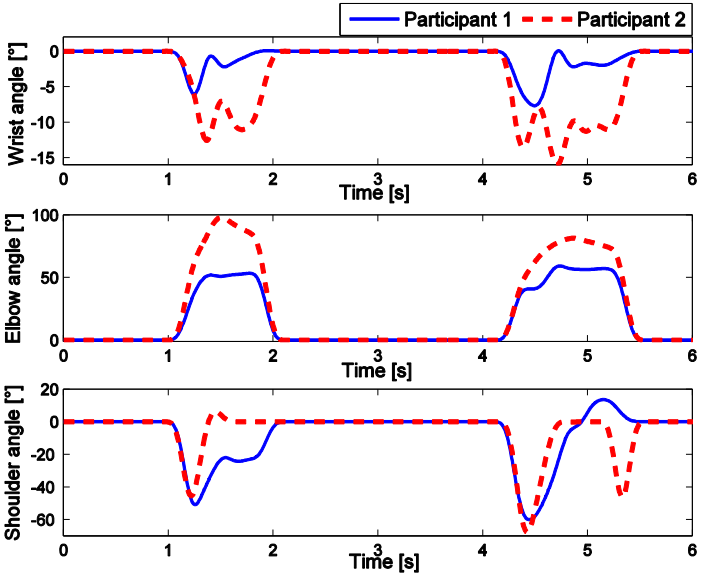
Simple social contexts:
- 'Hello', 'Congratulations' and 'Sympathies' greetings

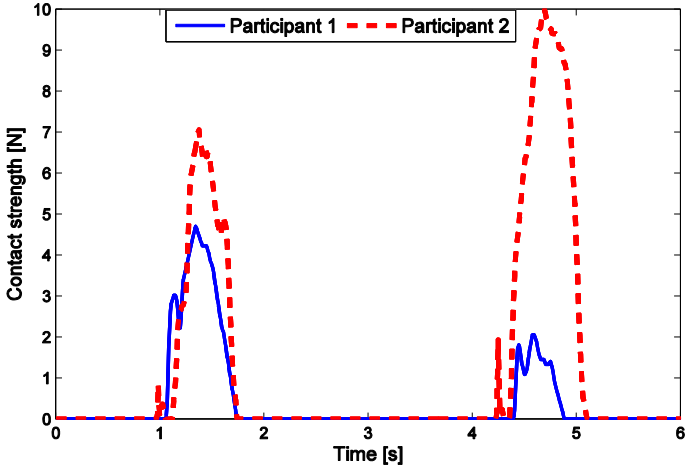
Data informations:
- 44 people
- aged 19-66 years
- more than 400 hanshakes
- around 15 minutes by a couple of participants

Experimental results

Example of two handshakes



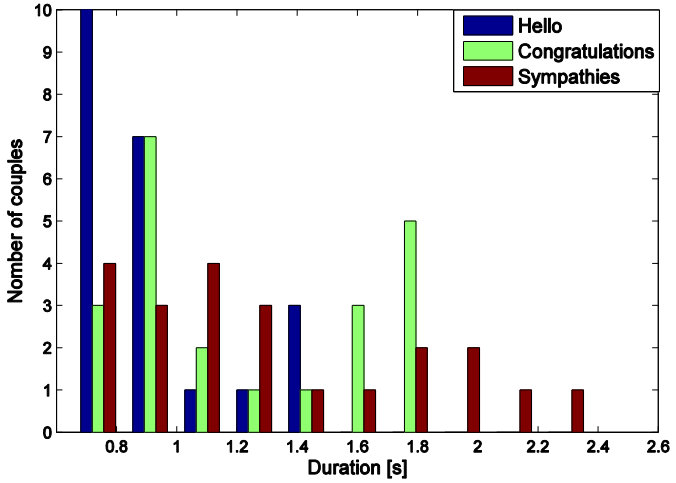




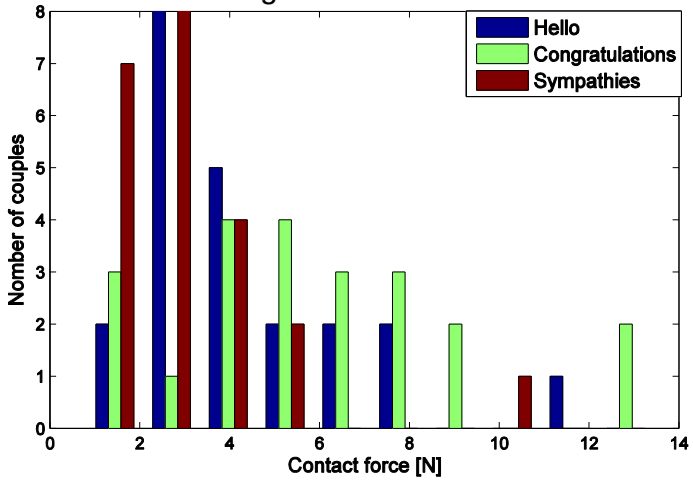
Experimental results

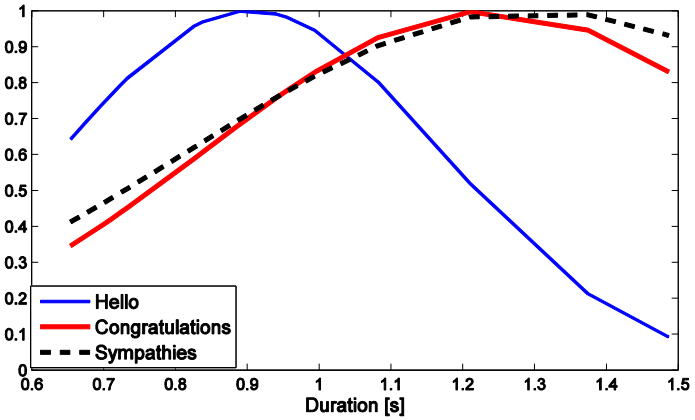
(Duration and Strength)

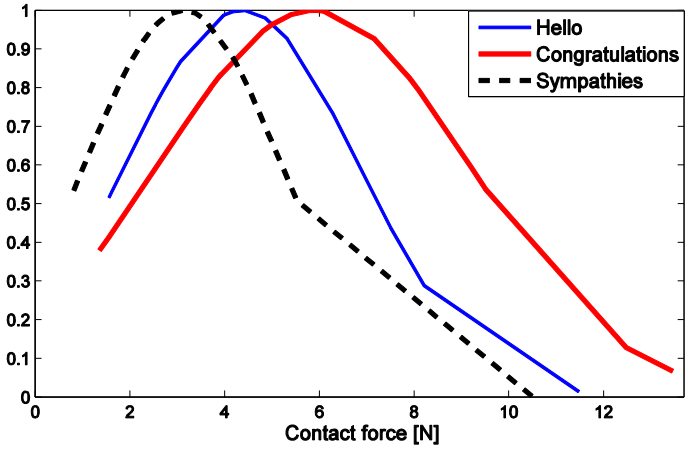
Duration: 0.65 to 1,5s



Strength: 0.5 to 14.5 N



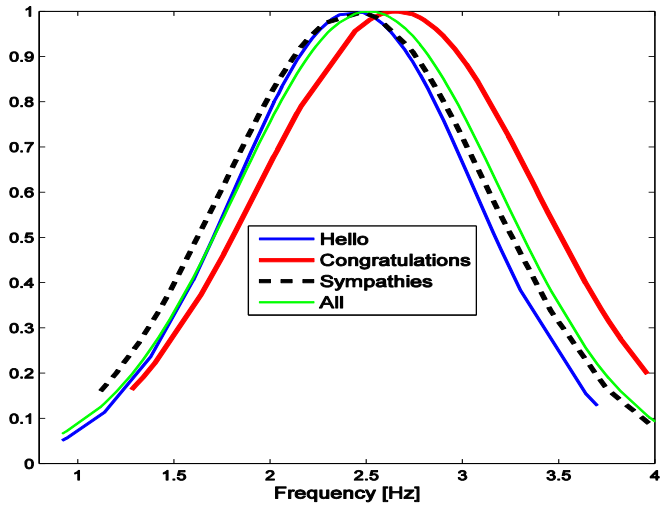


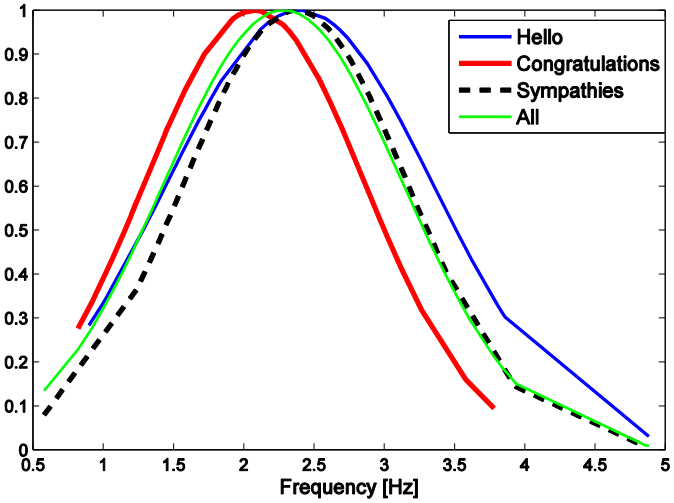


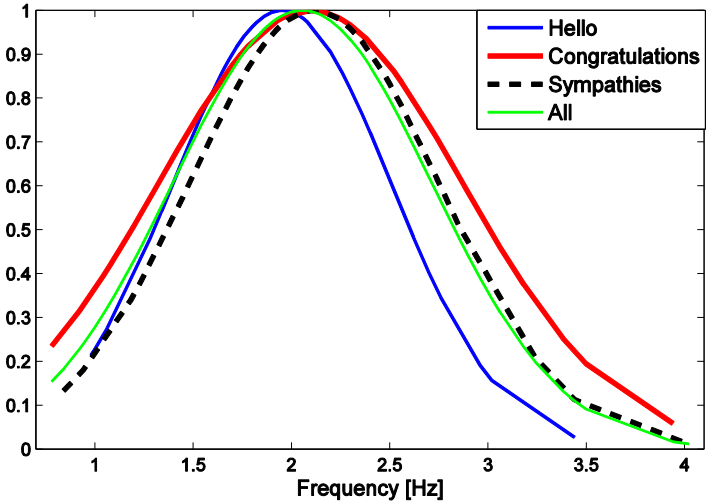
Duration \ Force	Low	Medium	High
Short	-	Hello	-
Long	Sympathies	-	Congratulations

Experimental results

(Joints main frequency)



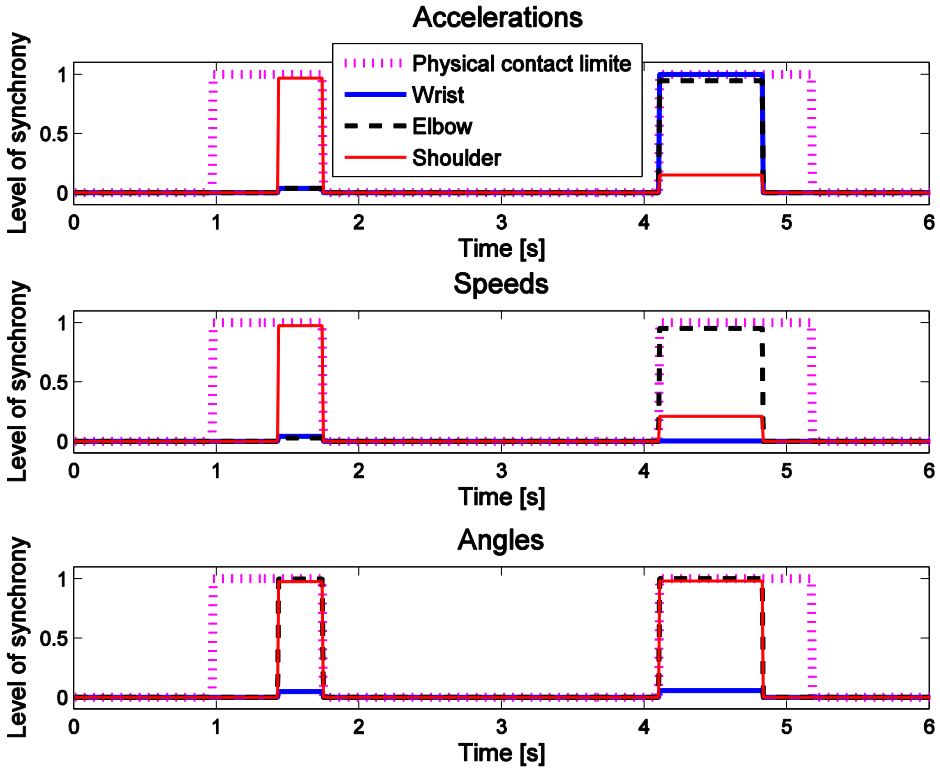


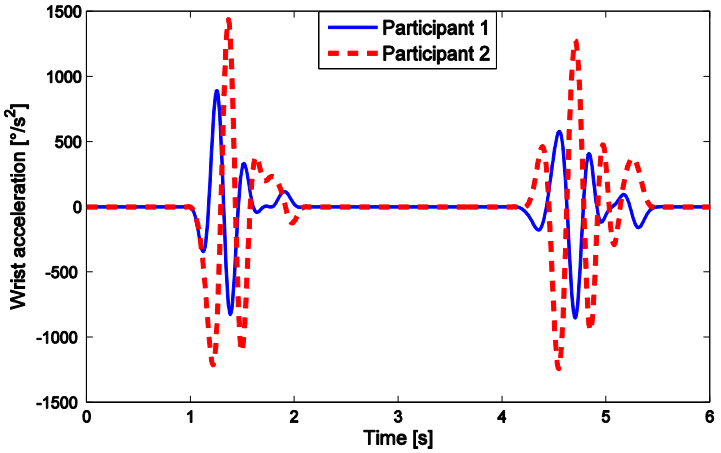


Same main frequency
Synchrony ?

Experimental results

(Synchrony evaluation: 'Hello' greetings)





How and where can be measured the synchrony ?

Conclusion

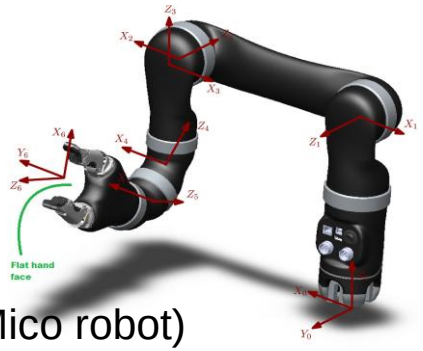
Handshake :

- Main phases
- Fundamental frequency of the movement in the Physical contact phase is around 2.5 Hz, duration is 1.2 s and the average maximum strength force is about 4.5 N.
- Parameters to design bio-inspired controller

Synchrony :

- Level of synchrony
- Link between physical synchrony and communication (emotional synchrony)

Future works



- Improve the experimental protocol
- Propose adaptive controllers models
- Using a compliant robot in order to reproduce handshakes (Kinova Mico robot)
- Evaluate robot social acceptance
- Taking into account the body posture of human
- Emotional state of the human
- Gaze coupling

Publications

1. Melnyk, A., Khomenko, V., Borysenko, V., Henaff, P. (2014) Sensor Network Architecture to Measure Characteristics of a Handshake Between Humans. IEEE XXXIV International Scientific Conference Electronics and Nanotechnology (ELNANO) pp. 264-268.

2. Melnyk A. A., Henaff P., Borysenko V. Ph. (2014) Analysis of Synchrony of a Handshake Between Humans, IEEE/ASME Int. Conf. on Advanced Intelligent Mechatronics (AIM), France, 1753- 1758.

3. Melnyk A., Khomenko V., Borisenko V., Henaff P., "Physical human–robot interaction in the handshaking case: learning of rhythmicity using oscillators neurons" , Proceedings of 2013 IFAC Conference on Manufacturing Modeling, Management, and Control, IFAC MIM '2013, St Petersburg, Russia, 19-21 June 2013.

4. Pugach G., Khomenko V., Pitti A., Melnyk A., Henaff P., Gaussier Ph., "Electronic hardware design of a low cost tactile sensor device for physical Human-Robot Interactions", Proceedings of 2013 IEEE XXXIII International Scientific Conference on Electronics and Nanotechnology, IEEE ELNANO '2013, Kiev, Ukraine, 16-19 April 2013.

5. Khomenko V., Melnyk A., Mesnil A., Henaff P., Borysenko V., "Adaptive behavior of electromechanical anthropomorphic robots during physical interaction with environment and with human being", Theoretical and Applied Aspects of Cybernetics, Proceedings of the 2nd International Scientific Conference of Students and Young Scientists, Cybernetics Faculty of T. Shevchenko National University of Kyiv, V.M. Glushkov Institute of Cybernetics of National Academy of Sciences of Ukraine, 12-16 November 2012.

6. Melnyk A. A., Henaff P., Razakarivony S., Borysenko V. Ph., Gaussier Ph., (2011) Adaptive Behavior Of An Electromechanical Arm Robot In a Case Of Physical Interaction With a Human Being, in Proc. of IEEE/ASME Int. Conf. on Advanced Intelligent Mechatronics (AIM2011), Hungary, pp. 689-694.