DESARROLLANDO
LA INDUSTRIA VERDE
INNOVADORA

INNOVATION MATCH MX 2016-2017

2º Foro Internacional de
Talento Mexicano

TITLE:

Towards the improvement of Healthy Ageing with Humanoid Robots

31 de Mayo
1 y 2 de Junio
2017
CDMX

CODE of the presentation:	IMMX-MA-0058

Author: Miguel P. Xochicale @_mxochicale

www.innovationmatchmx.com

ABSTRACT

INNOVATION MATCH MX 2016-2017

2º Foro Internacional de Talento Mexicano

According to The World Health Organization (WHO), 125 million of people worldwide were aged 80 years or older in 2015 and it is predicted that 350 million of older people will live in low- and middle-income countries by 2050. The WHO pointed out that some of the challenges in the Healthy Ageing arena are the improvement of methodologies for measurement, monitoring and understanding of physical activity. Therefore, I am proposing the use of humanoid robots to tackle the previous challenges.

Outline:

- **INTRODUCTION**
  Caring the elderly using Humanoid Robots.
- **METHODOLOGY**
  Human-Activity Recognition Chain and the State Space Reconstruction.
- **RESULTS**
  Quantifying the variability of simple movements.
- **CONCLUSIONS and FUTURE WORK**

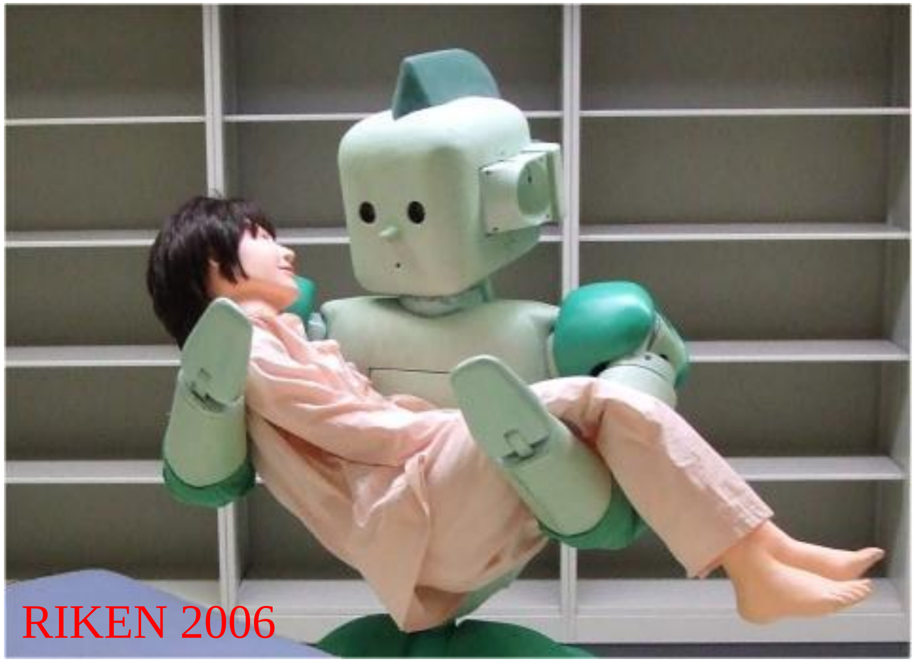
31 de Mayo
1 y 2 de Junio
2017

CDMX

www.innovationmatchmx.com

RI-MAN: Caring the elderly using Humanoid Robots

- Feedback of force using tactile information
- Human-friendly soft body
- Sound localization using 'ears'
- Tracking human face by integrating auditory and visual information
- Smell discernment by semiconductor gas sensor



http://rtc.nagoya.riken.jp/RI-MAN/index_us.html

RIBA-II, the next generation care-giving robot

- RIBA-II can crouch down and lift a patient off a futon at floor level.
- RIBA-II can detect a person's weight from touch alone using capacitive tactile sensors made entirely of rubber.

http://www.riken.jp/en/pr/press/2011/20110802_2/

PARO, Therapeutic Robot

- PARO has five sensors: tactile, light, audition, temperature, and posture sensors which PARO can perceive people and its environment.
- PARO has been found to reduce patient stress, improve patients' relaxation and motivation.

Paro Robots 2013

http://www.parorobots.com/

PALRO: Humanoid Robot designed to help humans

- PALRO is used for recreation activities for elderly people covering games, exercises, quiz and music.
- Analysis of sound types, recognition of faces with high-speed and high-accuracy, detection of moving bodies, identification of individual from voice prints, recognition of sound source direction.
- PALRO has 4 microphones, 2M-pixel camera, distance sensors, 20 servo motors, pressure sensors and 60 LEDs to generate facial expressions.

Palro Robot 2016
https://palro.jp/en/feature

NAO: Humanoid Robot for Therapy

- NAO has been used as an instructor for therapies in rehabilitation
- NAO has 25 degrees of freedom, capacitive sensors, sonars,
  4 mics, speakers,
  2 cameras, internet access.

https://www.ald.softbankrobotics.com/en/cool-robots/nao/find-out-more-about-nao

NAO: Humanoid Robot for Therapy

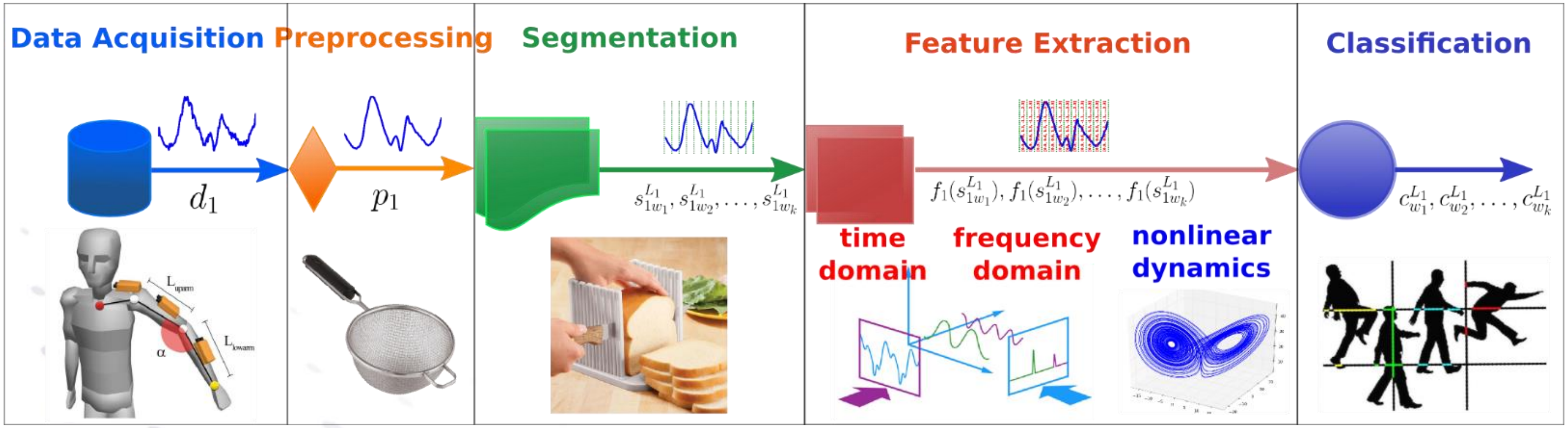
https://www.ald.softbankrobotics.com/en/cool-robots/nao/find-out-more-about-nao

Robocoach: Humanoid Robot for Exercise

Robocoach coaches the elderly to perform 15 types of arm exercise.

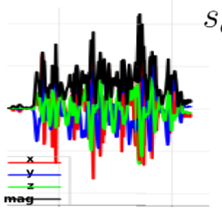
Ngee Ann Polytechnic’s School of Engineering, 2015

Human Activity Recognition Chain



State Space Reconstruction

Raw Data: $s_a(n)$



$$s_a(n) = \{s_a(1), \ldots, s_a(L)\}$$

$s =$ sensor (acc,mag,gyr)

$a =$ axis (x,y,z)

$n =$ index

$L =$ window length

Takens's Theorem: $E_m^\tau\{s_a(n)\}$

$$E_m^\tau\{s_a(n)\} = \{s_a(n), \ldots, s_a(n-(m-1)\tau)\}$$

$E_m^\tau =$ Embedded Matrix

$\tau =$ Time-delay

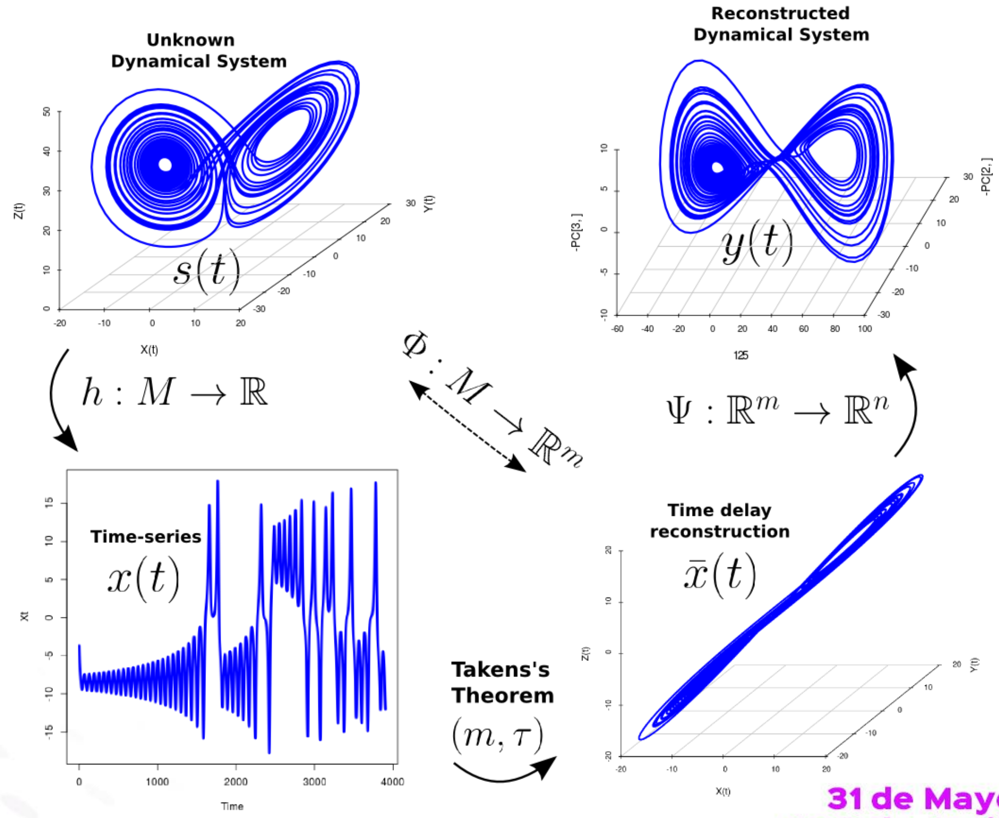
$m =$ Dimension

Principal Component Analysis

$$\mathrm{PCA}[E_m^\tau\{s_a(n)\}] = (\lambda_i, v_i)$$

$\lambda_i =$ Eigenvalues

$v_i =$ Eigenvectors



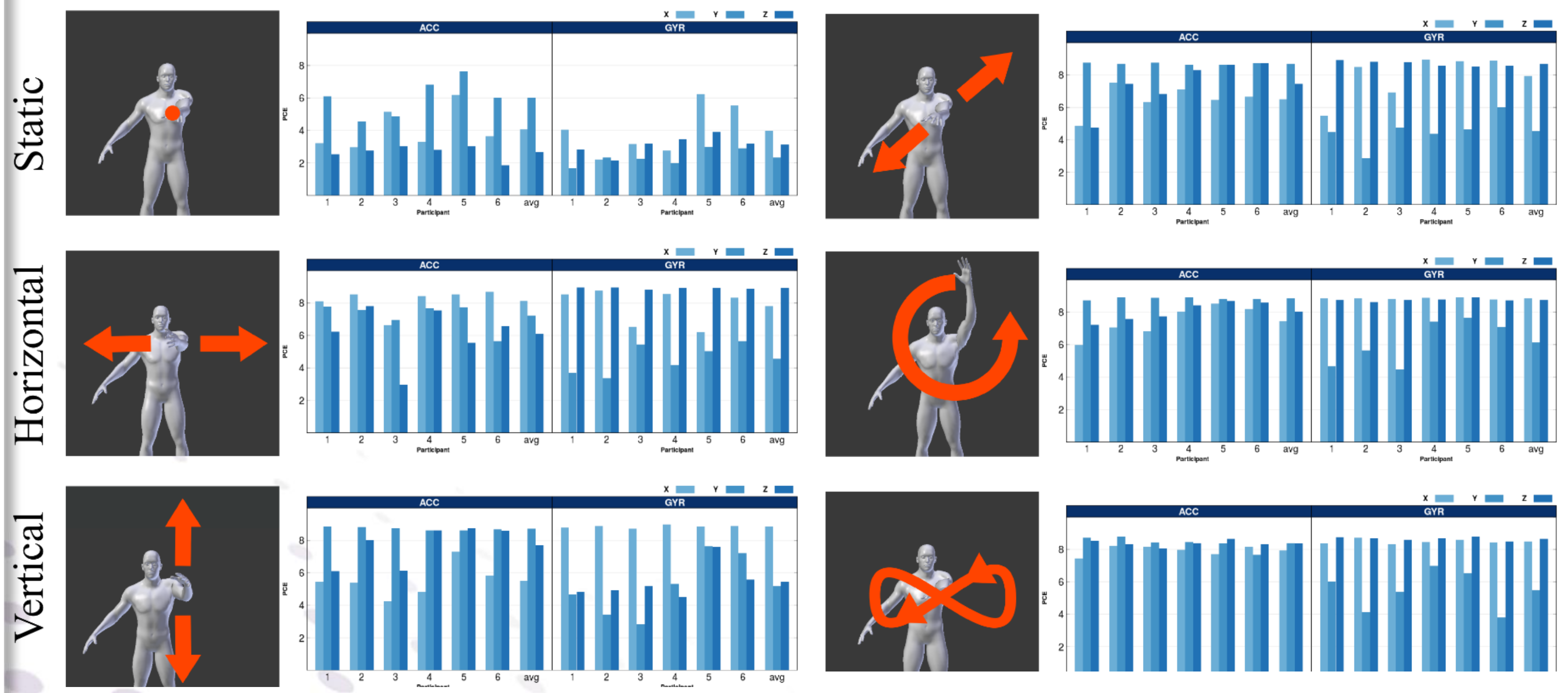
31 de Mayo
1 y 2 de Junio
2017

CDMX

www.innovationmatchmx.com

RESULTS

Variability Simple Movements @PerDis2016

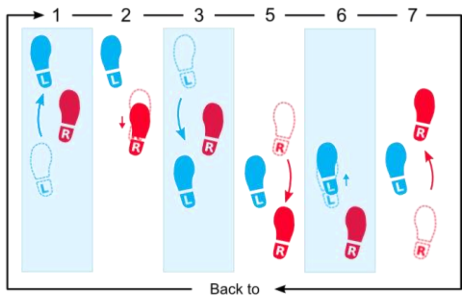


Quantifying variability in human activity can not only provide useful movement diagnostic information but also offers and approach to considering the manner in which people interact with displays.

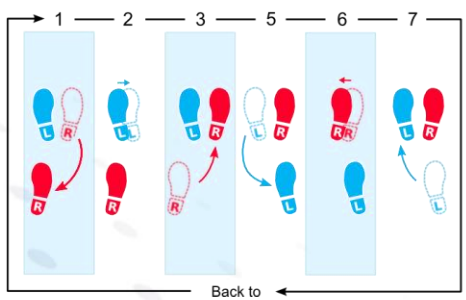
RESULTS

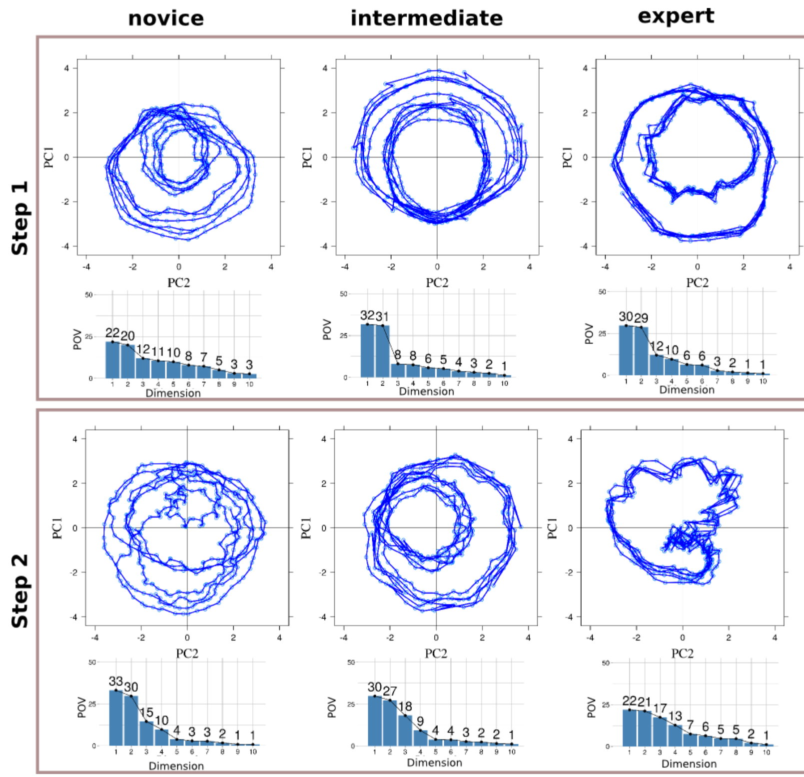
Movement Variability in Dance Activities @WeRob2016

Mambo



Side Cross-over





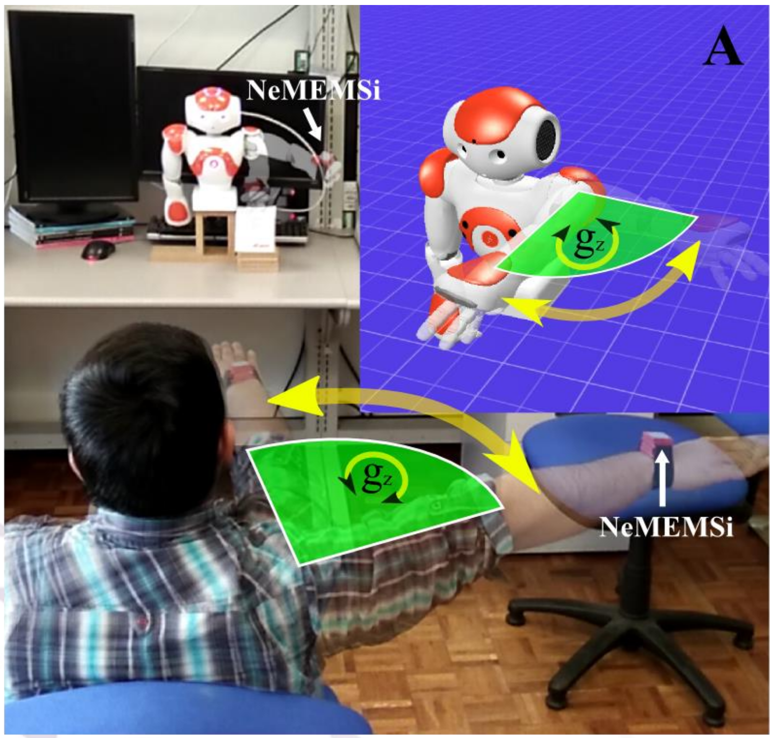
The shape of the reconstructed state spaces is helping us to link it with the level of skilfulness of the dancers

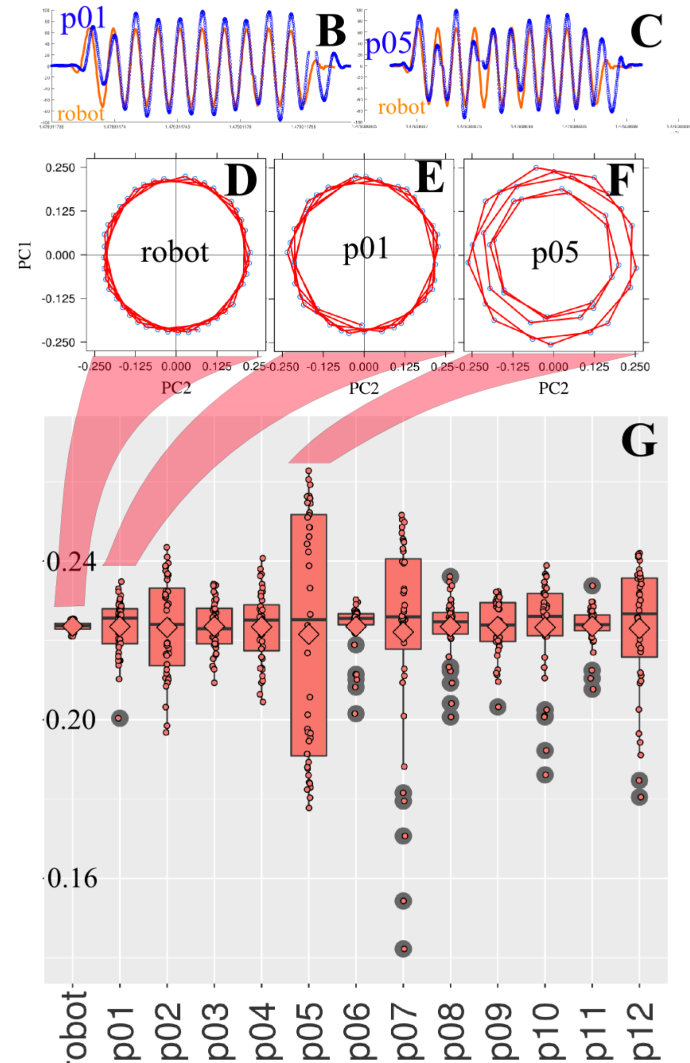
RESULTS

INNOVATION MATCH MX 2016-2017

2º Foro Internacional de Talento Mexicano

Human-Robot Imitation @HRI2017





Although the performed arm movements of healthy were very simple, the study reveals that participants showed different ranges of the proposed metric that can be linked to the level of imitation

CONCLUSIONS

- It has been shown that companies and research institutions have been working for the past 10 years with Humanoids in scenarios of nursing homes and physical therapies for the elderly.
- I presented the outcomes of three publications where I am proposing a metric to quantify the human movement.
- However, there are still many challenges to tackle:
  (i) Create more realistic environments where the elderly can be well monitored;
  (ii) Use humanoid robots with more natural movements; and,
  (iii) Create more adaptable humanoid robots according to the needs of the people.

FUTURE RESEARCH

- For future research, there are four areas that I intent to investigate:

  (i) Data collection from a wider range of individuals (different range of gender, age and state of health);
  (ii) Exploration of complex movements which can be performed by both persons and humanoid robots;
  (iii) Undertake a wider review of nonlinear dynamics techniques that can be used for the assessment of human movement when interacting with humanoid robots; and,
  (iv) Exploration of Deep Neural Networks for automatic classification of the activities of the elderly people.

REFERENCES

M. P. Xochicale and C. Baber and M. Oussalah. 2017.Towards the Quantification of Human-Robot Interaction Using Wearable Inertial Sensors. 12nd Conference of Human-Robot Interaction (HRI2017). March 2017, Vienna, Austria.
https://github.com/mxochicale/publications/tree/master/2017/HRI

M. Xochicale and C. Baber and M. Oussalah. 2016. Analysis of the Movement Variability in Dance Activities using Wearable Sensors. 2nd International Symposium on Wearable Robotics (WeRob16). October 2016, Segovia, Spain.
https://github.com/mxochicale/publications/tree/master/2016/WeRob

M. P. Xochicale and C. Baber and M. Oussalah. 2016. Understanding Movement Variability of Simplistic Gestures Using an Inertial Sensor. The Fifth ACM International Symposium on Pervasive Displays. June 2016, Oulu, Finland.
https://github.com/mxochicale/publications/tree/master/2016/PerDis

GRACIAS

INNOVATION MATCH MX 2016-2017

2º Foro Internacional de Talento Mexicano

Miguel P. Xochicale

Doctoral Researcher in Human-Robot Interaction
University of Birmingham, UK

@_mxochicale

31 de Mayo
1 y 2 de Junio
2017

CDMX

www.innovationmatchmx.com