Modeling Player Activity in a Physical Interactive Robot Game Scenario

Ewerton L.S. Oliveira* Davide Orrú* Tiago P. Nascimento** Andrea Bonarini*

* Department of Electronics, Information, and Bioengineering - Politecnico di Milano, Italy

** Department of Computational Systems - Federal University of Paraíba, Brazil

Corresponding Author (E.L.S. Oliveira): ewerton.lopes@polimi.it

Hai 2017
5th International Conference on Human Agent Interaction
17. - 20. October 2017 | CITEC, Bielefeld

Abstract

We propose a quantitative human player model for Physically Interactive RoboGames (PIRG) that can account for the combination of the player activity (physical effort) and interaction level. The model is based on activity recognition and a description of the player interaction (proximity and body contraction index) with the robot co-player. Our approach has been tested on a dataset collected from a real, physical robot game, where activity patterns extracted by a custom 3-axis accelerometer sensor module and by the Microsoft Kinect® sensor are used. The proposed model design aims at inspiring approaches that can consider the activity of a human player in lively games against robots and foster the design of robotic adaptive behavior capable of supporting her/his engagement in such type of games.

Game Scenario

Environment

- Human vs Holonomic Robot.
- 4m x 2m area.
- Towers placed at the corners.
  - 4 charging LEDs per tower.
  - Charging time: 2.5secs/LED
  - Push button on each tower.

Players role & win/lose condition

- Human player must be able to **secure all** the existing **towers without letting a single one be ruined down by the robot**.
- "Secure a tower" means turn on all 4 charging LEDs on each tower (using a tower charging button)
- If, at anytime, a tower falls (because of the robot or player) the game ends and the human player is defeated.
- Player can move across the entire playground.
- Human can block the robot's path by staying in front of it.
- Robot cannot try to put down an already captured tower, or one whose button is currently pressed by the human player.

Notice that while the player is trying to capture a given tower the robot can try to put down another one!

Robot & Other Hardware Components

Robot

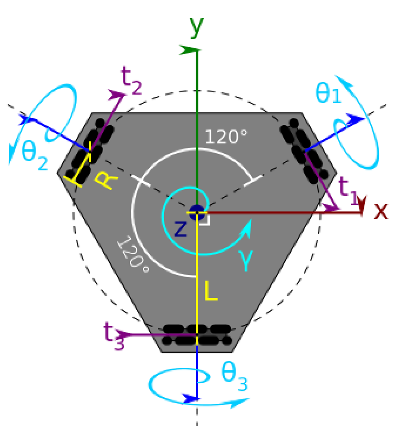
- Robust, triangular, omnidirectional base 5cm
- high (with 40 cm in diameter).
- Kinect sensor on top.
- Shuttle computer.
- Max velocity 1.4 m/sec.
- 85cm tall.

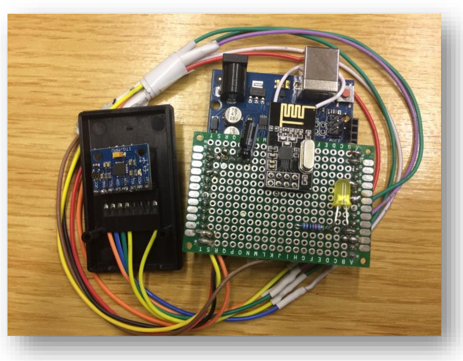
Software

- Native ROS integration

Accelerometer

- Custom device:
  - InvenSense MPU-6050
  - Arduino Uno
  - Nrf24l01 radio frequency





Method

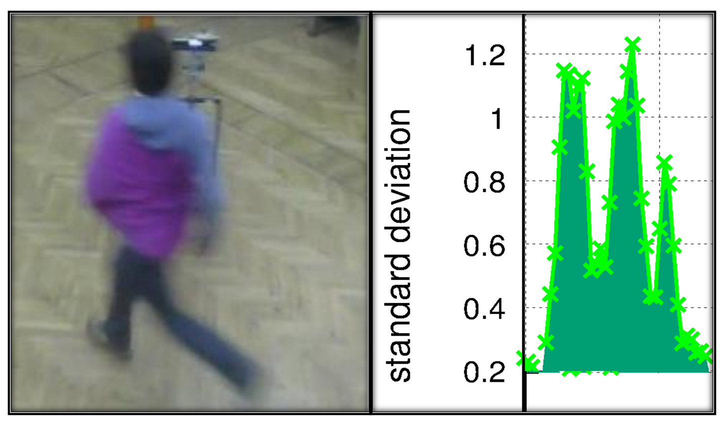
Activity Description

Step 1: Classify high-level activity. Here, *running; walking/dodging; locally moving* and *inactive*.

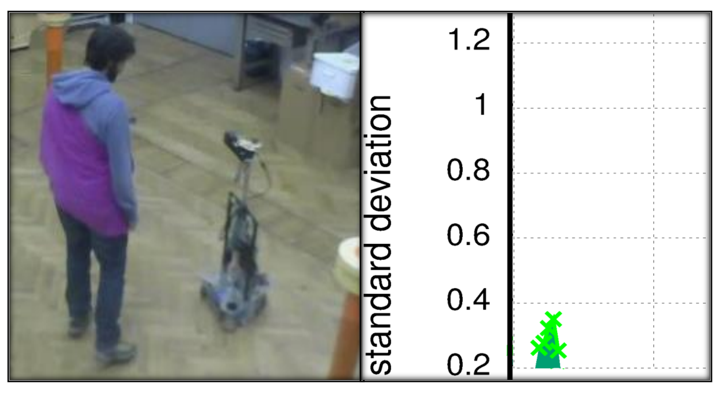
Step 2: Compute the general amount of activity $\alpha(m)$ given the classification of primitive motion m:

$$\alpha(m) = \sum_{i \in A} \omega_i \varphi_i$$

, where A stands for the set of activities; ω stands for the activity weight; φ for the stochastic prediction value for the motion primitive m.



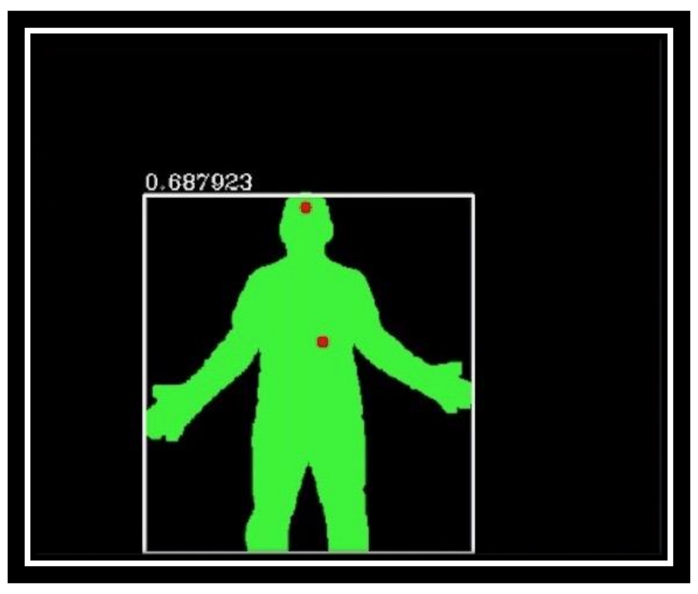
(a)



(b)

Motion primitives: a) acceleration-based motion primitive for "running". b) "locally-moving" motion primitive.

Interaction Description



Proximity is a measure ranging in [0, 1], computed from the data provided by Kinect, normalized given the sensor specifications.

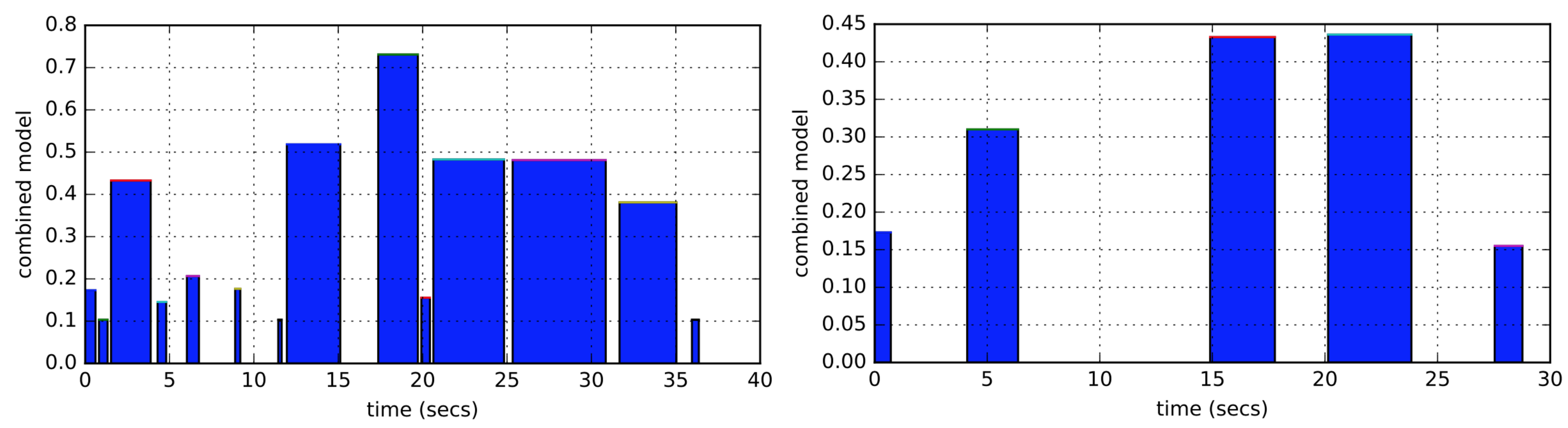
CI is also in [0 , 1] and it is calculated using a technique related to the bounding region, i.e., the minimum rectangle surrounding the body: the algorithm compares the area covered by this rectangle with the area currently covered by the player's silhouette.

Relational activity model

$$\varepsilon = \rho\alpha(m)$$

- ρ is the interaction description. Here, the combination of CI and proximity.
- the exact procedure for the combination of the interaction signals is not bound to a specific method.
- we have used a fuzzy logic system to obtain the desired combination. In principle, the combination of the signals depends on the specifics of the PIRG environment.

Results



On the left, the model output for an active player. A less active one is shown on the right.

Conclusion & Future Work

- We have proposed a simple baseline metric expected to enable a robot to take into account the player's attitude in order to adapt its own activity.
- We are currently extending the description of the interaction by taking into account the player's interaction with the game elements (towers), as well as the player's strategy. This would provide insights that would make possible to measure not just the activity level of the player, but also his/her skill level and potentially contribute to a better estimation of engagement.

Acknowledgements

This work was in part supported by the Brazilian National Council for Scientific and Technical Development (CNPq) under the Science Without Border Scholarship Program.

CIÊNCIA SEM FRONTEIRAS

www.polimi.it airwiki.ws.dei.polimi.it CNPq BRASIL GOVERNO FEDERAL