CENTRO DE INVESTIGACIÓN Y DE ESTUDIOS AVANZADOS DEL IPN
DEPARTAMENTO DE COMPUTACIÓN

OBJECT TRACKING ON SOFT-IRREGULARITY SURFACES MODELED by APPEARANCE-BASED METHOD

FARID GARCÍA LAMONT & JOSÉ MATÍAS ALVARADO MENTADO

farid@computacion.cs.cinvestav.mx, matias@cs.cinvestav.mx

ABSTRACT

Robots have acquired more freedom and capacity to process huge quantities of information, leading to be more autonomous and intelligent. For instance, robotic soccer players of RoboCup tournament. But these robots have limitations, one of them is they cannot move on surfaces that are not totally plain. They are designed to move on surfaces without irregularities, common features on real soccer games. The robot must learn, by artificial vision means and neural networks, to distinguish and avoid the irregularities lying on the surface. We propose to model the moving object and the surface with its features, textures, holes and slopes, by appearance-based method, such that the robots identify them and then to pursue the moving object without accident risks. The robot must decide if it can pass through or round an irregularity, besides it is considered the surface has different kinds of textures, then the robots speed must be updated when a texture change is detected in order not to suffer slides.

ANTECEDENTS

RoboCup's small-size robots move agile on the game field, but they are not designed to move on surfaces with irregularities, such as surfaces with different kind of textures, holes or slopes lying on it [7]. Robotic soccer game involves problems such as pattern recognition, concurrency control and decision making, but up to now, they have not paid attention to surface features [5].

A small-size game works as follows. There are two teams, each team with five players. They receive instructions from their respective "coach", via wireless. A digital video camera, located at two or three meters over the surface, sends games images, aerial view, to the coaches in order to process them, make decisions, attacking and defensive strategies, and finally communicates the instructions to players. By adding surface features, the players must move considering the irregularities, but without ignoring the coach's orders. For instance, if surface is slippery, then the players must move slowly in order not to suffer slides.

OBJETIVES

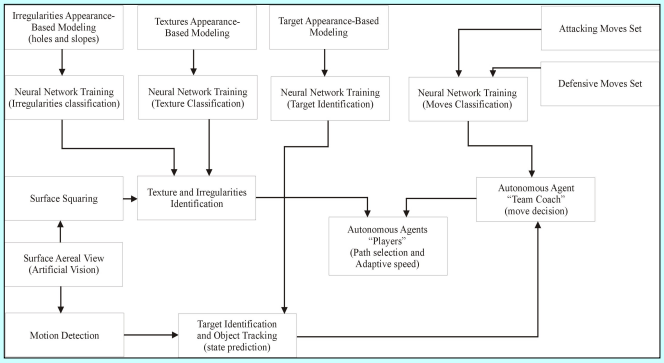
GENERAL OBJETIVE

Object tracking on soft-irregularity surfaces.

PARTICULAR OBJETIVES

1. Appearance-Based Modeling of surface textures and slopes.
2. Robotic soccer players learning based on neural networks for moving and tracking on soft surfaces, less than 15 degrees of slope.
3. Concurrent pursue of moving object on soft-irregularity surfaces.

METHODOLOGY



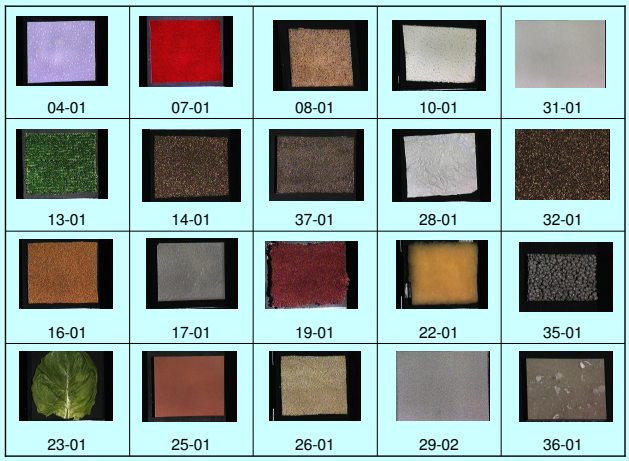
PROPOSAL

It is necessary to identify the surface's irregularities [3], holes, slopes and textures [2], [7] so as the players can move safely on irregular surfaces, We propose to appearance-based model such irregularities. This method computes the principal components from objects' image distribution [1], [9]. Images of holes, slopes and textures are taken from an aerial view. The principal components are used to train a neural network (NN) in order to classify the surface irregularities. Due to our video camera is located on top of the surface; it gives a surface aerial-view image. But, the surface features cannot be detected, because the whole image would be modeled as an only one object, therefore, the surface features would not be well integrated or even omitted. Thus, the surface is divided in squares, squaring, so as to get more information about surface features, and to identify such irregularities easily. Besides, squaring is employed as a reference system for players. The team is divided in five players and one "coach", both coach and players are modeled as autonomous agents [6]. The coach receives information from the video camera, elaborates strategies, makes decisions and sends its instructions, surface locations the players must occupy, to the players. Each player adapts its speed depending on the surface textures and decides where it can navigate in order to achieve a surface location. For ball tracking, the ball is also appearance-based modeled for a later recognition phase. Up to now, there are not appearance-based tracking methods. Usually motion is detected with optic flow methods, and then the object in motion is identified with appearance-based method [10]. Because of the game's nature, it is possible that the ball suffer occlusions. In order to robust ball tracking, future-states estimation, Kalman filter, is contemplated for our work.

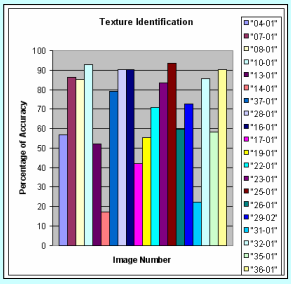
CURRENT RESULTS

TEXTURE IDENTIFICATION

- **Columbia-Utrecht Reflectance and Texture Database** [4].



- **Texture Identification Results**



FUTURE WORKS

It is planned to develop practical implementations of adaptive speed, due to simulations have showed speed variations of robots walking on surfaces with different kind of textures. Soccer games are also planned simulate by modeling the players as autonomous agents that are controlled from a virtual coach, also modeled as autonomous agent. The coach make decisions about the positions the players must occupy on the field, following a specific strategy, the players move to the indicated positions, adapting their speed when a texture change is detected. For object tracking, optic flow methods are considered to be implemented because of its efficiency but these method only detect motion, then it is necessary to add a object recognition phase, for these case appearance-based methods are a good choice.

CONCLUSIONS

It has been developed a neural network for surfaces textures recognition so as to adapt a robot's speed depending on the texture changes on the surface. Texture recognition is agile, this feature holds a huge promise; due to the robot reaction, speed updating, depends on how fast the texture recognition is. Our proposal can be extended for slopes and holes recognition by following the same steps for texture recognition. A neural network would identify if on a surface image there is a hole or slope, and how big it is, then it is decided if the robot can pass through or should avoid the hole or slope.

REFERENCES

1. Altamirano, L.C., Altamirano, L., Alvarado, M.: Non-Uniform Sampling for Improved Appearance-Based Models. Pattern Recognition Letters, pp. 521-535 (2002).
2. Brooks, A.C.: Vibration-Based Terrain-Classification for Planetary Exploration Rovers. IEEE Transactions on Robotics, pp. 1185-1191 (2005).
3. Castelnovi, M., Arkin, R., Collins, T.R.: Reactive Speed Control System Based on Terrain Roughness Detection. Proceedings of the 2005 IEEE International Conference on Robotics and Automation. pp. 891-896 (2005).
4. Columbia-Utrecht Reflectance and Texture Database, 2007.
5. Free University of Berlin, FU-Fighters, http://robocup.mi.fu-berlin.de/pmwiki/pmwiki.php
6. Painat, L., Luke, S.: Cooperative Multi-Agent Learning: The state of the Art. Autonomous Agents and Multi-Agent Systems, pp. 387-434 (2005).
7. Pietikäinen, M., Nurmela, T., Mäenpää, T., Turtinen, M.: View-Based Recognition of Real-World Textures. Patter Recognition. 37, pp. 313-323 (2004).
8. RoboCup Federation, http://www.robocup.org
9. Turk, M., Pentland, A.: Eigenfaces for Recognition. Journal of Cognitive Neuroscience. 3(1), pp. 71-86 (1991).
10. Yilmaz, A., Javed, O., Shah, M.: Object Tracking: A Survey. ACM Computing Survey. Vol. 38, No. 4, article 13 (2006)