ADVANCES IN INTELLIGENT AND *SOFT COMPUTING* 87

Emilio Corchado
Václav Snášel
Javier Sedano
Aboul Ella Hassanien
José Luis Calvo
Dominik Ślęzak (Eds.)

Soft Computing Models in Industrial and Environmental Applications, 6th International Conference SOCO 2011

Springer

Advances in Intelligent and Soft Computing 87

Editor-in-Chief: J. Kacprzyk

Advances in Intelligent and Soft Computing

Editor-in-Chief

Prof. Janusz Kacprzyk
Systems Research Institute
Polish Academy of Sciences
ul. Newelska 6
01-447 Warsaw
Poland
E-mail: kacprzyk@ibspan.waw.pl

Further volumes of this series can be found on our homepage: springer.com

Vol. 74. M.P. Rocha, F.F. Riverola,
H. Shatkay, J.M. Corchado (Eds.)
Advances in Bioinformatics, 2010
ISBN 978-3-642-13213-1

Vol. 75. X.Z. Gao, A. Gaspar-Cunha,
M. Köppen, G. Schaefer, and J. Wang (Eds.)
Soft Computing in Industrial Applications, 2010
ISBN 978-3-642-11281-2

Vol. 76. T. Bastiaens, U. Baumöl,
and B.J. Krämer (Eds.)
On Collective Intelligence, 2010
ISBN 978-3-642-14480-6

Vol. 77. C. Borgelt, G. González-Rodríguez,
W. Trutschnig, M.A. Lubiano, M.Á. Gil,
P. Grzegorzewski, and O. Hryniewicz (Eds.)
Combining Soft Computing and Statistical Methods in Data Analysis, 2010
ISBN 978-3-642-14745-6

Vol. 78. B.-Y. Cao, G.-J. Wang,
S.-Z. Guo, and S.-L. Chen (Eds.)
Fuzzy Information and Engineering 2010
ISBN 978-3-642-14879-8

Vol. 79. A.P. de Leon F. de Carvalho,
S. Rodríguez-González, J.F. De Paz Santana,
and J.M. Corchado Rodríguez (Eds.)
Distributed Computing and Artificial Intelligence, 2010
ISBN 978-3-642-14882-8

Vol. 80. N.T. Nguyen, A. Zgrzywa,
and A. Czyzewski (Eds.)
Advances in Multimedia and Network Information System Technologies, 2010
ISBN 978-3-642-14988-7

Vol. 81. J. Düh, H. Hufnagl, E. Juritsch,
R. Pfliegl, H.-K. Schimany,
and Hans Schönegger (Eds.)
Data and Mobility, 2010
ISBN 978-3-642-15502-4

Vol. 82. B.-Y. Cao, G.-J. Wang,
S.-L. Chen, and S.-Z. Guo (Eds.)
Quantitative Logic and Soft Computing 2010
ISBN 978-3-642-15659-5

Vol. 83. J. Angeles, B. Boulet,
J.J. Clark, J. Kovecses, and K. Siddiqi (Eds.)
Brain, Body and Machine, 2010
ISBN 978-3-642-16258-9

Vol. 84. Ryszard S. Choraś (Ed.)
Image Processing and Communications Challenges 2, 2010
ISBN 978-3-642-16294-7

Vol. 85. Á. Herrero, E. Corchado,
C. Redondo, and Á. Alonso (Eds.)
Computational Intelligence in Security for Information Systems 2010
ISBN 978-3-642-16625-9

Vol. 86. E. Mugellini, P.S. Szczepaniak,
M.C. Pettenati, and M. Sokhn (Eds.)
Advances in Intelligent Web Mastering – 3, 2011
ISBN 978-3-642-18028-6

Vol. 87. E. Corchado, V. Snášel,
J. Sedano, A.E. Hassanien, J.L. Calvo,
and D. Ślęzak (Eds.)
Soft Computing Models in Industrial and Environmental Applications, 6th International Conference SOCO 2011
ISBN 978-3-642-19643-0

Emilio Corchado, Václav Snášel, Javier Sedano,
Aboul Ella Hassanien, José Luis Calvo, and
Dominik Ślęzak (Eds.)

Soft Computing Models in Industrial and Environmental Applications, 6th International Conference SOCO 2011

Springer

Editors

Emilio Corchado
Universidad de Salamanca
Plaza de la Merced S/N
37008, Salamanca
Spain
E-mail: escorchado@usal.es

Aboul Ella Hassanien
Cairo University
5 Ahmed Zewal St.
Orman, Cairo
Egypt
E-mail: Aboitcairo@gmail.com

Václav Snášel
VŠB-TU Ostrava
17. listopadu 15
70833 Ostrava
Czech Republic
E-mail: vaclav.snasel@vsb.cz

José Luis Calvo
University of La Coruña
Avda. 19 de Febrero, S/N
A Coruña, 15403 Ferrol
Spain
E-mail: jlcalvo@udc.es

Javier Sedano
University of Burgos
Avenida Cantaria S/N
09006 Burgos
Spain
E-mail: jsedano@ubu.es

Dominik Ślęzak
Infobright
47 Colborne Street, Suite 403
Toronto, Ontario M5E1P8,
Canada
E-mail: Dominik.Slezak@infobright.com

ISBN 978-3-642-19643-0 e-ISBN 978-3-642-19644-7

DOI 10.1007/978-3-642-19644-7

Advances in Intelligent and Soft Computing ISSN 1867-5662

Library of Congress Control Number: 2011922548

Typeset & Cover Design: Scientific Publishing Services Pvt. Ltd., Chennai, India.

Printed on acid-free paper
5 4 3 2 1 0
springer.com

Preface

This volume of Advances in Intelligent and Soft Computing contains accepted papers presented at SOCO 2011 held in the beautiful and historic city of Salamanca, Spain, April 2011.

SOCO 2011 has received more than 100 technical submissions. After a through peer-review process, the International Program Committee selected 64 papers which are published in these conference proceedings. In this relevant edition a special emphasis was put on the organization of special sessions. Four special sessions were organized related to relevant topics as: Optimization and Control in Industry, Speech Processing and Soft Computing, Systems, Man & Cybernetics and Soft Computing for Medical Applications.

The selection of papers was extremely rigorous in order to maintain the high quality of the conference and we would like to thank the members of the Program Committee for their hard work in the reviewing process. This is a crucial process to the creation of a conference high standard and the SOCO conference would not exist without their help.

SOCO 2011 enjoyed outstanding keynote speeches by distinguished guest speakers: Dr. Amy Neustein - Linguistic Technology Systems (USA) and Prof. Ajith Abraham - Machine Intelligence Research Labs (MIR Labs), Europe.

For this special edition, as a follow-up of the conference, we anticipate further publication of selected papers in special issues of prestigious international journal as Neurocomputing (ELSEVIER), Expert Systems-The Journal of Knowledge Engineering (WILLEY-BLACKWELL) and International Journal of Speech Technology (SPRINGER).

Particular thanks go as well to the Workshop main Sponsors, IEEE Sección España, IEEE.- Systems, Man and Cybernetics-Spanish Chapter, The International Federation for Computational Logic and MIR labs.

We would like to thank all the special session organizers, contributing authors, as well as the members of the Program Committee and the Local Organizing Committee for their hard and highly valuable work. Their work has helped to contribute to the success of the SOCO 2011 event.

April 2011

The editors
Emilio Corchado
Václav Snášel
Javier Sedano
Aboul Ella Hassanien
José Luis Calvo
Dominik Ślęzak

Organization

Honorary Co-chairs

Carolina Blasco	Director of Telecommunication. Regional Goverment of Castilla y León (Spain)
Manuel Castro	IEEE Sección España (Chairman)

Advisory International Committee

Ashraf Saad	Armstrong Atlantic State University (USA)
Amy Neustein	Linguistic Technology Systems (USA)
Ajith Abraham	Machine Intelligence Research Labs - MIR Labs (Europe)
Jon G. Hall	The Open University (UK)
Paulo Novais	Universidade do Minho (Portugal)
Antonio Bahamonde	President of the Spanish Association for Artificial Intelligence (AEPIA)
Michael Gabbay	Kings College London (UK)
Isidro Laso-Ballesteros	European Commission Scientific Officer (Europe)
Amy Neustein	Linguistic Technology Systems (USA)

General Chair

Emilio Corchado	University of Salamanca (Spain)

Scientific Committee Chairs

Emilio Corchado	University of Salamanca (Spain)
Václav Snášel	VSB-Technical University of Ostrava (Czech Republic)
Javier Sedano	Technological Institute of Castilla y León (Spain)
Dominik Slezak	University of Warsaw & Infobright Inc. (Poland)
José Luis Calvo	University of A Coruña (Spain)
Aboul Ella Hassanien	Cairo University (Egypt)

Program Committee

José Luis Calvo	University of A Coruña (Spain)
Alberto Freitas	University of Porto (Portugal)
David Meehan	Dublin Institute of Technology (Ireland)
Eduardo José Solteiro Pires	University of Trás-os-Montes e Alto Douro (Portugal)
Florentino Fernández Riverola	University of Vigo (Spain)
Jesús Luna	Barcelona Digital Technology Centre (Spain)
Jose Alfredo F. Costa	Federal University of Rio Grande de Norte (Portugal)
Jose Manuel Molina	University Carlos III of Madrid (Spain)
Luciano Sanchez Ramos	University of Oviedo (Spain)
Luís Paulo Reis	University of Porto (Portugal)
Maciej Grzenda	Warsaw University of Technology (Poland)
Michal Wozniak	Wroclaw University of Technology (Poland)
Paulo Moura Oliveira	University of Trás-os-Montes e Alto Douro (Portugal)
Pedro M. Caballero Lozano	CARTIF Technological Center (Spain)
Sebastian Ventura Soto	University of Córdoba (Spain)
Stefano Pizzuti	Energy New technology and Environment Agency
Urko Zurutuza Ortega	Mondragon University (Spain)
Wei-Chiang Hong	Oriental Institute of Technology (Taiwan)
Andres Pinon Pazos	University of A Coruna (Spain)
Anna Bartkowiak	University of Wroclaw, Inst of Computer Science (Poland)
Daniela Zaharie	West University of Timisoara (Romania)
Enrique Herrera-Viedma	University of Granada (Spain)
Francesco Marcelloni	University of Pisa (Italy)
Rosa Basagoiti	Mondragon University (Spain)
Rui Sousa	Universidade of Minho (Portugal)
Sara Silva	INESC-ID, Lisboa (Portugal)
Tzung Pei Hong	National University of Kaohsiung (Taiwan)
Xiao-Zhi Gao	Aalto University (Finland)
Francisco Herrera	University of Granada (Spain)
Oscar Fontenla Romero	University of A Coruna (Spain)
Cesar Analide	Universidade do Minho (Portugal)
Miroslav Bursa	Czech Technical University (Czech Republic)
Noelia Sánchez Maroño	University of A Coruña (Spain)
Václav Snášel	VSB-Technical University of Ostrava (Czech Republic)
Alexander Gegov	University of Portsmouth (UK)
Ana Almeida	Polytechnic of Porto (Portugal)
Ajith Abraham	Machine Intelligence Research Labs (MIR Labs), Europe

José Fco. Martínez Trinidad	National Institute for Astrophysics, Optics and Electronics (Spain)
Marco Mora	Universidad Católica del Maule (Chile)
Petro Gopych	Universal Power Systems USA-Ukraine LLC (Ukraine)
Rosario Girardi	Federal University of Maranhão (Brazil)
Álvaro Herrero	University of Burgos (Spain)
André CPLF de Carvalho	University of Sâo Paulo (Brazil)
Angel Arroyo	Universidad de Burgos (Spain)
Benoît Otjacques	Public Research Centre - Gabriel Lippmann (Luxembourg)
Bogdan Gabrys	Bournemouth University (UK)
Bruno Baruque	University of Burgos (Spain)
Camelia Chira	Babes-Bolyai University (Romania)
Emilio Corchado	University of Salamanca (Spain)
Gregorio Sainz	CARTIF Technological Centre (Spain)
Javier Sedano	University of Burgos (Spain)
Luís Nunes	ISCTE (Portugal)
Mehmet Aydin	University of Bedfordshire (UK)
Paulo Novais	Universidade do Minho (Portugal)
Susana Ferreiro Del Río	TEKNIKER (Spain)
Turkay Dereli	University of Gaziantep (Turkey)
Yin Hujun	University of Manchester (UK)
Zhihua Cui	Taiyuan University of Science and Technology (China)
Zita Vale	Polytechnic of Porto (Portugal)
Ana Gil	University of Salamanca (Spain)
Aureli Soria-Frisch	Starlab Barcelona S.L. (Spain)
José Ramón Villar	University of Oviedo (Spain)
María N. Moreno	University of Salamanca (Spain)
Mario Köppen	Kyushu Institue of Technology (Japan)
Mª Dolores Muñoz	University of Salamanca (Spain)
Vivian F. López	University of Salamanca (Spain)
Ana Carolina Lorena	Universidade Federal do ABC
Abdelhamid Bouchachia	Alps-Adriatic University of Klagenfurt (Austria)
Adil Baykasoglu	University of Gaziantep (Turkey)
Andre de Carvalho	University of São Paulo (Brazil)
Andrea Schaerf	University of Udine (Italy)
Crina Grosan	Faculty of Mathematics and Computer Science Babes-Bolyai University (Romania)
David Oro Garcia	Barcelona Digital Technology Centre (Spain)
Fatos Xhafa	Universtat Politècnica de Catalunya (Spain)
Georgios Ch. Sirakoulis	Democritus University of Thrace (Greece)

Gregg Vesonder	Executive Director AT&T Labs - Research and AT&T Fellow, Adjunct Professor University of Pennsylvania, Computer and Information Science
Jose Riquelme	University of Sevilla (Spain)
Jose Valente de Oliveira	University of Algarve (Portugal)
Lahcene MITICHE	University of Djelfa (Algeria)
Luciano Sánchez	University of Oviedo (Spain)
Maria Pia Fanti	Politecnico di Bari (Italy)
Roman Neruda	Academy of Sciences of the Czech Republic (Czech Republic)
Ashish Umre	University of Sussex (UK)
José María Peña	Polytechnic University of Madrid (Spain)
Mario G.C.A. Cimino	University of Pisa (Italy)
Michael N. Vrahatis	University of Patras (Greece)
Yuehui Chen	University of Jinan (China)
Abraham Duarte	University King Juan Carlos (Spain)
Antonio Peregrin	University of Huelva (Spain)
Daryl Hepting	University of Regina (Canada)
Humberto Bustince	Public University of Navarra (Spain)
Jonathan Lee	National Central University (Taiwan)
Leticia Curiel Herrera	Universidad de Burgos (Spain)
Luciano Stefanini	University of Urbino "Carlo BO" (Italy)
Sung-Bae Cho	Yonsei University (Korea)
Eduardo Solteiro Pires	University of Trás-os-Montes and Alto Douro (Portugal)
Frank Klawonn	Ostfalia University of Applied Sciences (Denmark)
Paulo Moura Oliveira	University of Trás-os-Montes and Alto Douro (Portugal)
Rosario Girardi	Federal Universty of Maranhao (Brazil)
Tzung-Pei Hong	National University of Kaohsiung (Taiwan)
Rafael Bello	Central University Marta Abreu
Witold Pedrycz	University of Alberta (Canada)
Carlos Pereira	Polytechnic Institute of Coimbra (Portugal)
Jose Antonio Gomez	University of Castilla la Mancha (Spain)
Jorge Díez Peláez	Artificial Intelligence Centre – University of Oviedo (Spain)
Juan José del Coz Velasco	University of Oviedo (Spain)
Oscar Luaces	University of Oviedo (Spain)
Ayeley Tchangani	University of Toulouse III (France)
Xiao-Zhi Gao	Aalto University (Finland)
Gerald Schaefer	Loughborough University (UK)
Chia-Chen Lin	Providence University (Taiwan)
Teresa B Ludermir	Federal University of Pernambuco (Brazil)
Jorge Lopes	Brisa/IST

Belen Vaquerizo García	University of Burgos (Spain)
David Griol	University Carlos III of Madrid (Spain)
José Manuel Molina López	University Carlos III of Madrid (Spain)
Miguel Ángel Patricio	University Carlos III of Madrid (Spain)
Petrica Pop	North University of Baia Mare (Romannia)
Jesús García-Herrero	University Carlos III of Madrid (Spain)
Juan Gómez Romero	University Carlos III of Madrid (Spain)
Luis Correia	Lisbon University (Portugal)
Javier Carbó	University Carlos III of Madrid (Spain)
Antonio Berlanga	University Carlos III of Madrid (Spain)
Eleni Mangina	University College Dublin (Ireland)
Ana Cristina Bicharra	Universidad Federal Fluminense (Brazil)
Benjamín Ojeda-Magaña	University of Guadalajara (Spain) and Polytechnic University of Madrid (Spain)
Alexis Marcano-Cedeño	Polytechnic University of Madrid (Spain)
Antonio Couce-Casanova	University of Coruña (Spain)
Nashwa Mamdouh El-Bendary	Arab Academy for Science, Technology, and Maritime Transport
Amy Neustein	Linguistic Technology Systems (USA)

Special Sessions

Optimization and Control Systems in Industry

José Luis Calvo Rolle	University of Coruña (Spain)
Emilio Corchado	Univesity of Salamanca (Spain)
Antonio Couce Casanova	University of Coruña
Héctor Alaiz Moretón	University of LeónHector Quintian Pardo – University of Coruña
Javier Alfonso Cendón	University of León
Ramón Ferreiro García	University of Coruña
Andrés José Piñón Pazos	University of Coruña

Speech Processing & Compression: Soft Computing Models

Amy Neustein	CEO of Linguistic Technology Systems
Sid-Ahmed Selouani	Moncton University
Raed Abu Zitar	New York Institute of Technology
Douglas OShaughnessy	INRS EMT Montreal
Nabil Belacel	National Research Council of Canada
Eric Hervet	Université de Moncton
Youssef A. Alotaibi	King Saud University
Valentina E. Balas	Aurel Vlaicu University of Arad
Jean Caelen	CNRS, laboratoire LIG
Marius Balas	"Aurel Vlaicu" University of Arad, Romania
Dan Tufis	Romanian Academy

Walid Salameh	Princes Sumaya University of Science and Technology
Khaled Assaleh	American University of Sharjah
Assaad Makki	Ford Motor Company
Hussein Hiyassat	Arab Academy for Banking and Financial Sciences

System, Man, & Cybernetics

Emilio Corchado	Univesity of Salamanca
Manuel Grana	University of Basque Country
Richard Duro	University of Coruna
Juan M. Corchado	University of Salamanca
Vicent Botti	Polytechnical University of Valencia
Ramon Rizo	University of Alicante
Juan Pavon	University Complutense of Madrid
Jose Manuel Molina	University Carlos III of Madrid
Francisco Herrera	Univesity of Granada
César Hervás	Univesity of Cordoba
Sebastian Ventura	Univesity of Cordoba
Alvaro Herrero	University of Burgos
Bruno Baruque	University of Burgos
Javier Sedano	University of Burgos
Sara Rodríguez	University of Salamanca
José Luis Calvo	University of Coruña
Pedro Antonio Gutierrez	University of Cordoba
Leticia Curiel	University of Burgos
Raquel Redondo	University of Burgos

Soft Computing for Medical Applications

Vicente Vera	University Computense of Madrid
Dragan Simic	University of Novi Sad
Javier Sedano	University of Burgos
Emilio Corchado	University of Salamanca

Organizing Committee

Bruno Baruque	University of Burgos (Spain)
Leticia Curiel	University of Burgos (Spain)
Emilio Corchado	University of Salamanca (Spain) (Co-Chair)
Álvaro Herrero	University of Burgos (Spain)
Ángel Arroyo	University of Burgos (Spain)
Javier Sedano	University of Burgos (Spain)
José Luís Calvo	University of La Coruña (Spain)
Fernando De la Prieta	University of Salamanca (Spain)
Amer Laham	University of Salamanca (Spain)

Contents

Intelligent Systems

Multi-agents and Ambient Intelligence

Classification and Clustering Methods

Evolutionary Computation

Applications

Optimization and Control Systems in Industry

Speech Processing and Compression: Soft Computing Models

System, Man, and Cybernetics

Soft Computing for Medical Applications

Image Processing to Detect and Classify Situations and States of Elderly People

Ramón Reig-Bolaño, Pere Marti-Puig, Javier Bajo, Sara Rodríguez,
Juan F. De Paz, and Manuel P. Rubio

Abstract. Monitoring and tracking of elderly people using vision algorithms is an strategy gaining relevance to detect anomalous and potentially dangerous situations and react immediately. In general vision algorithms for monitoring and tracking are very costly and take a lot of time to respond, which is highly inconvenient since many applications can require action to be taken in real time. A multi-agent system (MAS) can establish a social model to automate the tasks carried out by the human experts during the process of analyzing images obtained by cameras. This study presents a detector agent integrated in a MAS that can process stereoscopic images to detect and classify situations and states of elderly people in geriatric residences by combining a series of novel techniques. We will talk in details about the combination of techniques used to perform the detection process, subdivided into human detection, human tracking ,and human behavior understanding, and where there is a case-based reasoning (CBR) model that allows the system to add reasoning capabilities.

Keywords: Multi-Agent Systems, stereo processing, human detection, Case Based Reasoning.

1 Introduction

One of the greatest challenges for Europe and the scientific community is to find more effective means of providing care for the growing number of people that

---

Ramón Reig-Bolaño · Pere Marti-Puig
Department of Digital and Information Technologies, University of Vic
C. de la Laura 13, 08500, Vic (Barcelona), Spain
e-mail: {pere.marti,ramon.reig}@ uvic.cat

Javier Bajo · Sara Rodríguez · Juan F. De Paz · Manuel P. Rubio
Department of Computer Science, University of Salamanca
Plaza de la Merced s/n, 37008, Salamanca, Spain
e-mail: {jbajope,srg,fcofds,mprc}@usal.es

E. Corchado et al. (Eds.): SOCO 2011, AISC 87, AISC 87, pp. 163–172, 2011.
springerlink.com

make up the disabled and elderly sector. Artificial intelligent systems have been recently examined as potential medical care supervisory systems. Among those systems are, multi-agent systems (MAS) [2] for elderly and dependent persons, providing continual support in the daily lives of these individuals; other examined systems are artificial vision systems, where we find medical image analysis and high level computer vision [1]. The study of artificial vision, specifically stereoscopic vision, has been the object of considerable attention within the scientific community over the last few years. However, it is still an open trend and the use of multi-agent systems within artificial vision. MAS has a widespread application to different domains, including in decision support systems [12], pattern classification [13], healthcare [14].

For many years, the scientific community has demonstrated an increasing interest in the study of artificial vision. Image processing applications are varied and include such aspects as remote monitoring [18], biomedical image analysis [17], character recognition [16], virtual reality applications, and enhanced reality in collaborative systems, tracking [15], among others. Although image analysis and people detection is a well explored topic, the use of multi-agent technology in this area has become the focal point of important interest [9]. Soft computing system to facilitates real time decision making in a robust manner and low solution cost [19] [20] [21].

This paper presents the detector agent that is capable of processing stereoscopic images and detecting people with a stereo camera, automatically identifying as states of interest if the person is standing or lying on the bed. The detector agent is based on robust and low complexity algorithms, with the additional advantage that they can be executed in real time with a low-cost hardware. The agent's internal structure is composed of different techniques of soft computing integrated with a mixture of an Artificial Neural Network (ANN) and a Support Vector Machine (SVM), used as a classification mechanism. By using this mixture, it is possible to exploit the advantages of both strategies in order to classify the status in a more reliable way. The mixture is carried out throughout lineal combinations with different parameters that minimizes the global error. This agent is integrated in a multi-agent system. The system has been tested in a small indoor environment characterized by very different lighting conditions in which it has to track people who can stay with a very low activity levels for a long time. In addition, there are many situations in which the figure to be monitored suffers a partial occlusion.

This paper is structured as follows: Section 2 describes in details the approach proposed for human detection; Section 3 describes the results and conclusions.

2 Detector Agent

Typical human detection strategies are based on one of the following techniques or a combination of them: background subtraction, temporal differencing and optical flow analysis. The background subtraction technique attempts to detect moving regions in an image by differencing between the current image and a reference background image in a pixel-by-pixel fashion [8]. Another possible approach to the human detection is the calculation of temporal differencing, using two or three consecutive frames from the video stream, and obtaining the absolute difference between them [4]. Optical flow [3] is the last common approach to human detection; it calculates an approximation to a vector map of the estimated movement of the pixels obtained from two consecutive frames.

This study focuses on the detection phase of multi-agent system, and more specifically in the detector agent, responsible for carrying out this functionality to allow Human Detection, Human Tracking and Human behavior understanding.

The detector Agent is a CBR [23] agent composed of a reasoning cycle that consists of four sequential phases: *retrieve, reuse, revise* and *retain*. The CBR system is completely integrated into the agents' architecture. The structure of the CBR system has been designed around the case concept. In order to initially construct the model case base starting from the available histogram data, the CBR stores the histograms obtained with the human detection and tracking techniques.

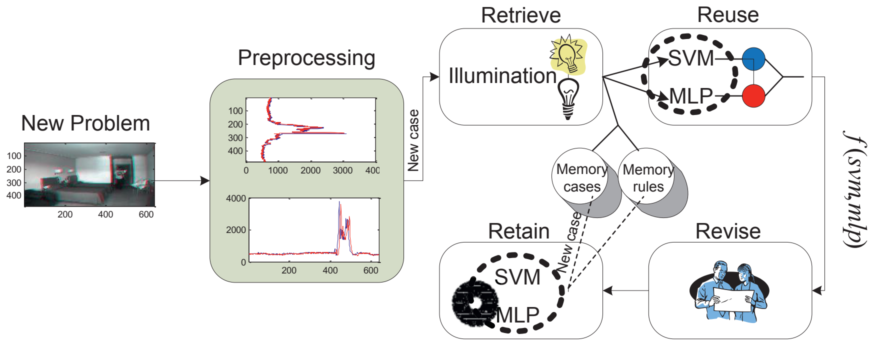

Fig. 1 Phases of the CBR

The figure 1 shows the tracking process followed by the detector agent. First the system receives the image and preprocesses the image. That is, once the prior preprocessing for the dimensionality reduction and the extraction of relevant information are done, we proceed to perform the classification. To perform the classification process we break up the information obtained from the horizontal and vertical histograms, this process is detailed in the section 2.1.

During the retrieval stage, we select the most similar cases to the present case, taking into account the illumination's class. This phase can be thought of as a data selection step that aims to retrieve the list of cases that might be most informative given a new sample to classify.

The adaptation of previous cases in order to solve a new problem is accomplished in the reuse stage. A mixture of experts, explained in the following subsections is used in this stage. The section 2.2 describes the mixture of the soft computing techniques indicated in 2.3 and 2.4. This process minimizes the final error of the mixture according to the weighted of the section 2.4 and the classification model in 2.5.

In the revision stage, the expert is provided with useful data about the decision made by the system. Every time a new problem is solved, the internal structure of the CBR system is updated (retain stage).

2.1 Preprocess, Extraction of Relevant Information

The implementation of the human detection is based on temporal differencing. In order to better capture the movement, the information can be extracted from three consecutive frames instead of only two. Then, $\mathbf{I}_t^{\mathbf{R}}(x,y)$ being the gray level right image intensity of the stereo pair at frame t, we define the right image's differences $\mathbf{D}_t^{\mathbf{R}}$(x,y) as:

$$\mathbf{D}_t^R(x,y) = k \cdot \left|\mathbf{I}_t^R(x,y) - \mathbf{I}_{t-2}^R(x,y)\right| \tag{1}$$

where the constant parameter k takes the value 2/3.

An analogous definition is used for the left image's differences $\mathbf{D}_t^{\mathbf{L}}$(x,y).

The objective for the human tracking part is to automatically find the box that encloses the person under monitoring. In order to accomplish this objective, the two frames of absolute differences of the stereo pair images are projected on the vertical and horizontal axes; sometimes these are called lateral histograms [5], and are calculated by summing the gray levels of the pixels in each of the columns and rows of the image differences respectively.

In eq. (2) we define the horizontal and vertical histograms of right stereo image differences.

$$\mathbf{h}_t^R(x) = \sum_y \mathbf{D}_t^R(x,y) \qquad \mathbf{v}_t^R(y) = \sum_x \mathbf{D}_t^R(x,y) \tag{2}$$

The same definition is used for the horizontal and vertical histograms of left stereo differences $\mathbf{h}_t^L(x)$ and $\mathbf{v}_t^L(y)$.

2.2 Mixture of Classifiers, General Process

Finally, for the human behaviour understanding part, in this first approach, the human detection agent will classify two positions, standing/walking and lying. For the classification process we used the lateral histograms of the image differences as data classifier against a trained classifier.

To perform the final calculation, several classifiers were applied and then a mixture of their outputs was made to provide the final estimation. The final output is based on the minimization of the final error of classification. The starting point for creating the experts mixture is based on the calculation of the output based on the weighted mean of classifiers as shown in Equation (3).

$$f(x_1,...,x_n) = \sum_i (w_1 p_1^i + .. + w_n p_n^i) x_i \tag{3}$$

Where x_i represent values obtained by the classifiers and w_i the weight values. To set the weights value, we define the set of variables that affect the final estimation. In this case we have taken into account several factors p_i to calculate the final weights. The goal is to find the set of values of w_i that minimize the final error value in the estimation given the values of p and x. To calculate this value is part of the definition of mean square error to measure the level of error leaving us with the expression to minimize expression (4) subject to the indicated restrictions.

$$
\begin{aligned}
& f(w_1,\ldots,w_n) = \sum_i ((w_1 p_1^i + .. + w_n p_n^i)x_i - y_i)^2 \\
& st \\
& \quad 1 - w_1 - \ldots - w_n = 0
\end{aligned} \tag{4}
$$

The w_i are calculated according to the parameters described in 2.4. The section 2.5 details the mixture for this case study and the parameters showed in 2.4.

2.3 Classifiers

The **Support Vector Machine** (SVM) [22] is a supervised learning technique applied to the classification and regression of elements. SVM can be applied in a variety of fields such as chemistry, ambient intelligence, modeling and simulation, and data or text mining. The algorithm represents an extension of the linear models [11]. Due to the fact that the dimensionality of the new space can be very high, it is not feasible to calculate hyperplanes that allow the production of linear separability. For this, a series of non-linear functions called kernels is used.

The following equation is used to perform the classification (5) [7].

$$
class(x_k) = signe\ [w\Phi(x_k) + b] = signe\left(\sum_{i=1}^{m} \lambda_i y_i \Phi(x_i)\Phi(x_k) + b\right) \tag{5}
$$

Where λ_i is a Lagrange multiplier, y_i output value for the patter b constant and $\Phi(x)$ a kernel function, The calculation of these values is described in [38].

From the hyperplane calculated by SVM we proceed to calculate the distance of each of the points to the hyperplane. These distances will be calculated to estimate the error in the calculation of the distance and to make the mixture of methods. The distance is calculated according to equation (6)

$$
d(x;w,b) = \frac{|\, w \cdot \Phi(x) + b \,|}{\|w\|} \tag{6}
$$

MLP is the most widely applied and researched artificial neural network (ANN) model. MLP networks implement mappings from input space to output space and are normally applied to supervised learning tasks [6]. Sigmoid function was selected as the MLP activation function, with a range of values in the interval [0, 1]. It is used to classify the different states of the people detected in the room

2.4 Relevant Factors

The detected relevant factors were based on the error during the estimation of the average value for each of the types, on the variance of the data and on the hit rate. To calculate the average error we assume that N>> n because the total number of images to estimate, though unknown, is much greater than the set of images used during the training. The value of the factor is set according to the ratio of the sample mean and the error.

$$p_i^e = \bar{x}/e \, , \quad e = \pm k \frac{S_c}{\sqrt{n}} \tag{7}$$

Where k is defined from the stated confidence level, S_c is the quasi-variance and n is the number of elements in the sample.

We define a factor for each of the i classifiers and for each classifier we define a different factor for each different class defined.

Another factor is based on the value obtained as an output for the classifier, taking into account the distance with respect to the average theoretical value of the class, the variance and the value provided by the classifier. Figure 2 shows graphically the distribution of values obtained from a classifier for the class 1 and 2 (up and down) representing for both the normal distribution of the mean μ_1 and μ_2 ,the values x_1 and x_2 correspond to the estimated value of the classifier for a particular pattern

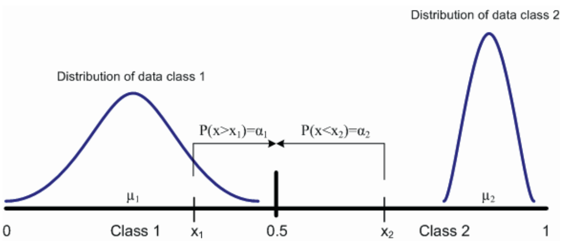

Fig. 2 Distribution of the values of a classifier for each class

The value of the factor for class 1 and class 2 as appropriate the value obtained with the case x_1 or x_2 is defined by the expression (29). This factor changes for each classifier and for each case.

$$p(x_1) = \begin{cases} k \cdot P(z > \frac{x_1 - \mu_1}{\sigma_1}) & x_1 > \mu_1 \\ 1 & ioc \end{cases} \qquad p(x_2) = \begin{cases} k \cdot P(z > \frac{x_2 - \mu_2}{\sigma_2}) & x_2 < \mu_2 \\ 1 & ioc \end{cases} \tag{8}$$

Where k is a constant, x_1 is the value obtained by the classifier, μ_1 is the average for the values obtained by the classifier for class 1, σ_1 the variance. We similarly define the variables for the second case.

The last factor taken into account that is related to the hit rate for each method, the hit rate is defined by the number of correctly classified. The value of the factor is constant for all cases given a particular classifier. To calculate these values the following operation is performed:

$$p_j^i = p_j^i / (p_j^1 + \ldots + p_j^n) \tag{9}$$

Where i corresponds to the classifier i.

2.5 Classification Model

The classification model applied to the case study part of the proposed mixture in Section 3.3. In the mixture, the classification models are applied based on the SMO and the MLP weighted by the factors described in section Relevant factors, eventually leaving the model as follows:

$$f(x_1,.x_2) = (w_1 p_1 + w_2 p_2^i + w_3 p_3)x_1 + (w_1(1-p_1) + w_2(1-p_2^i) + w_3(1-p_3))x_2 \tag{10}$$

Where w_i are calculated according to (7), the value p_1 is calculated according to (8), p_2^i is calculated from (9), p_3 contains the hit rate, all these parameters are defined so as to meet (10), the values of x_1 and x_2 correspond to the estimation calculated by SVM and the MLP.

3 Results and Conclusions

A broader experimentation was done to test processing and detection of different people under different lighting conditions and different distances from the stereo vision system. We employed 640x480 sized images and sub-pixel interpolation to enhance the precision in the stereo calculation. The environment in which the system was developed is a hospital room. The rooms were small in size, containing one or two beds. The environment may had have very different lighting conditions that could change rapidly. There is the possibility of natural light through a window and there are several possibilities for artificial lighting, with lamps located either on the ceiling or wall lamps.

To perform the analysis a dataset composed of 682 images of video sequences, recorded under different configurations of light and people in a residence room was studied. The case study consisted of a series of images to monitor a person in a room with different light conditions: 248 images with natural light in the room (37%), 186 images with fluorescence light in the room (27%) and 245 images with incandescent light on the back wall of image (36%). Moreover, the case study took into account different possible positions for the people in the room: lying or standing in different zones of the room. The 682 images were tagged as follows: a successful classification of 680 images (standing or lying) and a wrong classification of 2 images, to introduce a certain distortion in the system with the aim of verifying the performance of the algorithms.

To perform the classification process we start with the information obtained from the horizontal and vertical histograms of the previous classification and proceed to evaluate the efficiency of the proposed classification technique. To evaluate the significance of the possible classification techniques used during the reuse phase, we performed a comparison between different classifiers following Dietterich's model. 5x2- Cross-Validation [10].

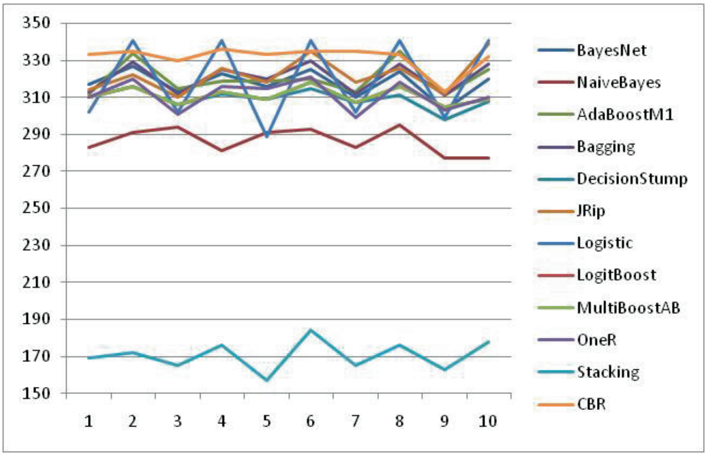

Fig. 3 Number of hits in the classification process

Figure 3 shows the different classifiers used during the classification process. The lines represent the number of hits obtained in the 5x2 cross validation for each classifiers. The proposed CBR system presents the highest hit rate against the other methods, the maximum value of the test is 682/2 according the cross validation. The CBR incorporates the classification model exposed in section 2.The deviation in the number of hits is also low so we can determine that the hit rate is more constant than the rest of classifiers.

In the test sequences we have worked with images with a single person in scene, as the main use of the system is monitoring people when they are alone in a room. However, the system could be adapted to detect more than a person in a scene, with the decomposition of the image into sub-images according to the activity detected in different regions.

The classification of the images varies depending on the illumination. In the case of images of low contrast it becomes more difficult to make a proper detection and classification. The illumination issues are, by far, one of the trickiest questions relating to real-time real-world systems. The approach was designed to be independent of the illumination, however we have stated the worst results with wall lamps illumination, probably due to higher noise introduced by the large amplification gain due to the low illumination; and the best results correspond to scenes with fluorescent illumination or with natural tamed daylight.

Acknowledgments. This work has been supported by the MICINN TIN 2009-13839-C03-03.

References

1. Rangarajan, A., Hsiao, I.T., Gindi, G.: A Bayesian Joint Mixture Framework for the Integration of Anatomical Information in Functional Image Reconstruction. Journal of Mathematical Imaging and Vision 12(3), 199–217 (2000), doi:10.1023/A:1008314015446
2. Wooldridge, M.: Introduction to MultiAgent Systems. John Wiley & Sons, Chichester (2002)
3. Barron, J., Fleet, D., Beauchemin, S.: Performance of optical Flow techniques. Int. J. Comput. Vision 12(1), 42–77 (1994)
4. Collins, R.T., Lipton, A.J., Kanade, T., Fujiyoshi, H., Duggins, D., Tsin, Y., Tolliver, D., Enomoto, N., Hasegawa, O., Burt, P. and Wixson, L.: A system for video surveillance and monitoring, Carnegie Mellon Univ., Pittsburgh, PA, Tech. Rep., CMU-RI-TR-00-12 (2000)
5. Davies, E.R.: Lateral histograms for efficient object location: speed versus ambiguity. Pattern Recogn. Lett. 6(3), 189–198 (1987)
6. Gallagher, M., Downs, T.: Visualization of learning in multilayer perceptron networks using principal component analysis. IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics 33, 28–34 (2003)
7. Ivanciuc, O.: Applications of Support Vector Machines in Chemistry. In: Lipkowitz, K.B., Cundari, T.R. (eds.), pp. 291–400. John Wiley & Sons, Chichester (2007)
8. Kim, K., Chalidabhongse, T.H., Harwood, D., Davis, L.: Real-time foreground-background segmentation using codebook model. Real-Time Imaging 11(3), 172–185 (2005)
9. Rodríguez, S., De Paz, J.F., Bajo, J., Tapia, D.I., Pérez, B.: Stereo-MAS: Multi-Agent System for Image Stereo Processing. In: Cabestany, J., Sandoval, F., Prieto, A., Corchado, J.M. (eds.) IWANN 2009. LNCS, vol. 5517, pp. 1256–1263. Springer, Heidelberg (2009)
10. Dietterich, T.G.: Approximate statistical tests for comparing supervised classification learning algorithms. Neural Computation, 1895–1923 (1998)
11. Vapnik, V., Lerner, A.: Pattern Recognition Using Generalized Portrait Method, pp. 774–780 (1963)
12. Quteishat, A., Lim, C.P., Tweedale, J., Jain, L.C.: A neural network-based multi-agent classifier system. Neurocomputing 72(7-9), 1639–1647 (2009)
13. Vuurpijl, L., Schomaker, L.: A framework for using multiple classifiers in a multiple-agent architecture. In: The Third International Workshop on Handwriting Analysis and Recognition, pp. 1–6 (1998)
14. Corchado, J.M., Bajo, J., Abraham, A.: GERAmI: Improving the delivery of health care. IEEE Intelligent Systems 3(2), 19–25 (2008)
15. Cho, J.S., Yun, B.J., Ko, Y.H.: Intelligent video tracking based on fuzzy-reasoning segmentation. Neurocomputing 70(4-6), 657–664 (2007)
16. Chow, T.W.S., Rahman, M.K.M.: A new image classification technique using tree-structured regional features. Neurocomputing 70(4-6), 1040–1050 (2007)
17. Liu, H.Q., Jiao, L.C., Zhao, F.: Non-local spatial spectral clustering for image segmentation. Neurocomputing 74(1-3), 461–471 (2010)

18. Allili, M.S., Ziou, D.: Object tracking in videos using adaptive mixture models and active contours. Neurocomputing 71(10-12), 2001–2011 (2008)
19. Corchado, E., Arroyo, Á., Tricio, V.: Soft computing models to identify typical meteorological days. Logic Journal of the IGPL (2010)
20. Lima, L., Novais, P., Costa, R., Cruz, J., Neves, J.: Group decision making and Quality-of-Information in e-Health systems. Logic Journal of the IGPL (2010)
21. Sedano, J., Curiel, L., Corchado, E., de la Cal, E., Villar, J.R.: A soft computing method for detecting lifetime building thermal insulation failures. Integrated Computer-Aided Engineering 17(2), 103–115 (2010)
22. Prasad, T., Das, S., Roychoudhury, J., Abraham, A.: Implementation of a new hybrid methodology for fault signal classification using short -time fourier transform and support vector machines. In: Corchado, E., Novais, P., Analide, C., Sedano, J. (eds.) SOCO 2010. Advances in Intelligent and Soft Computing, vol. 73, pp. 219–225. Springer, Heidelberg (2010)
23. Yu, W.D., Liu, Y.C.: Hybridization of CBR and numeric soft computing techniques for mining of scarce construction databases. Automation in Construction 15(1), 33–46 (2006)