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Ontology Enrichment and Evaluation Using OntoRich

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Abstract—**This paper presents the OntoRich framework, a support tool for semi-automatic ontology enrichment and evaluation. The WordNet is used to extract candidates for dynamic ontology enrichment from RSS (Really Simple Syndication) streams. With the integration of OpenNLP the system gains access to syntactic analysis of the RSS news. The enriched ontologies are evaluated against several qualitative metrics.**

Keywords—**ontology enrichment, ontology evaluation, stream processing, WordNet, natural language processing**

I. INTRODUCTION

In recent years, much effort has been put in ontology learning as an imperative for the concept of Semantic Web. The migration from Web 2.0 to Semantic Web [1] is still considered only a theoretical approach mainly because of the effort that this transformation would imply. Many solutions were proposed during the recent years both for populating and evaluating ontologies, but working with ontologies is not a straightforward process because some important problems arise. First of all, the knowledge needed for populating ontologies is spread over the internet in an unstructured way and information extraction tools have to be designed for each website in particular. Information Extraction methods by means of domain specific templates and the lightweight use of Natural Languages Processing (NLP) techniques have been already proposed [2], [3]. Another good heuristic is to use a search engine to find web pages with relevant content. However, current search engines retrieve web pages, not the information itself [4]. After the information is retrieved, a system for term extraction is needed in order to obtain candidates for ontology enrichment. An ontology has to be evaluated against several metrics in order to be considered as a valid ontology for the domain it covers.

The life-cycle of ontologies in the space of Semantic Web involves different techniques, ranging from manual to automatic building, refinement, merging, mapping or annotation. Each technique involves the specification of core concepts for the population of an ontology, or for its annotation, manipulation, or management [5]. These core concepts are referred to as Ontology Design Patterns and represent an important guideline [6] for the design of an ontology engineering tool, such as the OntoRich system. Ontology engineering has become an important domain since the idea of Semantic Web was taken into consideration. It involves various tasks such as editing, evolving, versioning, mapping, alignment, merging, reusing and extraction . The management of available web knowledge is a difficult task because of the dynamic nature of the Internet [7]. The first consideration was to provide an automatic way for information extraction from the web and the considered solution is based on RSS feeds that more and more websites provide nowadays. An RSS feed provides a standardized XML file format that allows the information to be published once and viewed by many different programs. Because of the standard format a single RSS Reader system is enough to fetch information from many websites that are related to a certain domain.

Ontologies provide explicit formalization and specification of a domain in the form of concepts, their corresponding relationships and specific instances [8]. The instances contain the actual data that is queried in knowledge based applications. Several approaches for extracting concepts, instances and relationships exploit separately or integrate statistical methods, semantic repositories such as WordNet, natural language processing libraries such as OpenNLP, or lexicon-syntactic patterns in form of regular expressions [9]. The developed system provide users with the capability to choose among and mix these methods in order to obtain potential candidates for ontology enrichment.

Ontology evaluation is an important task in real life scenarios. When creating an application based on semantic knowledge it is necessary to guarantee that the considered ontology meets the application requirements. Ontology evaluation is also important in cases where the ontology is automatically populated from different resources that might not be homogeneous, leading to duplicate instances, or instances that are clustered according to their sources in the same ontology [10]. In this line, an important problem is to compare several ontologies that describe the same domain and choose the one that best fits a certain user needs [11]. However, the ontology evaluation is still a challenging task within the semantic web, and especially of ontology engineering. The difficulty in choosing one ontology from a number of similar ones is given by the numerous ways you can classify such a structure. Due to the fact that an ontology represents a large number of concepts, one can split them in a very large number of ways and categories. For example, one can classify ontologies by the abstractness or concreteness of there meaning how good they cover a subject, or how well can they be used in more different subjects [12]. Moreover, one can split them by the number or relations a given ontology has, or by the way these relations are used between different concepts.

Contributions: This research is an extended version of [13]. Given the lack of systems designed to manage rapidly changing information at the semantic level [14], RSS streams are exploited to extract candidates for dynamic ontology enrichment. With the integration of OpenNLP and WordNet the system gains access to syntactic analysis of the RSS streams.

Organisation: Section II introduces the top level architec-

A Semantic Approach to Automatic Diacritics Restoration

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Abstract—**By all means the world-wide-web is the most comprehensive collection of unstructured documents reason why enabling machines and people to collaborate using the web in a semantic web (Berners Lee) paradigm is a real challenge. The vast majorities of documents on the web are written without diacritical marks and makes them ambiguous for people and machines as well. In this paper we describe a semantic knowledge-based system that restores the diacritical marks and in the same time provides with word senses (WSD) for texts written in Romanian. The main factor that provides success in disambiguating the most difficult words is using parallel texts, aligned ontologies and translation services.** *(Abstract)*

Keywords-component; diacritics restoration; Romanian; WSD; bi-lingual corpora; WordNet

I. WHAT ARE DIACRITICS AND ACKNOWLEDGING THE DE FACTO SITUATION

According to Wikipedia a diacritic, (also diacritical mark, diacritical point, diacritical sign) is a glyph added to a letter, or basic glyph. A first observation is that all language groups Germanic, Celtic, Romance, Slavic, Baltic, Finno-Ugric, Turkic or Arabic for that matter use diacritics, and their usage is specified by the orthographic standards for each of these languages. While the purpose of these diacritics may vary from one language to another, it is acknowledged that at least for languages using the Latin alphabet that the main usage of diacritics is to change the sound value of the letter to which they are added. Traditionally printed texts used diacritics as a norm but in some cultures like for instance the Arabic only religious texts and some educational ones needed to actually use them. It was personal computers that changed the situation for „good". The lack of early localized software and keyboards were the main reasons why today the de facto standard situation of the web is: no diacritics.

II. WHY BOTHER WITH DIACRITICS RESTORATION?

What hold true for the Arab reader then holds true for every human reader today. He reads thousands of web pages and seems not to be bothered by the missing signs. He UNDERSTANDS. Even when missing diacritics may generate text ambiguity it seems that the human brain carries with it all the possible meanings of the text until it is able to subtract enough information from the context to be able to say "this is the intended meaning of the text, this is the correct sense of the word x and by the way, it should/shouldn't have diacritics". Let's follow a sample of ambiguous text in Romanian where there are five alphabet letters that need diacritics ă, î, ş, ţ, â and another five for the corresponding capital letters. Let's consider the phrase taken from the web (with no diacritics):

   (a)   Tara lui este cunoscuta.

Here there is one word cunoscuta meaning "known" that should contain the diacritic sign on the final letter *a* and correctly be written like *cunoscută*. With or without the diacritical mark there is no ambiguity so far. The second word that may or may not have diacritics is the first word of the sentence, the word *Tara*. Now, if the intended meaning was

   (b)   His defect is known.

The word should remain written with no diacritics. However if the intended message was

   (c)   His country is known.

The word should be written with the diacritical sign comma like *Ţara*. As a side-note it should be mentioned that this word can also have according to [1] another sense for the basic *tara* – the meaning of unmarked weights for laboratory measurements which by the way makes sense in the context of phrase (a) and also could derive from another diacritics-enabled word *ţâră* having (another) two senses 1. (n.) *rag, tatter* and 2. (adj., adv.) *little, a few* which in this context do not make sense. It is interesting to mention here (also it will be discussed in detail in paragraph) that both words have the same *part-of-speech* (**POS**) syntactic tag and as a result even an analysis at this level could not elevate the sense ambiguity. In this small context the ambiguity would still be there for a Romanian language human reader as well, however a phrase like (d) or (e) following shortly would settle the matters:

   (d)   Tara lui este Romania.
   Eng. His country is Romania.
   (e)   Este prea ingamfat.
   Eng. He is overly proud.

Here the word sense disambiguation (**WSD**) was performed by the human reader by reading further the context. Implicitly the human reader performed also a task acknowledged in computational linguistics as anaphora resolution (**AR**). The situation is much more complex though when the WSD task must be performed by computational means. This is the main reason why diacritics restoration (**DR**) task should be dealt with and more so nowadays when semantically annotated corpora are generated for a variety of languages. Early works in the domain saw interests for French accent restorations in works of Simard [2],[3] and Spanish in Yarowsky [4],[5] followed by other European languages. The latest newcomer in the field, the Arabic was for instance

Cooperative Multirobot System Integration in a Smart House

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Abstract—**Integrating multirobot systems in intelligent houses is a challenge in nowadays research. Independently, there were many encouraging results in context aware systems for intelligent houses and in cooperative multirobot systems. We aim to show that using the knowledge information and the communication at ontological level between systems we can integrate a cooperative multirobot system in a Smart House. We use a multiagent oriented approach and a Smart House Graphical Simulator to demonstrate the systems adaptation.**

Keywords—cooperative multirobot system, smart house, multiagent system, ontology, adaptation

I. INTRODUCTION

In line with the research related to intelligent systems and robots an application with a promising future refers to a system of mobile robots that are integrated into an intelligent home (SmartHouse).

New proposed directions in intelligent systems include new approaches for ontology-based multiagent system that offer the possibility to ease the design and development of complex simulation scenarios that concern the distinct simulation actors and the simulation environment at the same time [1]. One such approach [2] proposes a new simulation middleware named PlaSMA that extends the JADE (Java Agent Development Framework) platform with simulation control capabilities that both ensure synchronization and provide a world model based on a formal ontological of the application domain.

Another new type of JADE extension is to use an OSGi (Open Services Gateway initiative framework - a module system and service platform for the Java programming language that implements a complete and dynamic component model) environment approach in order to provide for a smart house the possibility to update the architecture during system runtime without reboots [3].

Recent solutions focus on expanding the auto control aspects of a smart house similarly to a digital ecosystem. One such case is the ThinkHome [4] system whose goals are to minimize energy loss and maximize the inhabitants' comfort by relieving them from annoying tasks such as readjustments of their preferences by adding learning capabilities and context awareness in this system. This smart home is reconfiguring itself by adding the domain knowledge of architecture and building physics into the ThinkHome knowledge base. Still, the system is always acknowledging the residents' desires if they choose to change them, this being achieved through a self-managing and adapting society of autonomous acting agents.

Also, fuzzy logic and parallel computing seems to be employed more frequently in smart home multi-agent system since it tends to get better practical results [5].

Concerning the learning capabilities of smart house systems, approaches like improved Q-learning algorithms are present [6] as well as employing learning automata which are useful in designing learning algorithms for stochastic scenarios [7].

Challenges in building robots adaptability to the smart house system refers to two key motivations. The first is finding a suitable cooperative model system compatible with the smart house, designed to perform missions for which the robots were assigned, and the second is to describe the model using a mechanism known to the system.

One of the essential roles of a representation is that it will act as a substitute for the real object to be controlled. A good representation of the robot also makes possible reasoning based on the model; different algorithms can perform such reasoning to infer new knowledge, to reflect as closely as possible the further evolution of the environment in which the system operates.

Developing such a model is a challenge for anyone interested in representing a part of the real world. The fact that one has to represent, for example, elements of the state of mind in which a family member is upset or thinking, in order to alert the company robot to perform its duty, can often be a complex issue and hard to reach .

In addition to an adequate representation of the robots, the intelligence of robotic system consists also in its interaction with smart home environment. Robots that perform services for a smart home environment must have more key features: location, navigation, mapping, human-robot interaction, object recognition and manipulation of objects. To perform these functions the robots must be in connection with sensory systems of the house, as well as with other robots to retrieve relevant information about what's going around.

In our approach the cooperative multirobot system has three types of robots: the supervisor robot, the robot that carries out transportation activities and the company robot, which deals with home entertaining people (especially children) will be adapted to the smart house system using a multiagent system and communicating ontology and a graphical simulator for the Smart House.

The paper is organized as follows: section 2 deals with the mechanism of adaptation of the cooperative multirobot

Robust Real time Visual Odometry in outdoor dynamic environments

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Abstract— **In the present article we propose a method for localization able to provide the position and orientation in 3D space using exclusively stereo vision. Traditional localization methods such as odometry from wheel encoders or GPS in the outdoor case need a superior alternative considering performance and costs. A calibrated stereo camera is the only sensor involved in localization; position at world scale is obtained without involving sensors such as wheel encoders or GPS. The method integrates both optical flow based motion computation and stereo reconstruction using sparse interest points to compute motion. The proposed scheme is a combination of two approaches: the three point algorithm and the ICP algorithm. Robustness is obtained by using a two stage RANSAC inlier selection, one using the intensity image and one using the reconstructed 3D points, and Iterative Closet Points framework-based error refinement process. World scale pose estimation is obtained by computing successive motion vectors characterized through their orientation and magnitude. The method involves fast algorithms capable to function at real time frequency. We present results supporting global localization performance, consistency and speed as well as the robustness of the approach by testing it in unmodified, real life, very crowded outdoor dynamic environments.**

Keywords-component; Visual odometry, Stereo vision, Localization, Mobile robot, Real-time

I. INTRODUCTION

Recent trends in mobile robotics deal with a fundamental requirement of any mobile robot, the possibility of localizing itself. As robots moved from a highly deterministic environment such as a production line to a real life environment such as day to day human activity areas, the proposed solutions for localization had to deal with more and more difficult scenarios.

Solutions that used both custom infrastructure and expensive sensor configurations exist already. Wheel odometry is the most commonly encountered solution that allows easy and cheap localization but is reliable only for a few tens of meters, at best, due to accumulated measurement errors. The most successful attempt to replace sensors destined to localization such as wheel encored or IMUs was based on laser range finders. Laser range finders extended localization to the most general level, that of SLAM, which allows inferring global location from scratch even with wrong prediction.

A different alternative that has previously been explored but which only recently has been shown to provide better results relies on using cameras as sensors. Mainly two directions evolved, one that approaches localization from the perspective of SLAM and another category known as Structure from Motion (SFM) methods. SFM methods approach localization from a geometric point of view. Our paper focuses on the latter type of approaches. Structure from motion methods allow recovering both scene geometric structure and camera extrinsic as well as intrinsic parameters from sets of images of the scene taken from different poses.

Many different works use different types of cameras (including omnidirectional cameras), but most work is based on monocular or stereo cameras.

II. RELATED WORK

One of the most cited approaches by Nister [1] presents solutions for both monocular and stereo setups. In the case of monocular camera the first pose change is reconstructed with the 5 point algorithm and in the case of a stereo camera, a 3 point perspective method referred therein is enough to compute the relative pose change. RANSAC is used to reject outlying points and some refinement step, not detailed, is used to compute a final pose change.

Other work presented by Konolige [3] is based on stereo vision. In this case, the authors use 3D triangulation from stereo, a procedure avoided by Nister because of depth calculation imprecision due to disparity noise. The algorithm uses RANSAC to select a suitable hypothesis and scores it by the inliers number. A final nonlinear minimization step that uses the sum of reprojection differences is used as the objective function. In order to improve global consistency the authors rely on GPS as well as other sensors.

A similar approach used among other purposes for the Boston Dynamics Big Dog robot is given by Howard [2]. In this case, a difference in approach comes from the inlier selection algorithm which is based on the rigid scene structure assumption and finds the biggest rigid structure within the 3D stereo reconstructed points. Similar to previous, a least squares minimization step is used to compute the motion which uses as the objective function the projection in both previous and current frames. Other sensors such as expensive IMU are used to offer a reference.

Scaramuzza [10] presents a solution tested on an omnidirectional camera that uses only one point to compute the motion hypothesis for RANSAC outlier rejection. This is possible because the motion model is restricted to planar

Articulated Pose Estimation in Surveillence Videos

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Abstract: Detecting and estimating human body configuration is a challenging task. It is an intense researched area and a large number of methods were proposed. Despite the high number of methods we cannot choose a method which can handle generally the problem of human detection and pose estimation.

Our scope was to create generally usable system in video surveillance able to provide the highest quantity of information about the human motion and body configuration.

We investigated three types of methods representing different approaches of the problem. The first method is a cascade classifier from the machine learning methods family. From template based methods we studied the Chamfer matching. The third method was the Pictorial Structure based algorithm and belongs to the part-based detection family.

According to our investigation neither method were enough general or efficient to fulfill our scope, but can be used complementarily to cover the most of the cases in video surveillance.

In this article we not only present the methods and investigate their performance in different cases but also we modify the methods by introducing some improvements.

Keywords: Human detection; Pose Estimation; Cascade Classifier; Chamfer Matching; Pictorial Structure

I. INTRODUCTION

The video surveillance in our day receives a distinguished attention. The scope of the most surveillance systems is to track the people and human behaviors. The majority of the surveillance systems only work as a data acquisition system, the data processing is done by human operators. Our scope is to help the human operators by automatic tracking and recognizing the human behaviors.

One of the most important tasks in human tracking and behavior recognition is the detection. By detection we understand localization and body configuration recognition or estimation.

The first step in developing an efficient system is to identify the demands of the system, and identify the working environment. In case of the image processing systems identifying the working environment is important because the environment defines the applicable constrains to the algorithm. In most of the cases constrains represent an important influencing factor to the algorithms efficiency. The most important demands related also to the environment are the following: sizes of the humans object on the image are variable, the background can be static or dynamic, and the background can be more or less cluttered [1].

Considering the system demands we investigated three types of methods belonging to different approaches. Even if the scopes of these methods are the same: detecting people, they work well in different scenarios, and all of them have some weakness.

In the next section we will investigate a machine learning method specially an adaboost based cascade classifier. We also present some improvement in training phase, which help us to build a better classifier. The third section relates the chamfer matching methods and its performance. In the fourth section we present the Pictorial Structure based framework belonging to the part based approach. This section also contain some improvement to the framework to handle some uncertain cases. The last section contains the discussion and general framework.

II. CASCADED CLASSIFIER

In this chapter we present our Cascaded Classifier used to detect humans and estimate their body configuration. We know that the humans are deformable and can take various poses and can appear in diverse views. These properties of human objects make the detection challenging and an interesting task.

A way to detect humans is the "single window" methods. These methods are variants of machine learning algorithms and need some training sets. Taking into account the properties of human objects our training data will be very complex with high degree of in-class variability [2,3].

Because of the high intra-class variability of the training set single classifier is not the best choice for this task. Currently known single classifiers are not suitable for this task because of the high degree of in-class variability. Using a single classifier we will face overtraining or a low performance, because "objects" are too diverse to possess a specific feature that distinguish from the rest of the world. The classification can be done by searching some set of feature constellation that is specific to the objects. This challenging task can be overcome by dividing one of the classes to form subclasses that possess specific features constellations that distinguish from all other patterns, and use a specialized classifier for every subclass [4]. However using this approach, the classification complexity grows linearly with the number of subclasses. The majority of the object detection applications need to work real-time, so our detector needs to be very fast.

To overcome the problem of intra-class variability of the training set we used a cascaded classifier described in [8] our previous work. Our cascaded classifier merges two steps: the pose estimation and the classification.

Using a pose estimator before classification, the estimator does not preserve the coarse-to-fine strategy, and it makes

Appearance Based Large Scale Area SLAM

Application to real and simulated urban environment

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Abstract—**A major attribute in obtaining an autonomous vehicle is the ability to map an area. Robotic mapping tries to solve the problem of getting a spatial model of a real environment, using the onboard sensors. The area has been researched intensively in the past years but it still poses a great number of challenges. Mapping indoor environments already seems an easy task, but it is rarely the case for mapping such an area. The interest, these days, is moving towards mapping unstructured and even large scale areas, which poses many open challenges and questions. The main contribution of this article is the implementation of a method for the usage of submaping algorithms, which unlike other such mapping methods is not based on statistical independence between the maps. The method is based on the EKF (Extended Kalman Filter) approach for SLAM (Simultaneous Localization and Mapping). The approach is capable to get the final map without adding approximations to the ones introduced by the EKF, meaning less errors and all this in linear time. A novelty is our decision to use a well known computer game as the one of the environments for testing the mobile robot applications; the "Need for Speed" game is one of our test environments.**

Keywords: robotics, SLAM, submaps, loop-closure

I. INTRODUCTION

This paper tackles one of the key problems in mobile robotic research that is mapping a large area based on local sensor data gathered by the robot moving in an unknown environment.

Autonomous mobile robots must capable of navigating in dynamic, unstructured or unknown spaces. Simultaneous localization and mapping (SLAM) [1] is the robots' capability to build and update a map of its operating environment, known or unknown, and to localize itself in it at the same time.

Bayesian filters provide a good probabilistic framework for estimating in a recursive fashion the state of the dynamical system. Most of the methods approached until today, including Kalman filters and particle filters rely on the Bayesian foundation.

In this scenario, the vehicle is moving through a real and a synthetic unknown environment, which is populated with landmarks, measured by the on-board sensors, in this case a monocular camera. The SLAM problem requires having appropriate representations for both the observation model and for the motion model. This is usually performed by calculating its prior and posterior distributions by the usage of probabilistic algorithms, for instance Kalman Filters, Particle Filters [2] or Expectation Maximization [3].

These probabilistic approaches are the most popular because mapping is usually affected by uncertainty and by sensor noise. The advantage of these types of algorithms is that they approach the problem by modeling separately the distinct sources of noise or the effects they have on the measurements [4]. From this basic approaches, more complex algorithms relying on the EKF have arrised dealing with techniques for extracting features, methods for fusing different types of sensors, algorithms to improve data association and techniques aimed at reducing the complexity of the computations and improving filter consistency.

Even if these methods had relative success, the classical SLAM solution based on the EKF, has two disabilitating limitations. The fact that it needs updating the entire map covariance matrix second to each measurement, which gives a memory complexity and a time complexity of $O(n2)$ per each step, n being the total number of features stored in the map [5]. The second one is the fact that the EKF approximates for linearizing which includes errors in the estimations which sometimes give optimistic values for the map, which can result in inconsistency [6], [7]. Both these problems become even more disabilitating in large scenarios because linearization errors are bigger because the uncertainty in the vehicle position and features which are further starting point of the map is larger and the memory and calculation requirements increase.

Methods have appeared which try to solve the previous limitations and make SLAM techniques appropriate to larger areas. They are based on breaking the maps which solve the scaling and consistency problems of the classical EKF SLAM applied for large scale areas at the same time. The core of this idea was that if computations and consistency are becoming a problem with larger areas, why not keeping the areas small by dividing the working area.

This rest of the paper will talk about a short overview of the   SLAM submapping techniques, then will follow a section which reviews the feature extraction techniques which were used. Section IV is about the submapping algorithm. The last sections are about the experiments we performed in two distinct environments and the obtained results.

II. STATE OF THE ART

SLAM algorithms which use local maps have been proven to be performing satisfactory for the mapping of large areas because they are improving the consistency in the final estimate and decrease computational cost.

Through the first submapping techniques is the Postponement [8] and the Compressed EKF [9] which are cutting the computational costs by updating in a local area surounding the robot, and performing global map update when the robot moves to another area. The results obtained

Intermodal Time-dependent Route Planning based on a Multi-objective Genetic Algorithm

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Abstract—**The Intermodal Freight Routing Problem (IFRP) has become a current research subject, because a valuable planning of the routes can reduce both the consignors' and the customers' costs. Therefore, for the Intermodal Transportation System (ITS), applications which should develop effective and fast algorithms for solving the IFRP are mandatory. The considered problem is described through a mathematical model and further a multi-objective genetic algorithm is implemented for finding the time-dependent routes with time limit. Those paths that have the total price and time minimal must be found. In order to show the accuracy of the algorithm, the obtained solutions are compared with those resulted by applying a multi-objective exact algorithm.**

Keywords-intermodal transport, routes planning, non-dominated genetic algorithm, multi-objective genetic algorithm

I. INTRODUCTION

Nowadays, the freight transportation plays an important role in the international logistics, because it has significant effect upon both the shippers' and the customers' costs. In the long-distance freight transport case, the traditional transportation, which uses only one transport mode, cannot longer fulfils the whole customers' requirements set. Consequently, it was observed that the usage of the intermodal transport is mandatory. The intermodal transport is defined as a successively combination of two or more transport modes (air, ship, train, road) which perform a seamless door-to-door service for moving the freight from source(s) to destination (s) [1], [2].

The Intermodal Freight Routing Problem (IFRP) is a task much more complex than when only a transport mode is used. In the research field, the Intermodal Transportation System (ITS) has become a current subject because it offers a better economical and feasible transportation than the traditional transportation systems [3], [4]. In the ITS, the IFRPs are defined as multi-objective problem and the networks are time-dependent.

There are only a few papers that treat the multi-objective IFRP [5]. A multi-objective genetic algorithm for solving the bi-objective multi-modal routing problem with time windows was presented in [6]. In order to find the multi-objective routes, in [7], the authors propose a heuristic algorithm, dividing the basic problem in an easier sub-problems set. A tabu-search based method, for the bi-objective optimization in the rail-truck routes planning used to the hazardous materials has been proposed by [8]. Another method for bi-objective routing is developed in [9].

For solving the IFRP in the multi-objective and time dependent case, a multi-objective genetic algorithm, known as Non-dominated Sorting Genetic Algorithm (NSGA-II), is used. The paper objective is to find the routes from a source to a destination such that the transportation time and price to be minimized.

The paper is organized as follows. In Section 2, the mathematical model of the treated problem is described. Section 3 focuses on the steps of the implemented multi-objective genetic algorithm and the specific characteristics. The tests and results are highlighted in Section 4. In Section 5, the conclusions are presented.

II. PROBLEM DESCRIPTION

The intermodal transportation network can be defined as a direct graph $G = \{V, E, M, T, C\}$, where:

$V = \{v_1, ..., v_n\}$ - the vertices set;

$E = \{e_1, ..., e_l\}$ - the arcs set;

$M = \{m_1, ..., m_\alpha\}$ - the set of the transport modes;

$T = \{T_1^M, ..., T_n^M\}$ - the set of the prescheduled timetables;

$C = \{C_1^M, ..., C_n^M\}$ - the costs set;

$T_{v_p v_q} = \{t_{d_1}, ..., t_{d_k}\}$ - the departure times set from the node v_p to the node v_q. $\forall i \in \{1, ..., k\}$, the pair $(v_p, v_q)_{\omega_i}$, where $\omega_i \in \Omega_{v_p v_q} = \{t_{d_1}^{m_{\alpha 1}^{id1}}, ..., t_{d_k}^{m_{\alpha k}^{idk}}\}$, means that it is going from v_p at time $t_{d_i} \in T_{v_p v_q}$, with the transport mode $m_{\alpha_i} \in M$ which has an unique identifier id_i and a costs vector c_i for arriving to the node v_q.

For each node $v_p \in V$, are defined:

$T_{v_p}^M = \{T_{v_p v_{q1}}^M, ..., T_{v_p v_{qj}}^M\}$ - the timetables from v_p to the neighbors nodes set $\{v_{q1}, ..., v_{qj}\}$.

$C_{v_p}^M = \{C_{v_p v_{q1}}^M, ..., C_{v_p v_{qj}}^M\}$ - the costs set from v_p to the neighbors nodes set $\{v_{q1}, ..., v_{qj}\}$.

A. Mathematical Model

The considered problem can be defined using a mathematical model, described in the following.

1) Objective

The objective is to find all paths from a source to a destination such that $F = \{f_t, ..., f_p\}$ to be minimized, where:

f_t - represents the total travel time to arrive from a source *s* to a destination *d*; where the travel time along to the arcs, the

On-Line Error Detecting Codes for DRAMs

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Abstract— **Multi-bit soft and hard errors are a main concern for DRAMs because of the continuous evolution of the technology node. The shrinking of the memory cell area leads to increased vulnerability to radiation-induced soft errors, hence the need of error detecting and correcting codes. For DRAMs, the Berger code can be used to detect all unidirectional errors, but lacks error correction features and produces a considerable delay when considering large memory sizes. The proposed codes are an enhancement of the classical Berger codes and can be used to detect, localize and correct single or multi-bit errors. The hardware required is discussed as well and evaluated from several points of view, which are necessary for on-line DRAM repair strategies.**

Keywords: DRAM, soft errors, error detection, error correction, error localization, Berger code

I. INTRODUCTION

In the IRTS Roadmap for 2011 [1], the low-power trend is exposed as a growing concern in the coming years. The overall power consumption of a memory in a SOC grows steadily because the total memory size increases faster than the area dedicated to logic. This translates in a growth in memory static power, but in order to maintain a low-power principle, the memory dynamic power is also kept as constant as possible. Also, logic dynamic power increases faster than the logic static power. This is somehow expected because the leakage power is the most problematic one and should be lowered or kept constant.

Today's emerging technologies favor a low-power architecture and chip design. For memories, this relates to reducing the dynamic and static power. But this reduction in power must not translate into errors, hard or soft. However, most errors that occur in memories are unrelated one to each other, as explained in [2]. Because the memory sizes continue to increase as predicted by the ITRS Roadmap of 2011, Error Detection Codes (EDC) and Error Correcting Codes (ECC) are widely used in order to keep the memory error-free. Well-known ECC include: the Hamming codes are able to detect up to 2 bits in error and correct 1 bit in error [3], BCH codes which are powerful enough to correct up to 5 erroneous bits [4] and Reed-Solomon codes which process the information on symbols of specific bit-sizes (proved to be effective for burst-error types) [3]. However, each of the ECCs mentioned before have a specific disadvantage. Hamming codes are very inefficient and can correct only 1 bit in error, while the BCH and Reed-Solomon codes have a very complex decoding circuit, which is lengthy and power-consuming. Some improvements for these codes have been proposed, to provide better performance and characteristics [5, 6, 7, 8, 9, and 10].

Some proposals even include a combination of 2 codes, so that the advantages of each one are taken into consideration [11].

EDCs are a faster and economical alternative to ECC, without the correction part. So, the errors are detected and other mitigation techniques are used in order to eliminate the errors. This is a solution when considering the energy consumption, performance degradation and time. The energy consumption is greatly reduced because the detection process is fast and simple, rather than the complex decoding circuit of the BCH or Reed-Solomon codes. For example, the Berger code [13] can be generated using a Full Adder tree-shaped parallel counter [13], while the actual detection process is done by a simple digital comparator. More complex codes similar to the Berger code are *t-symmetric-error-correcting/all-unidirectional-error-detecting (t-SyEC/AUED)* codes [14, 15, 16, 17]. The design consists of binary blocks which are capable of correcting up to *t* symmetric errors and detect all unidirectional errors. Note that if *t=0*, these codes become the Berger codes. However, these types of codes are suited for asymmetric channels, such as digital transmissions.

There is no performance degradation in the system during the error detection phase, but when an ECC reaches the correcting stage, the overall system performance is reduced due to the complex computations. Also, any ECC is time consuming especially when the errors are random, unrelated and affect more than one bit.

The Berger code mentioned before is used for detecting unidirectional errors. A recent implementation is the one proposed in [13] in which they suggest a parallel counting tree of Full Adders. The check bits are calculated by summing all the 1s or 0s from the information bits and appending the sum to the original information bits, generating an encoded word. Unidirectional errors are a special case of soft errors that can occur in DRAMs due to cosmic rays radiations. When an alpha-particle or high-energy neutron strikes a DRAM cell, it creates a burst of charge which discharges the cell (if previously charged to nominal value), therefore flipping its initial value. For example, if the charged state symbolized a logic value of 1, after a radiation strike, the value will flip to a value of 0; vice versa if the charged state is a value of 0. This has been reported in several studies and works [18, 19, 20, 21, 22]. So far, mitigation techniques for soft errors include EDCs and ECCs because these soft errors can be corrected by a simple re-compute and rewrite.

In [4], simple and innovative ideas are used to reduce the cache power consumption, while having ECC. Instead of using a single ECC, they propose the use of 2 independent codes, but which can share the same parity matrix (needed for the error detection and correction). So, a simple and fast ECC searches for at most 1 error in a memory word and corrects it. If more than 1 error occurred, the current cache line is disabled and transferred to a Hi-ECC block, which can correct up to 5 bits in error and detect up to 6 (based on the BCH code). After the errors are corrected, the cache line is re-enabled. The power consumption is reduced by disabling the

A new and efficient semi-supervised segmentation method for renal tumors in CT images

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Abstract—**Computed tomography (CT) is today a key modality in imaging tumors for diagnosis, therapy and follow-up purposes. Segmentation of CT images is still a challenging task in literature due to the low contrast and some artifacts like partial volume, motion artifact and attenuation. We propose an efficient semi-supervised method for CT image segmentation. Our aim is to alleviate the limitations of fully automatic segmentation, that is, to provide robust segmentation for any kind of imaging parameters and target object. Our algorithm is based on user-assisted initialization with labels and the use of image patches as data features. The segmentation problem is solved in a continuous min-cut partition of a graph. We present extensive validation on clinical data on pathological focal structures like cysts and tumors of kidneys. Results show a very high similarity agreement with the ground truth provided by medical expert delineations.**

Keywords—**computed tomography, image segmentation, renal tumors, continuous graph-cuts, patch feature, label based semi-supervision.**

I. INTRODUCTION

Computed tomography (CT) is the most common image acquisition technique that reflects the anatomical structure of the human body in 3D. It offers accurate information such as a precise spatial localization and information about the structures densities. These advantages make the use of CT imaging of particular interest in areas including head, chest and abdomen. CT is used in several domains of medicine, for example, computer aided-diagnosis, pathology follow-up, treatment planing and therapy (surgery, radio-therapy, chemo-therapy etc.). Computer assistance plays an important role in all this kind of clinical application. Due to medical image analysis technology that grew rapidly in last decades, considerably facilities were brought for clinical examinations. Segmentation is of extreme importance in most of the mentioned domains. Segmentation of computed tomography (CT) images is still a challenging task due to the low contrast and some artifacts like partial volume, motion artifact and attenuation. To this end, the development of efficient CT image segmentation techniques of biological structures (e.g. different organs, heart chamber, blood vessels) or focal diseases like tumors is needed. Actually, most segmentation methods that succeeded in the case of CT imaging are those making use of target-specific constrains or priors. Several types of priors have been suggested in the literature: those coming from *functional* constrains (when using contrast agents during the image acquisition) [1], *shape* priors [2], and *image*-based [2]. In this work, we consider 2D slices of the 3D volumes in CT images, without contrast enhancement agents. In consequence, we will not discuss the use of functional constraints provided by contrast product. However, such kind of priors could be easily included in our formulation if needed. Anatomical shape priors are powerful for CT image segmentation dealing very well with weak edges and heterogeneous structures and they have been successfully used for different anatomical structures segmentation like for instance the heart [3], [4], the prostate [5], [6], the breast [7] or the kidney [8]. Shape constrains can be encoded in the form of statistical shape models. These models need however from large data set to be constructed, and are often computationally heavy. Thus, they can hardly be used for pathological cases due to high variation in shape, size and position of lesions. Other shape constrains can be encoded in a simpler manner as for instance imposing a smooth boundary [3]. We will have such regularization in our approach. Finally, priors can be related to the imaging physics, that is, related to the observed intensities of the CT image. For example, we consider intensity-based priors or learned texture as specific parametric intensity models to characterize the observed data. A wide range of image features are used for modeling CT observed data. Intensity features are often used by means of analytical models of the gray-level distribution (Gaussian distribution being the most used model [9]). The main drawbacks of these gray-level distribution models are related to distribution parameter estimation and to its dependency on the imaging system settings such as dynamic range. Intensity gradient features can also be used [10]). However, they are usually used to segment homogeneous regions, not necessarily anatomical structures. Texture features have also proved to be successful in CT segmentation, particularly statistical patterns of the intensity due to their advantage of being independent of the imaging system physics.

Rather than characterize the data with analytical distribution models or texture patterns, in this work we propose a CT image segmentation method based on a different representation with a *graph* of image *patches*. The use of patches as image features allow us to be more independent of the imaging system. Our choice of feature is also supported by previous works in the literature. Patch features were first introduced for texture synthesis [11] and image denoising [12] in natural images. In [13], Coupé et al. extended the non-local means filter [12] to reduce speckle noise in US images. In [14], [15], the patch-based approach was also successfully used for spatio-temporal registration and for motion or/and elasticity estimation in US image sequences of the heart.

Here, we address the problem of efficient, interactive extraction of a foreground object in CT imaging, where the

Computerized characterization and diagnosis of the inflammatory bowel diseases and of the colon cancer based on ultrasound images, using superior order cooccurrence matrices

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Abstract— **The inflammatory bowel diseases (IBD) are severe, chronic and recurring disorders. The colo-rectal tumors are frequently met in the population of the developed countries, being similar in appearance with the IBD, inside the ultrasound images. The most reliable methods for the diagnosis of the IBD are invasive (endoscopy, colonoscopy, histopathology) or irradiating (CT). We aim to develop computerized methods for the noninvasive assessment of the bowel inflammation level, based on information obtained from ultrasound images. The texture is an important property of the internal organ tissues, providing subtle information about the pathology. In this work, we analyze the role that the superior order Gray Level Cooccurrence Matrix (GLCM) has in the characterization and automatic diagnosis of the inflammatory bowel diseases and of the colo-rectal tumors. We consider the third and fifth order GLCM, we derive the extended Haralick features, and we assess the efficiency of these features through powerful classifiers.**

Keywords – inflammatory bowel diseases, colo-rectal tumors, texture, superior order GLCM, recognition accurracy

I. INTRODUCTION

The inflammatory bowel diseases (IBD) are a group of disorders whose evolution is frequently chronic, with activation peaks and remission periods. There are several clinical, laboratory and paraclinical parameters used to assess the activity phase. Most used clinical scores are the Crohn's Disease Activity Index (CDAI) and Truelove Witts. Together with laboratory parameters, they can assess to some degree the activity but are not enough accurately. [1] The standard methods of diagnosis and of inflammatory phase assessment are the endoscopic, radiologic and histopathology exams, but these are too invasive for severe forms and they cannot be permanently repeated. Computer tomography and magnetic resonance imaging are elective imagistic methods, being less accessible and expensive. Ultrasonography has similar potential in diagnosis, but with advantages like: noninvasivity, reduced cost and the possibility of repeatability. Our aim is to develop new methods of activity assessment in inflammatory bowel diseases, based on utrasonography examination, combined with the computer-aided analysis of images. The texture is an important visual feature, able to provide subtle information abou the pathology. During our research, we developed texture-based methods in order to emphasize the features that characterize

each inflammatory bowel disease and the digestive tumors [2]. In this work, we improve the texture analysis methods by defining the Grey Level Cooccurrence Matrix (GLCM) of superior order. The GLCM of order three was previously used for crop classification within the radar images [3], and also for the characterization of the trabecular bones in proximal femur radiographs [4]. The GLCM of order n was theoretically approached by Akono in [5]. However, the superior order GLCM was poorly implemented in the domain of medical image analysis and recognition. We define and experiment the third and fifth order GLCM in order to improve the characterization and diagnosis of the Inflammatory Bowel Diseases (IBD) and colo-rectal cancer. For the detection of the relevant textural features, we implemented the Correlation-based Feature Selection (CFS) and Consistency-based feature subset ealuation methods [6]. For the purpose of automatic diagnosis, we implemented the methods of Support Vector Machines (SVM) [7], Multilayer Preceptron (MLP) [7], and AdaBoost [7].

II. THE DESCRIPTION OF THE INFLAMMATORY BOWEL DISEASES AND OF THEIR ASPECT IN ULTRASOUND IMAGES

There is a group of intestinal diseases, known as Inflammatory Bowel Diseases (IBD), that have unknown causes, but are important because of their severity. The Crohn's disease (CD) and Ulcerative colitis (UC) are the most frequent forms. The inflammation extends to all the layers in Crohn's disease [8], and only to the mucosa in the Ulcerative colitis [1]. Concerning the case of the Ulcerative colitis, hypoechoic lesions that correspond to the ulcerations appear. Patients with inflammatory bowel diseases present, alternatively, periods of remission and of activity. Inflammatory or neoplastic bowel pathology is associated with the thickening of the bowel wall. Concerning the features of the Crohn's disease, the characteristic visual appearance is that of a "target" image (Figure 1). In the acute form, a removal of the separation between the composing layers is noticed. In the chronic form, the composing layers appear as being distinct. The dominant process at histological layer is that of fibrosis, which generates an echo-poor halo surrounding a central echogenic zone [9]. Ulcerative colitis is a mucosal disease, the halo being a less prominent feature (Figure 2). [1] The colorectal tumors (Figure 3) share a lot of characteristics with the IBD, like wall thickening and increased vascularity. However, like

Chemoterapy Induced Cardiotoxicity Early Prevention, Diagnosis and Continuous Supervising Software Framework

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Abstract— **The continuous progress of the anti-cancer solutions in medicine, suppose also some additional methods aimed to prevent and protect the patients against the already known possible adverse effects of them, identified sometime as being responsible for many dangerous destructions at the level of internal human organs, the most important being the cytostatic treatment induced hearth diseases. Because there are a complex set of factors which must contribute to establish the risk of the cardiotoxicity at the oncologic patients, such a context strongly required a robust multifunctional distributed software environment aimed to assist the medical procedures in this field. Consequently, in this paper are described the most important features of CardioTox software solution, as a unified computerized web accessible cytostatic-induced cardiotoxicity monitoring framework.**

Keywords-multifunctional distributed software environment; Tissue Doppler Imaging; TDI parameters, multimedia distributed database; cardiotoxicity score

I. INTRODUCTION

It is already known that some anti-cancer medication may induce even dramatic associated effects concerning the healthy status of some internal organs, the most important being the possible adverse effects concerning the hearth. [1]

As it is stated in the medical literature, and according to our researches, there are a complex set of factors which must contribute to establish: the risk of the cardiotoxicity at the oncologic patients, the incidence of the cardiotoxicity, and the best therapy to prevent and/or to maintain under control the cardiotoxicity [2],[5],[6]. Such a context strongly required a robust multifunctional distributed software environment.

Because, until now, the evaluation and monitoring methods for the cardiotoxicity are not very clearly established, a very flexible and versatile software tool is needed. There exists few such dedicated software on the market. In the best case, it exists small applications, which solve punctual / on time problems.

In order to assist the specific medical strategy, our aim was to implement the needed algorithms and software tools as a unified computerized web accessible environment.

In what follows, we will present the most important algorithms which are implemented in the context of the computerized system named CardioTox, as well as the general architecture of CardioTox Information System, and the distributed architecture of the multimedia database which is one of the core components of the system.

II. THE MOST IMPORTANT ALGORITHMS

The Parameters used to detect the cardiac dysfunctionalities as important mortality and morbidity predictive factors in the patients treated with antracyclines as cytostatic medication, are [3][4]:

-left ventricle ejection quotient (*LVEF*)

-left ventricle shortening quotient (*LVSF*).

Based on these parameters, according to the major part of the specific studies the cardiac toxicity is supposed in the following situations [4]:

- LVEF decreases under 10% face to the basic value estimated before the beginning of the treatment;
- LVEF decreases under 20% face to the basic value, despite a normal systolic function;
- LVEF decreases under 45% (29,30).

Using the echocardiography as investigating method, the calculation principle of the *left ventricle ejection quotient,* which is implemented in the context of CardioTox information system, is based on the so called *Simpson method*, as it is shown bellow [4]:

- after the interactive establishment of the endomiocardic anatomic contour of the left ventricle, by directly drawing on the computerized echocardiographic image, it is calculated the total volume of all elementary cylinders, that have the same height;
- the *ejection quotient* is calculated as a fraction between the modification of the volume of the left ventricle, and the end-diastolic volume of them.
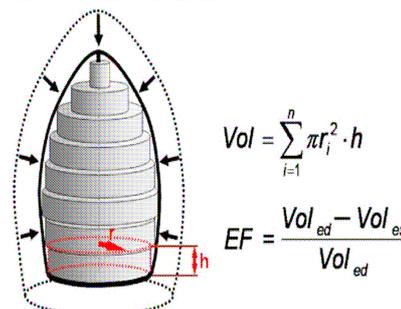

$$Vol = \sum_{i=1}^{n} \pi r_i^2 \cdot h$$

$$EF = \frac{Vol_{ed} - Vol_{es}}{Vol_{ed}}$$

Figure 1. Calculation principle of the *left ventricle ejection quotient*

Methods to estimate the Cardio Toxicity of Cytostatic Medication

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Abstract— **Cardiotoxicity being the most dreaded effect of the anti-cancer medication, it is obvious the great importance of the early detection of the cytostatic induced cardiac function alteration. Considering the wide range of medical and physiologic factors which are involved in such a context, all of them being centered around the monitoring of both the immediate and/or late associated adverse effects of cytostatic medication in various cancer diseases, our paper presents some results concerning the development of a cardiotoxicity estimation and monitoring software component, aimed to be integrated in the context of a fully featured dedicated expert system.**

Keywords- computerized methods fusion, targeted cardiac imaging, multimedia distributed database, maximum-likelihood estimation, cardiotoxicity score

I.   INTRODUCTION

Cardiotoxicity is the most dreaded effect of the anti-cancer medication; the life-hope obtained as result of the oncologic treatment may be dramatically decreased by the mortality due to the cardiac problems induced by the specific chemotherapy. Other secondary effects of the oncologic treatments may have an important impact on the quality of life, but generally they have a minor negative impact related to the surviving hope. By definition, *Cardiotoxicity* means the *myocardial dysfunction* which may appear immediately, or in a longer time period after an oncologic treatment, being often not-reversible. Consequently, the great importance of the early detection of the cardiac function alteration is obvious.

Until now, the evaluation and monitoring methods for the cardiotoxicity are not very clearly established. There are some diagnose methods, and in order to establish the Cardiotoxicity were proposed specific boundary values of some so considered relevant parameters.[9][10] Traditionally, in order to detect the cardiotoxicity induced by the oncologic treatments, were used mainly the *ejection quotient* and the *left ventricle shortening quotient,* but related to the subtle modifications of the myocardial function, which appear in the first stages of the cardiotoxicity, we defined and implemented the so called *cardiotoxicity score*, in the context of a dedicated software environment.

II.   STATE OF THE ART: CLINICAL AND PARACLINICAL MEDICAL METHODS FOR THE DETECTION OF THE CYTOSTATIC INDUCED CARDIOTOXICITY

The actual clinical and paraclinical medical methods, used for the detection of the cytostatic induced cardiotoxicity, are [2]:

(1) Multiple Gated Acquisition Scan (MUGA Scintigraphy) is a trusted calculus of the *left ventricle ejection quotient*;

(2) Echocardiography used for the evaluation of the *diastolic and systolic function***,** is helpful for the detection of the sub-clinic cardiotoxicity by means of the *deformation* and **of** the *deformation rate*

(3) Electrocardiography is important because its possibility to put into evidence a precocious marker of the cardiotoxicity, namely the *prolongation of corrected QT interval* (see Fig. 1 on the next page)

(4) Biochemical Cardiac Markers – in this method, the toxicity is associated with the increase of the concentration of the biochemical cardiac markers

(5) Markers of the endothelial destruction – in this method, the toxicity is associated with the increase of the plasmatic and serologic concentration of the endothelial destruction markers

(6) Identification of genetic variations – is a method which assure the identification, before treatment, of the toxic effects susceptibility

(7) TCI - Targeted Cardiac Imaging – is a method providing structural information about the metabolic and functional processes, as visualization of the first modifications of the metabolic processes

(8) Nuclear Magnetic Resonance Imaging provides detailed high resolution anatomic information, as basis of a trusted calculus of the *left ventricle ejection quotient***;** the combination with *gadolinium* provides detailed information about the cardiac function

(9) Endomiocardic biopsy represents the *gold standard test* for the evaluation of the cardiomiopaty induced by anthracyclines**;** the relevant modifications may be often observed after a small cumulative dosage of doxorubicine (180mg/m2), or even smaller, function of individual sensitivity of the patient. [3][5][7][21]

Diagnosing Respiratory Abnormalities: A Multimedia Data Mining Approach

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Abstract—**Spirometry is a common pulmonary function test. It is used for diagnosing pulmonary problems such as chronic obstructive pulmonary disease (COPD) or asthma, as well as a screening tool for restrictive pulmonary disorders. Several numerical features are used in the diagnosis process. The output of the test is saved as a graph which represents the volume of the air coming out from the lungs plotted in respect to the flow of air. The shape of the graph also has a great influence in the diagnosis process. The amplitude of the graph and its concavity are some of the multimedia features which take part in the diagnosis process. We present an initial experiment on mining multimedia features in order to classify spirometry test results.**

Spirometry; multimedia mining; feature extraction; image processing; data preprocessing.

I. INTRODUCTION

Lung health is a major concern for both physicians and patients. Different tests are carried out in order to diagnose a patient suffering from some kind of pulmonary disease. The most widely used pulmonary function test is spirometry.

During the spirometry test the volume and flow of air coming from and to the lungs are recorded by specialized instruments. The results of these tests allow the physicians to diagnose pulmonary diseases such as chronic obstructive pulmonary disease (COPD) or asthma. The test requires that the patient inhales as much air as possible and then exhales it for six seconds. Several specific features are recorded during this time: Forced Vital Capacity (FVC) – the total volume of air exhaled after a full inspiration, Forced Expiratory Volume at 1st second (FEV1) – the volume of air which is forcibly exhaled in one second, ratio of FVC to FEV1 (FEV/FVC), Peak Expiratory Flow (PEF), Forced Expiratory Flow 25–75% (FEF 25–75). Other features with variable medical importance are recorded as well. All the recorded features are then compared with normal values, which are computed based on the physical features of the patient, such as age, gender, height or weight.

A patient can suffer from obstructive, restrictive or mixed disorder. An obstructive disorder is characterized by the disproportionate reduction of the maximal airflow from the lung in relation to the maximal volume that can be displaced form the lung. This is due to the fact that the airways narrow themselves during exhalation. The FEV1/FVC ratio is also reduced. FEV1 is the volume of air that is forcibly exhaled in the first second, whereas FVC is the total volume of air exhaled after a full inspiration. Spirometry is used for screening and diagnosing restrictive disorder. In many cases,

where restrictiveness is diagnoses, the patient is referred to other, more sophisticated tests, such as bronchoscopy or bronchography. A restrictive disorder is characterized by a low FVC. Usually, a low spirometric FVC together with a normal or high FEV1/FVC ratio depicts a restrictive disorder.

Handheld spirometers have become financially affordable, therefore they are common and can be used in primal care evaluation of obstructive disorders.

Data mining has been intensively used in electronic medical tools. Different methods, algorithms and processes have proven to be effective in assisting the physicians in the diagnosis process. Classification is the process by which an object is assigned to a known class, by the values of its features and of those of that particular class. In the case of the medical domain, such a process is used for assessing the type of disease of which a patient is suffering, based on the results of different medical tests.

With the ever-growing quantity of data, specialized tools are becoming a must have in hospitals and clinics worldwide. Besides the quantity extent of the data, another aspect of equal importance is the type of data. Technological advances have allowed engineers to create intelligent and accurate machines which can record and store medical data in the form of image, audio and video. Medical specialists are faced now with an even bigger problem, which is the extraction of information from a large amount of multimedia data. Multimedia data bases and data warehouses are common software in hospitals. The data stored in these repositories has been the subject of research from both academic and industrial community. Thus, a new branch of data mining has taken shape: multimedia data mining.

Multimedia data mining [6] is considered a multidisciplinary field, combining techniques from traditional data mining and multimedia data processing, such as image or audio processing. In the preprocessing stage, specific data is extracted from the multimedia data, which is then transformed into regular features which are later used in the data mining process. When dealing with images for example, common features include texture or edges.

In this paper we present the results of applying multimedia data mining on spirometry data. The scope of these preliminary experiments was to determine in what extent multimedia features influence the classification process of normal values and obstructive or restrictive disorders.

The rest of the paper is structured in the following way: in Section II we present some of the previous work which has been done in the field and which has motivated us to conduct these experiments. Section III presents our previous work