

Software Survey for Breast Image Processing

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Abstract – Computer-aided diagnosis (CAD) systems are computational tools that aim to help medical professionals in their diagnostic decisions. Software for processing images has contributed in many ways to medicine, such as, the diagnosis and treatments of diseases such as breast cancer. Breast cancer is one of the main causes of women death all over the world. However, early detection of the disease increases greatly the possibility of cure. Therefore, several types of computer systems based on image processing are being developed by many research groups in order to aid the radiologist in the accuracy of the diagnosis. The aim of this survey was to search for signs of the current state of technology, identifying image processing software in the global marketplace for assistance in medical diagnosis. The outcomes measured were obtained through the searches done in scientific publications repository Web of Science using the Derwent database, including records of deposits of world patents. Data measurement revealed that there were only 107 patent registrations. Further studies and research need to be designed, since the keyword “image processing software” showed only 3 patent registrations. The United States is the leader in the number of patents per country, with a total of 40 registrations in the abstract search. The title search resulted in only 20 registrations, although this quantity was much larger than that found in other countries. The this survey showed that there is a paucity of patent registration in lesser-developed and developing countries. The reasons may be the absence of a strategic enterprising vision for encouragement to improve technical and scientific endeavors.

Keywords – Breast Neoplasms, Image Processing, Software.

I. INTRODUCTION

Breast cancer is the most common type of malignancy that affects women worldwide, both in developing and developed countries. In the United States, it was estimated that 200,000 new cases were diagnosed and 40,000 women died in 2014 [1]. In Brazil, it was estimated that 57,120 new breast cancer cases would occur in 2014, with a calculated risk of 56.09 cases per 100,000 women [2].

Mammography is the standard imaging diagnostic test for the evaluation of breast tissue. This type of examination may detect nonpalpable breast masses, microcalcifications and asymmetry. However, the false-negative rate of mammography ranges from 10% to 15%, and it may reach 40% in patients with dense breasts [1, 3]. In general, reading and interpreting mammograms is a very demanding job for the radiologist. A radiologist depends on training, experience, and subjective criteria in order to make a judgement. Even the most highly trained expert may have an inter-observer variation rate of 65–75%. Computer-aided diagnosis (CAD) systems may help

radiologists interpret mammograms for mass detection and classification [3]. Since 65–90% of the biopsies of suspected cancer turn out to be benign, it is very important to develop CADs that may help to distinguish benign from malignant lesions. The combination of CAD scheme and expert knowledge would greatly improve detection accuracy. The sensitivity of detection without CAD is 80%. With CAD, sensitivity reaches 90% or more [4-6]. However, the use of this exam as a screening method reduces mortality by 25%. Therefore, the development of a new computer-aided detection scheme based on analysis of global mammographic image features is of interest. Furthermore, the performance of this new scheme could be tested in the detection of positive screening mammography examinations [7,8].

Thus, Computer-Aided Detection systems may help radiologists in the complex task of reading and interpreting mammographic images, with automation of the medical diagnosis process through image interpretation [9]. Breast tissue biopsies of suspected cancer are benign in 65 to 90% of the cases, making it crucial to develop CAD systems that may assist in discriminating benign from cancerous lesions [9].

New research related to computer-aided radiological diagnosis emerged after the increasing demand of hospitals and clinics for a rapid and concise radiological diagnosis, along with advances in computer science and image processing [10]. Computer-aided diagnosis or computer-aided detection is a relatively recent computer tool, which has been implemented to provide double re-reading, increasing the sensitivity of the method. Some clinical studies have demonstrated that CAD increases the sensitivity of breast cancer detection in up to 21% [10-13].

Therefore, a current analysis of breast image processing software has importance for the healthcare sector. This assessment was a study of patent registrations, with the purpose of analyzing the current marketplace regarding technologies applied. Furthermore, it verified whether the marketplace had not yet reached saturation point for the launch of any future product [11].

Thus, the aim of the current article was to present a study on the state of technology by means of a software survey for breast image processing for assistance in medical diagnosis.

II. METHODS

In compliance with methodological procedures, we performed a search in the Derwent Innovation Index International patent database in June 2015, using the Web of Science repository which provides scientific

publications [12,13]. Research was conducted according to a quantitative study, based on a comparative analysis of results using a neopositivist approach, since measurements are considered to be richer than verbal descriptions. The Derwent database has registrations of patent deposits from various issuing patent organs, such as the American, European, German and Japanese offices [14, 15]. The following keywords were used in this assessment: breast cancer diagnosis software, image processing software and mammography software. The search fields used in the Derwent database were the title and abstract of the topics [13]. With the search results, it was possible to construct graphs using Microsoft Office Excel 2013. The 107 registrations were extracted from the research by titles and topics. Analysis of the results was carried out using a code from the International Patent Classification (IPC) system. It enabled us to analyze the situation of the developing software, and see whether the software had been previously developed or whether it had already been appropriated by another inventor.

III. RESULTS

In the patent search, it was noticed that the search terms returned a larger quantity of patent deposits by abstracts and titles, related to the terms software for diagnosis breast cancer, resulting in 72 registrations, 32 mammography software and 3 image processing software. Therefore, a total of 107 (one hundred and seven) patents were found until 2014.

Table 1 showed the results of the number of patents deposited related to search terms:

Table 1. Number of registrations obtained with search terms, by abstracts and title.

<i>Term</i>	<i>Number of Patents Found</i>
<i>Breast cancer diagnosis software</i>	72
<i>Mammography software</i>	32
<i>Image processing software</i>	3
TOTAL	107

Fig 1 shows the number of patents per country, resulting from the abstract search. The highest number of patents was found in the United States of America (USA), with 40 registrations. In second place were patents registered in the worldwide database (WO), through the Patent Cooperation Treaty (PCT), with 37 patents deposited. In third place was the European Patent Organization (EP) with 11 patents, followed by Japan in fourth place with six registrations. At the end, countries with the smallest number of patents were included, such as France (FR), India (IN), Germany (DE), Mexico (MX), China (CN) and Brazil (BR), which together totalled 13 patents.

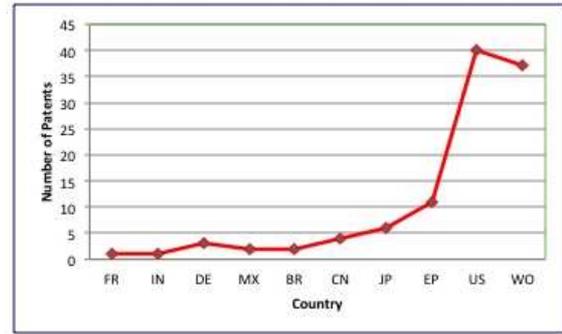


Fig. 1. Number of Patents per Country (Abstract)

Fig 2 shows the number of patents deposited according to country of origin, resulting from a search by titles, where it was observed that a larger quantity of registrations had been deposited by the USA. This fact may be due to both the greater number of patents deposited by the United States and the corroboration of the keywords breast cancer diagnosis software, used in the patent search.

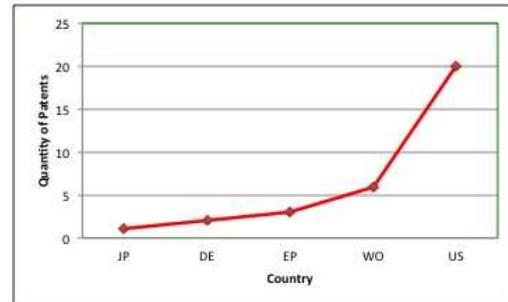


Fig. 2. Quantity of patents deposited per country of origin

In this survey, an investigation into patent registrations based on the International Patent Classification (IPC) system was also carried out. There is no specific section for Computer Science or Engineering. Therefore, Section G is of interest to this study. This classification symbolizes Physics and contains the subclass G06K. It is where the subgroups 019/00 (digital computer apparatus or methods), and 019/20 (data processing) are compartmentalized. Therefore, the largest quantity of patent registrations occurred in section G, with 14 cases. In Section A (Human Necessities), the representative of the subclass encompassing diagnoses, surgery and identification of the referred classification (IPC), there was a total of 10 cases, as highlighted in Fig 3.

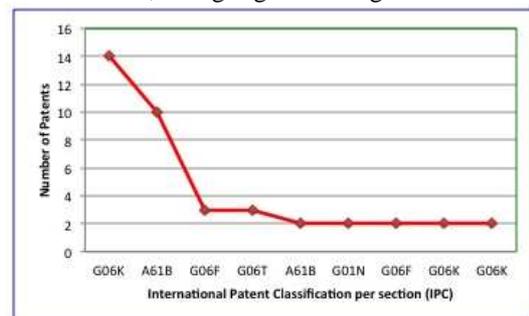


Fig. 3. International Patent Classification per section (IPC)

IX. CONCLUSION

The survey was undertaken, employing the Web of Science Service, a repository of scientific publications. The Derwent database was used, since it has the greatest number of registrations in the field of image processing software. The Derwent database includes registrations of patent deposits from renowned offices, e.g. the European, American, German and Japanese offices. Data measurement revealed that there were only 107 patent registrations. Further studies and research need to be designed, since the keyword “image processing software” showed only 3 patent registrations.

The United States is the leader in the number of patents per country, with a total of 40 registrations in the abstract search. The title search resulted in only 20 registrations, although this quantity was much larger than that found in other countries. The results of this survey showed that there is a paucity of patent registration in lesser-developed and developing countries. The reasons may be the absence of a strategic enterprising vision for encouragement to improve technical and scientific endeavors. Furthermore, the worldwide tendency to conduct research into software development for assistance in medical diagnosis is still lacking in underprivileged countries.

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