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MoleTest$^{\mathrm{TM}}$: A Web-based Skin Cancer Screening System

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***Abstract*—This paper reports on a research and development programme undertaken in the Bioengineering Research Group http://teapot.dit.ie/ at Dublin Institute of Technology which led to the launch, in September 2010, of a new SME called Moletest UK Limited. Based on an exclusive license awarded by Dublin Institute of Technology in 2010, we report of the development of the world's first remote skin cancer screening system which is based on a customer uploading a good quality digital image of a suspect mole. A 'background to the case' is given and the concept of the approach discussed together with an overview of the methods and algorithms developed in order to provide the service now available.**

***Index Terms*—Intensive Applications and Services (RIAS), Skin cancer screening, Tele-Dermatology, Telemedicine, Large scale e-health systems.**

I. INTRODUCTION

This paper provides an overview of a new web-based technology for skin cancer screening called Moletest$^{\mathrm{TM}}$ [1] and [2]. The technology is based on an expert system designed to classify moles through an analysis of a good quality digital image uploaded by the user of the system. The technology is an example of an intensive application and service in the area of *Health Informatics* and has been developed as a personalized e-Health Service. Health Informatics is the appropriate and innovative application of concepts and technologies to improve health care and health and may be subdivided into two principal categories:

- **Tele-Health** which is related to direct (video conferencing) or indirect (website delivery) of health information or health care to a recipient;
- **e-Health** which encompasses products, systems and services, including tools for health authorities and professionals and personalized health systems for patients and citizens.

The market for global Tele-Health, e-Health and Telemedicine in general is estimated to reach the order of \$13.9 Billion by 2012 [3]. The system discussed in this paper is an example of Telemedicine known as Tele-Dermatology and the reason for developing the system is that one in six people will develop skin cancer at some stage in their lives but 90% of early melanoma cases can be cured. Thus if the condition is spotted early enough, Melanoma is almost always curable. However, if it has time to spread, the condition can be fatal.

A standard approach to the diagnosis of Melanoma is to urge people to look for any change in colour, size and shape of a mole or freckle, following the A-B-C-D guidelines which are as follows:

- **Asymmetry** - any change in the shape of the mole or freckle.
- **Border irregularity** - any change in edge irregularities.
- **Colour variety** - different shades of colour on the same mole or freckle.
- **Diameter** - most melanomas are 6mm or more in diameter.

Another option is to use a mole mapping chart, such as that provided by www.my-skincheck.com, to help people familiarize themselves with their skin and make it easier to identify any changes. Finally, an easier, albeit more expensive method for checking a mole, is to use technological advances such as 'mole mapping'. Mole mapping is usually based on total body photography where an overview is taken and those images of moles that appear to be suspicious and are taken again at higher magnification. These images are then submitted to diagnostic software which assesses the mole and makes a relative prediction as to whether it is benign or malignant. This process is educational for patients as they can be talked through each case and informed about what is being looked for throughout the procedure by a Dermatologist. Clinics frequently store any images so that they can be used for comparison and to identify any changes that may occur over time. If a mole is diagnosed as being suspicious, a referral is made to a plastic surgeon for its removal. Mole mapping does not change the risks of getting skin cancer, but it helps to detect it earlier. However, it can be expensive as it usually requires specialist clinics to be established and managed.

Skin cancer is one of the most common forms of cancer and is particularly common in Caucasians. With rates of malignant melanoma expected to treble over the next thirty years, it is important to develop user friendly technologies that can screen for this condition. There are two types of skin cancer. Non-melanoma, which usually occurs in people that spend or have spent a lot of time working outdoors, and, if caught early, can be cured and melanomas, or malignant melanoma. This is the most serious form of skin cancer and, if not detected, can quickly spread to other parts of the body. It usually appears as a mole or freckle and thus, can, in principal, be diagnosed using suitable image analysis of the mole or freckle.

It is often difficult to visually differentiate a normal mole from abnormal and general practitioners do not usually have significant expertise to diagnose skin cancers. Skin cancer specialists can improve the identification rate by over 80% but are often severely overloaded by referrals from regional general practices. It is possible for a general practitioner to take a high quality digital image of the suspect region on a patients skin and email the result to a remote diagnosis center. However, this can also lead to a (remote) overload and it is for this reason that Moletest has been developed, i.e. in response to the need for a screening method that can 'filter' benign melanomas via a general practice or by a user directly.

II. MOLETEST$^{\text{TM}}$

Moletest ([1], [2]) represents a unique healthcare opportunity for remote skin diagnosis of suspicious moles using digital images and has the potential to become a world-wide life-saving product. While there are a range of competitive technologies available, Moletest is the only system of its type that can provide accurate reports based solely on the submission of high fidelity digital images using an Internet resource. The online facility has been designed specifically to combat skin cancer that is predicted to become the fourth most common cancer for men and for women in the UK alone by 2024.

A. *Skin Cancer*

Incidence of skin cancer continues to rise. Malignant Melanoma is often diagnosed late and this delay can be fatal. Exposure to UV radiation increases the risks of malignant melanoma development. Patients are advised to report moles that have changed, grown, bled, itched, and so on to their doctor or dermatologist. The clinical diagnosis is difficult and many 'normal' moles are removed and some cancerous ones are not. Skin cancers are extremely common. In 2006 over 81,600 non-melanoma skin cancer, were registered in the UK and 14,593 in Ireland but registration is known to be incomplete. It has been estimated that the lifetime risk of developing malignant melanoma is 1 in 91 for men and 1 in 77 for women in the EU based on statistics on incidences and mortality data for 2001-2005. In the UK, the number of confirmed cases is thought to be about 5% of the total number of patients examined annually. In other words around 2 million people are examined for skin cancer each year and Figure 1 shows the rising rates of melanoma (past and projected) for the UK. However, in practice, vastly more are likely to want to check out a suspect mole without having to visit their GP if the alternative were relatively cheap and easy to use.

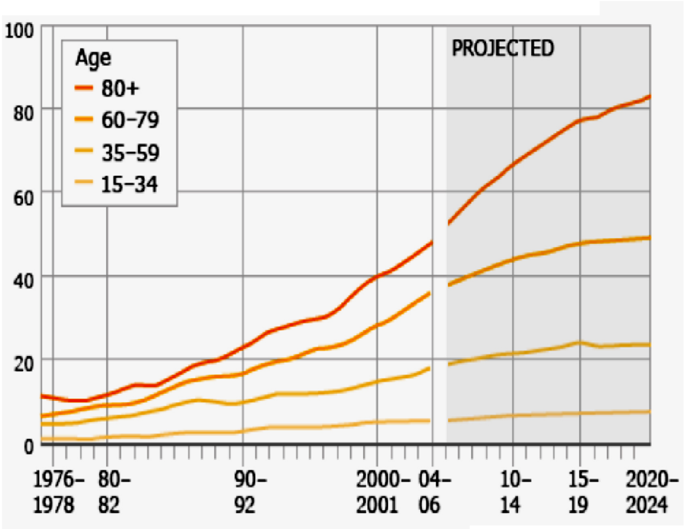


Fig. 1. Rising rates of melanoma per 100,000 (past and projected) for the UK (Source: Cancer Research)

People now in their 60s and 70s are more than five times more likely to be diagnosed with malignant melanoma than their parents were. Men of this age in particular are now seven times more likely to get the disease than they were in the 1970s. This is blamed on the advent of cheap package holidays in the 1970s which has led to a 'generation shift' in the rates of skin cancer. This generation - who would have been in their 20s and 30s when cheap package holidays became popular - now have 36 cases of malignant melanoma per 100,000 compared with 7 per 100,000 in the mid-1970s. The extrapolated statistics show the annual European figure for skin cancer is around 2,460,000 which represent only 5% of those asking to be tested giving a potential EU market alone of 50 million tests per year. These statistics have provided the focus for the project reported in this paper, i.e. the development of a generic skin cancer screening system designed for ease of use, interoperability and remote operation.

B. *Technology*

The technology used is based entirely on an analysis of a good quality colour digital image of the area of skin to be diagnosed [4]. The specific area of interest is identified automatically using a unique object location algorithm. Various features are then identified and measures obtained which include both conventional Euclidean and fractal geometric parameters, the letter being used to quantify object texture and boundary irregularity, for example. A combination of these parameters is used to generate a 'feature vector' which is then compared with historically equivalent cases where the medical outcome is known. This involves a continuously evolving expert system against which the results are tested using a bespoke Fuzzy Logic decision making engine. The accuracy of the diagnosis is 90%++ and is due primarily to the application of fractal geometry for characterizing objects that are innately textural (as with medical images in general) and are therefore not suitable for use in conventional machine vision systems. The system is entirely unique in that is relies exclusively on high fidelity optical images thereby providing the basis for an online system that is cheap, reliable and easy to use.

III. IMAGE ANALYSIS

Details of the approach used to develop the original skin cancer screening system are given in [5] and [6]. In this section, we provide a brief overview of the image analysis that is used for Moletest.

Image analysis involves the use of image processing methods that are often designed in an attempt to provide a machine interpretation of an image, ideally, in a form that allows some decision criterion to be applied [7]. Image analysis for pattern recognition uses a range of different approaches that are not necessarily based on any one particular theme or unified theoretical approach. The main problem is that, to date, there is no complete theoretical framework or mathematical model for simulating the processes that take place when a human interprets an image generated by the eye, i.e. there is no fully compatible model, currently available, for explaining the processes of visual image comprehension. Hence, machine vision remains a rather elusive subject area in which automatic inspection systems are advanced without having a fully operational theoretical framework as a guide. This is why numerous algorithms for understanding two- and three-dimensional objects in a digital image have and continue to be researched in order to design systems that can provide reliable automatic object detection, recognition and classification in an independent environment, e.g. [8], [9], [10], [11].

In the work reported here, the object is analyzed in terms of metrics derived from both a Euclidean and fractal geometric perspective, the output fields being used to train a fuzzy inference engine. The approach is unique in that it specifically exploits fractal geometry in digital imaging [12] to assess border and surface irregularity, for example, and Euclidean geometry to assess shape and asymmetry in terms of area, perimeter and centre of gravity. Colour component analysis is also undertaken. In this sense, the image analysis algorithms developed are based on an extension and quantification of the A-B-C-D guidelines discussed in Section I.

The recognition structure is based on some of the image processing, analysis and machine vision techniques reported in [13], for example. The approach considered is generic in that it can, in principle, be applied to any type of imaging modality for which there are numerous applications where self-calibration and learning is often mandatory. Example applications may include remote sensing, non-destructive evaluation and testing and other applications which specifically require the classification of objects that are textural. The system reported in this paper is, in principle, just one of a number of variations which can be used for medical image analysis and classification in general. This is because the system includes features that are based on the textural properties of an image (defined in terms of fractal geometric parameters including the Fractal Dimension and Lacunarity) which is an important theme is medical image analysis.

IV. FEATURE DETECTION AND CLASSIFICATION

Suppose we have an image which is given by a function $f(x, y)$ and contains some object described by a set of features $S = \{s_1, s_2, ..., s_n\}$. We consider the case when it is necessary to define a sample which is somewhat ‘close’ to this object in terms of a matching set. This task can be reduced to the construction of some function determining a degree of proximity of the object to a sample - a template of the object. Recognition is the process of comparing individual features against some pre-established template subject to a set of conditions and tolerances. This process commonly takes place in four definable stages:

- image acquisition and filtering (as required for the removal of noise, for example);
- object location (which may include edge detection);
- computation of object parameters;
- object class estimation.

We now consider aspects of each step. In particular, we consider the design features and their implementation together with their advantages, disadvantages and proposals for a solution whose application, in this paper, focuses on the problem of designing a skin cancer screening system. It is for this reason, that the examples given to illustrate the steps proposed, are ‘system related’.

The system discussed in this paper is based on an object detection technique that includes a novel segmentation method and must be adjusted and ‘fine tuned’ for each area of application. This includes those features associated with an object for which fractal models are well suited [7] and [12]. The system outputs a decision using a knowledge database which generates a result (a decision) by subscribing different objects. The ‘expert data’ in the application field creates a knowledge database by using supervised training with a number of model objects [14]. The recognition process is based on the following principal steps:

1) Image Acquisition and Filtering.
   A physical object is digitally imaged and the data transferred to memory, e.g. using current image acquisition hardware available commercially. The image is (Wiener) filtered to reduce noise and to remove unnecessary features such as light flecks.
2) Special Transform: Edge Detection.
   The digital image $f_{m,n}$ is transformed into $\tilde{f}_{m,n}$ to identify regions of interest and provide an input dataset for segmentation and feature detection operations [15]. This transform is based on an edge detection filter designed specifically for the application considered [5].
3) Segmentation.
   The image $f_{m,n}$ is segmented into individual objects $\{f^1_{m,n}\}, \{f^2_{m,n}\}, \dots$ to perform a separate analysis of each region. This step includes such operations as thresholding, morphological analysis and edge detection.

4) Feature Detection.
   Feature vectors $\{x_k^1\}, \{x_k^2\}, \ldots$ are computed from the object images $\{f_{m,n}^1\}, \{f_{m,n}^2\}, \ldots$ and corresponding transformed images $\{\tilde{f}_{m,n}^1\}, \{\tilde{f}_{m,n}^2\}, \ldots$. The features are numerical parameters that characterize the object inclusive of its texture. The feature vectors computed consist of a number of Euclidean and fractal geometric parameters together with statistical measures in both one- and two-dimensions. The one-dimensional features correspond to the border of an object whereas the two-dimensional features relate to the surface within and/or around the object.
5) Decision Making.
   This involves assigning a probability to a predefined set of classes [16]. Probability theory and fuzzy logic [17] are applied to estimate the class probability vectors $\{p_j^1\}, \{p_j^2\}, \ldots$ from the object feature vectors $\{x_k^1\}, \{x_k^2\}, \ldots$. A fundamental problem has been to establish a quantitative relationship between features and class probabilities, i.e.

$$\{p_j\} \leftrightarrow \{x_k\}$$

   where $\leftrightarrow$ denotes a transformation from class probability to feature vector space. A 'decision' is the estimated class of the object coupled with the probabilistic accuracy [18].

The approach reported in this paper uses a number of new algorithms that have been designed to solve problems associated with the above steps, details of which lie beyond the scope of this publication but are available in [5] and [6]. For example, two new morphological algorithms for object segmentation have been considered which include auto-threshold selection. One of these algorithms - a contour tracing algorithm - extracts parameters associated with the spatial distribution of an object's border. This algorithm is also deployed in the role of feature detection.

With regard to the decision making engine, the approach considered is based on establishing an expert learning procedure in which a Knowledge Data Base (KDB) is constructed using answers that an expert makes during normal manual work. Once the KDB has been developed, the system is ready for application in the field and provides results automatically. However, the accuracy and robustness of the output depends critically on the extent and completeness of the KDB as well as on the quality of the input image, primarily in terms of its compatibility with those images that have been used to generate the KDB.

V. APPLICATION TO SKIN CANCER SCREENING

A demonstration version of the system is available online at http://eleceng.dit.ie/arg/downloads/SCSS.zip which includes information on the system and an instruction manual. Installation is initiated through `setup.exe` from the root folder in which the downloaded application has been placed (after unzipping the downloaded the file setup.zip).

The system developed has been designed for use with a standard PC with input from a good quality digital camera using Commercial-Off-The-Shelf (COTS) hardware. It analyses the structure of a mole or other skin 'defects', detects cancer-identifying features, makes a decision using a knowledge database and outputs a result. Dermatologists create a KDB by training the system using a number of case-study images. This produces a KDB which 'improves' with the use of the system.

The current system is composed of the following basic steps:

1) Filtering
   The image is Wiener filtered [7] to reduce noise and remove unnecessary and obtrusive features such as light flecks.
2) Segmentation
   The image is segmented to perform a separate analysis of each object (moles and/or other skin features). Two segmentation modes are available:
   - Automatic Mode
     The software identifies a mole as the largest and darkest object in the image. This mode is applicable in most cases.
   - Manual Mode
     The area of interest is manually selected by the user. This is most useful in cases when multiple moles and/or foreign objects are present in the image with possible overlapping features, for example.
3) Feature Detection
   For each object, a set of recognition features are computed. The features are numeric parameters defined in [5] and [6] that describe the object in terms of a variety of Euclidean and fractal geometric parameters, colour components and statistical metrics in one- and two-dimensions. The one-dimensional features correspond to the border of a mole and the two-dimensional features relate to the surface within the object boundary. In addition, a recognition algorithm is used to analyse the mole *structure* as illustrated in Figure 2. This provides information on the possible growth of the object when an inspection is undertaken over a period of time.
4) Decision Making
   The system uses fuzzy logic to combine features into a decision. A decision is the estimated class of the object and its accuracy. In the system available at http://eleceng.dit.ie/arg/downloads/SCSS.zip, the output is designed to give two classes: *normal* and *abnormal*. This provides the simplest output with regard to the use of the system in a general practice, for example, in which abnormal cases are immediately referred to a specialist.

A. Key Advantages

The technology delivers high accuracy and automation which has been made possible by the following innovations:

Fractal geometric analysis:

Biological structures (such as body tissues) have

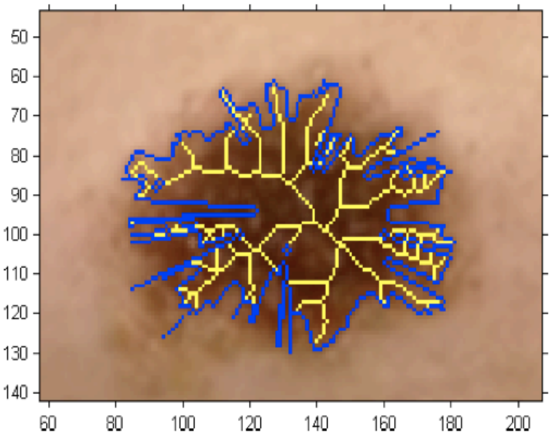
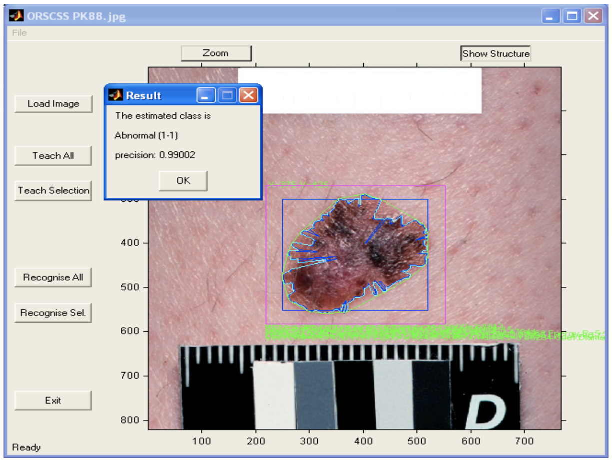


Fig. 2. Analysis of the structure of a mole for comparative growth analysis.



The estimated class is

Abnormal (1-1)

precision: 0.99002

Fig. 3. Example of the ouput generated by the skin cancer screen system.

natural fractal properties. Numerical measurements of these properties, enables efficient and effective detection of abnormalities.

Extended set of detectable features:

High accuracy is achieved when multiple features are measured together and combined into a single result.

Advanced fuzzy logic engine:

The knowledge-based recognition scheme used enables highly accurate diagnosis and offers significant improvements over current diagnostic methods.

B. *Knowledge Database*

The knowledge-based required by the system requires extensive training before clinical operation. The training process includes a review and probabilistic classification of appropriate images by experts. The minimal number of training images depends on the number of classes and the diversity of objects within each class. An example of the output generated by the system is given in Figure 3 which provides a decision as to whether the object is 'normal' or 'abnormal' together with an estimate of the associated precision.

C. *Comparison with Other Approaches*

There are a number of commercially available products which offer a range of aids and tools for skin cancer detection. Some of them use an extensive database to estimate the pathology and may require a relatively significant amount of time to make a decision. Other products calculate several properties and represent them graphically. Medical staff are then used to make a final decision. More interesting techniques involve the capture of images using different sensors or a multiplicity of different images. However, these systems are as yet, not approved for clinical diagnosis and are not a referenced form of Dermatoscopy. The following list provides some of the more common products currently available: (i) MoleMAX - http://www.molechecks.com.au; (ii) DermLite - http://www.dermlite.com/mmfoto.html; (iii) DermoGenius Lite - http://www.dermogenius.de; (iv) MelaFind - www.melafind.com. Comparing these products with the methods developed for the Moletest system, it is clear that there are no other automatic recognition systems with self-adjusting procedures and self-controlled functions.

D. *Discussion*

The methods discussed in the previous sections represent a novel approach to designing an object recognition system that is robust in classifying textured features, the application considered in this paper, having required a symbiosis of the parametric representation of an object and its geometrical invariant properties. In comparison with existing methods, the approach adopted and reported in this paper has the following advantages:

Speed of operation. The approach uses a limited but effective parameter set (feature vector) associated with an object instead of a representation using a large set of values (pixel values, for example). This provides a considerably higher operational speed in comparison with existing schemes, especially with composite tasks, where the large majority of methods require object separation. The principal computational effort is that associated with the computation of the features defined in Section IV.

Accuracy. The methods constructed for the analysis of sets of geometrical primitives are, in general, more precise. Because the parameters are feature values, which are not connected to an orthogonal grid, it is possible to design different transformations (shifts, rotational displacements and scaling) without any significant loss of accuracy compared with a set of pixels, for example. On the other hand, the overall accuracy of the method is directly influenced by the accuracy of the procedure used to extract the required geometrical tags. In general, the accuracy of the method will always be lower, than, for example, classical correlative techniques. This is primarily due to padding, when errors can occur during the extraction of a parameter set. However, by using precise parameterization structures based on the features defined in Section IV, remarkably good results are obtained.

Reliability. The proposed approach relies first and foremost on the reliability of the extraction procedure used to establish the geometrical and parametric properties of objects, which, in turn, depends on the quality of the image; principally, in terms of the quality of the contours. It should be noted that the image quality is a common problem in any vision system and that in conditions of poor visibility and/or resolution, all vision systems will fail. In other words, the reliability of the system is fundamentally dependent on the quality of the input data.

Among the characteristic disadvantages of the approach, it should be noted that: (i) The method requires a considerable number of different calculations to be performed and appropriate hardware requirements are therefore mandatory in the development of a real time system; (ii) the accuracy of the method is intimately connected with the required computing speed - an increase in accuracy can be achieved but may be incompatible with acceptable computing costs. In general, it is often difficult to acquire a template of samples under real life or field trial conditions which have a uniform distribution of membership functions. If a large number of training objects are non-uniformly distributed, it is, in general, not possible to generate accurate results.

VI. WEBSITE DEVELOPMENT

The reader is referred to the Moletest website available at http://www.moletestuk.com which was developed by Digital Trip Limited http://www.digital-trip.co.uk/ starting in early 2010. Figure 4 shows the Home Page of the website which includes contact details, information, instructions and prices etc. The user is required to register on-line and upload a good quality colour image of the mole which can be pre-processed as required to the specifications of the example images that are provided as a user guide. In principle, all customers need to do is upload a 5MP image or better of the suspect mole to Moletest's website - an image of this quality can even be taken on some mobile phones - pay a fee and wait for their results, which they will normally get within 24 hours. The online service uses an easy-to-understand 'traffic light' approach to screening for non-melanoma and melanoma skin cancer. Green denotes a 'normal' lesion, amber 'borderline' and red a possible 'cancerous melanoma'. The results are based on using a 42 element feature vector to train a fuzzy inference engine using both Euclidean and fractal parameters as discussed in [5] and [6] and illustrated in Figure 5

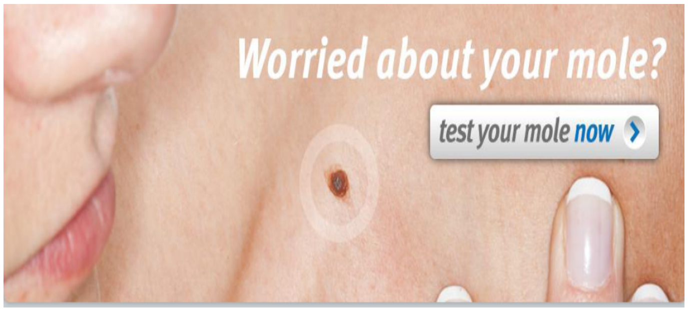


Fig. 4. Home Page of Moletest Website http://www.moletestuk.com

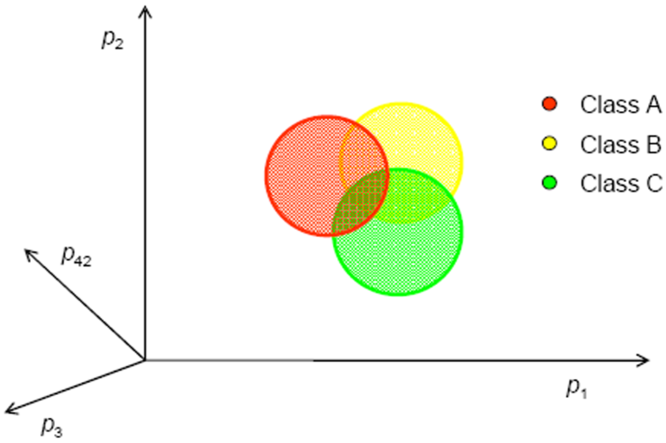


Fig. 5. Decision making engine based on Fuzzy Sets for 42 Features composed of both Euclidian and fractal geometric parameters.

The system - which is supervised and audited by a panel of advisory dermatologists - evaluates the customer's image against a knowledge database of known results to see if there are any characteristics consistent with previous cases of cancer using the classification scheme outlined in Section IV and discussed further in Section V. The system continues to 'learn' by comparing its findings with later clinical diagnoses of dermatologists following biopsies and other examinations, using these comparisons to inform future analyses. It is envisaged that the new Moletest service will have the dual benefits of increasing the early detection of non-malignant and malignant melanoma (one of the most deadly cancers if not detected early), whilst potentially saving vast amounts of time spent within GP surgeries assessing healthy patients that could have otherwise been screened by Moletest.

The website has been developed in collaboration with a team of leading Dermatologist's headed by Professor R Cerio at The London Cancer Centre. This includes monitoring the images submitted to evaluate the output of the expert system and to train the system further. Figure 6 shows the 2010/2011 timetable for handing over to the 'expert system' after which routine monitoring of the decisions obtained are undertaken by a Dermatologist.

Since the lunch of the service in September 2010, the growth of the system has been quasi linear. Figure 7, Figure 8 and Figure 9 provide example statistics on usage of the Moletest website from launch to 1 November 2010.

VII. WEBSITE LAUNCH

The launch of Moletest was undertaken be de Facto Communications Limited http://www.defacto.com/ which specialize in integrated PR and communications for healthcare com-

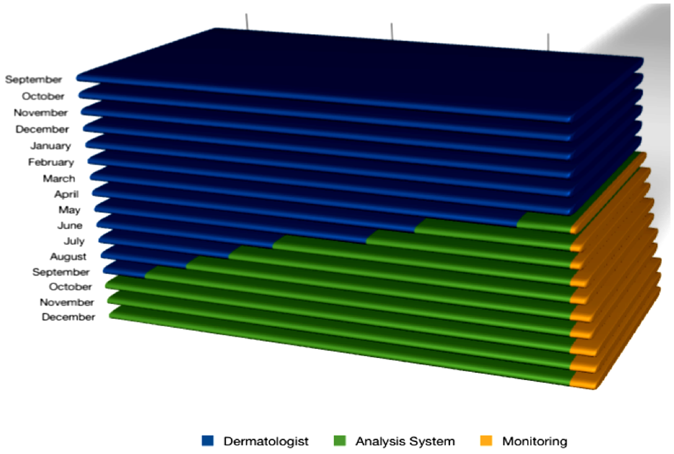


Fig. 6. Time-table for ‘hand-over’ to Moletest’s image analysis system.

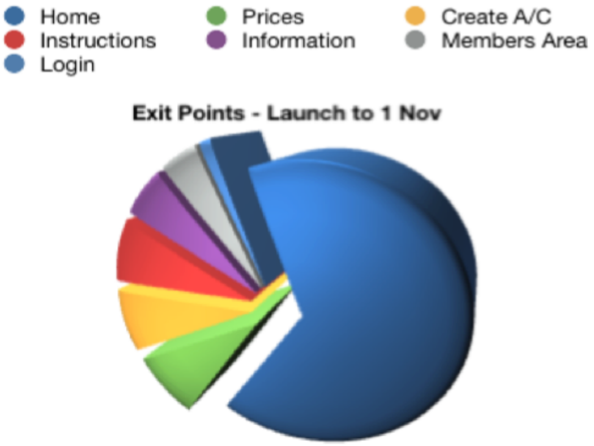


Fig. 7. Statistics associated with Exit Points

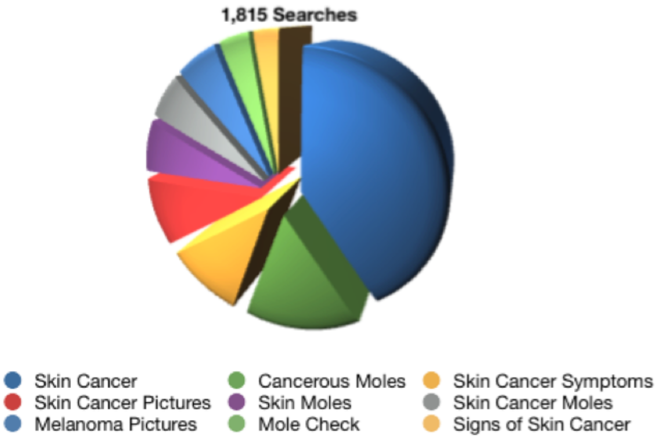


Fig. 8. Statistics associated with Searches.

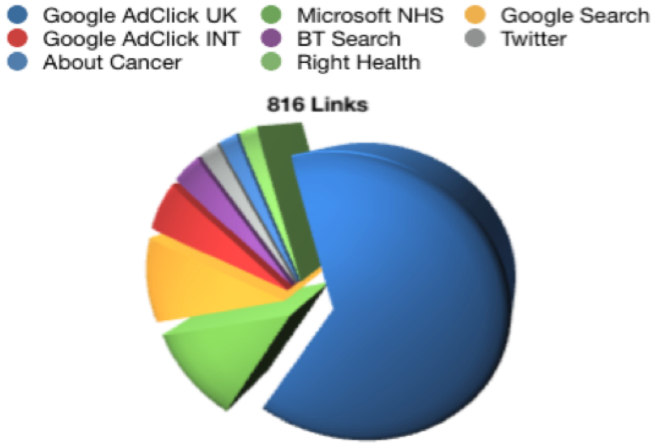


Fig. 9. Statistics of Links.

panies and their products and services in fields ranging from pharmaceuticals and diagnostics to medical devices and IT. The launch of the service included the development of technical and consumer based video series for *youtube*, examples of which are available at [19], [20] and [21]. The launch also included a series of interviews and press coverage, e.g. [22], [23], [24], [25] and [26].

In terms of developing an intensive application and service, one of the principal issues in operating the service has been to develop an image suitability test which assesses whether or not the quality of the image uploaded by a user is suitable for submission to the image analysis and decision making engine. This test has been developed since the launch of the service as experience has been gained with the type and quality of images submitted and has been undertaken in parallel with changes to the instructions given to the user with regard to the importance of uploading good quality images. The image suitability test includes checks on:

- contrast and brightness;
- image resolution;
- object completeness;
- noise.

The system automatically responds to a user if the image they submit is not suitable, requesting that a better quality images is uploaded based on one or more of the four classifications given above and directing the user to the examples given on the website.

VIII. CONCLUSION

Moletest is based on a methodology for implementing applications that is concerned with two key tasks:

- the partial analysis of an image in terms of its fractal structure and the fractal properties that characterize that structure;
- the use of a fuzzy logic engine to classify an object based on both its Euclidean and fractal geometric properties.

The combination of these two aspects has been used to define a processing and image analysis engine that is unique in its modus operandi but entirely generic in terms of the applications to which it can be applied.

The image analysis technology developed for Moletest is part of a wider investigation into the numerous applications of pattern recognition using fractal geometry as a central processing kernel. This includes the design of pattern recognition algorithms including the computation of parameters in addition to those that have been used to develop Moletest such as the information dimension, correlation dimension and multifractals [12]. The inclusion or otherwise of such parameters in terms of improving systems such as Moletest remains to be understood. However, it is clear that texture based analysis alone is not sufficient in order to design a recognition and classification system. Both Euclidean and fractal parameters (as well as other metrics relating to colour composites) need to be combined into a feature vector in order to develop an operational image analysis system which includes objects that have textural properties such as those associated with medical imaging and in the case of Moletest, Tele-Dermatology.

The overall response to Moletest has, to date, been positive. This includes comments such as the following made by Prof Rino Cerio, Consultant Dermatologist and a Professor in Dermatopathology, and a member of Moletest's professional advisory panel [2]: *The incidence of malignant melanoma has quadrupled over the last 30 years, due to the advent of cheap air travel to locations of greater ultra violet sunlight exposure and patients' failing to get moles checked until it is far too late. Although a rare form of cancer, melanoma, accounts for over 75% of skin cancer deaths - most of which could have been avoided with early detection. With skin cancer rates increasing, Moletest could potentially screen hundreds of thousands of cases of benign and safe moles away from GP surgeries - leaving the NHS to concentrate on higher risk patients. Any advances in screening or testing procedures that complements existing detection services should be welcomed by the medical community.*

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