

Multimedia Visualisation for Breast Cancer

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Abstract

Multimedia represents a set of powerful tools for dissemination of data, in the context of teaching, public awareness education, and interpretation of research results. The Computing Resources for Research group at University College Cork is involved in the development of data visualisation systems for life science research. Building on the groups' skills in Multimedia, Information Technology and Learning and Cancer Research, we develop sophisticated multimedia content for researchers and practitioners in the life sciences. We have recently built a suite of animations on Breast Cancer aimed at patients, clinicians and researchers.

Keywords: Multimedia, Visualisation, Cancer, Breast Cancer

1 Introduction

Cancer is a class of diseases or disorders characterized by uncontrolled division of cells, and the ability of these cells to invade other tissues, either by direct growth into adjacent tissue through invasion or by implantation into distant sites by metastasis. Metastasis is defined as the stage in which cancer cells are transported through the bloodstream or lymphatic system. Cancer may affect people at all ages, but risk tends to increase with age. It is one of the leading causes of death in developed countries.[1]

Breast cancer begins in breast tissue, which is made up of glands for milk production, called lobules, and the ducts that connect lobules to the nipple. The remainder of the breast is made up of fatty, connective, and lymphatic tissue.[2]

Breast cancer in women represents a significant health problem because of the numbers of individuals affected by this disease. Thirty percent of all cancers in women occur in the breast making it the most commonly diagnosed female cancer. The availability of easily interpretable information by way of multimedia, on early detection, treatment and prevention of breast cancer represents an extremely valuable resource to patients, researchers and clinicians.

Our application is a multimedia application presenting general information for breast cancer in terms of biology, treatment and diagnosis. The application covers basic information for the public, in terms of basic breast cancer biology and education on early detection, and treatment, through to high level research concepts, molecular visualisation and data aimed at researchers and clinicians.

2 Multimedia and Visualisation

2.1 Multimedia

Multimedia is any combination of text, art, sound, animation, and video delivered to you by computer or other electronic or digitally manipulated means and is richly presented sensation.[3] Multimedia is media that uses multiple forms of information content and information processing (e.g. text, audio, graphics, animation, video, interaction) to inform or entertain the (user) audience.[4] The computer info can be represented through audio, graphics, image, video and animation in addition to traditional media (text and graphics).

2.2 Scientific Visualisation

Scientific and Information visualisation are branches of computer graphics and user interface design that are concerned with presenting data to users by means of images. Both fields seek ways to help users explore, make sense of, and communicate about data. They are active research areas, drawing on theory in information graphics, computer graphics, human-computer interaction and cognitive science.

Desktop programs capable of presenting interactive models of molecules and microbiological entities are becoming relatively common (Molecular graphics). The fields of Bioinformatics and Cheminformatics make heavy use of these visualization engines for interpreting lab data and for training purposes. The advent of such tools has resulted in the fields' biggest growth, growing contemporaneously with the internet.

Medical imaging is a huge application domain for scientific visualization with an emphasis on enhancing imaging results graphically, e.g. using pseudo-colouring or overlaying of plots. Real-time visualization can serve to simultaneously analyse results within or beside an analyzed (e.g. segmented) scan.

2.3 Multimedia in Scientific Visualisation

Multimedia technology is widely applied in scientific visualisation especially in medical area. Variable presentations are provided for scientific research. Scientific visualisation includes image processing, graphics, animation, 3D presentation and so on. Multimedia technology provides multiple approaches for visualization.

Microscopic images and illustrations are common presentations in the field of cancer visualization. Such imaging requires hi-tech, expensive equipment, and the outputs are device-specific, with interpretation requiring expertise.

New multimedia technology gives the cheap, easy to understand platform for cancer visualization especially for education. 2D animations can present complex biology processing from cell to whole body levels. These animations can be embedded into computer applications, web pages and movies. 3D application can simulate object in different level with mathematic models.

3 Cancer Visualisations

In recent years there has been a great deal of interest concerning three catch-phrases: nonlinear dynamics, chaos, and complexity. This interest has led to a large number of popular-science articles relating to the visualization of cells, many of these feature very high end graphical simulations [5].

Technologies such as ultrasound are being used to evaluate solid tumours in 3D [6] and also 3D microscopy imaging to display 3D biological tissue architecture during carcinogenesis [7]. Models and Simulations are being widely used, for example Mathematical models have been used to describe ontogenetic growth [8]. Two-dimensional modelling has been used in the area of tumour growth and morphology [9], while simulations have been used in the area of benign avascular tumour growth [10].

Common breast cancer visualisations are static images and animations. The presentation formats are quite simple; some of contents are professional E.g. ultrasound images, charts and volume rendering 3D images that require expertise to interpret.

4 Problems

4.1 Cancer

Cancer is a group of diseases in which cells are aggressive (grow and divide without respect to normal limits), invasive (invade and destroy adjacent tissues), and often metastatic (spread to other locations in the body). These three malignant properties of cancers differentiate them from benign tumours, which are self-limited in their growth and do not invade or metastasize (although some benign tumour types are capable of becoming malignant).

4.2 Scope

Our visualization is focussed on breast cancer at body, tumour and cell levels. The application presents breast anatomy, breast cancer cell growth, tumour growth and spread (metastasis). The application details breast cancer examination and treatment also.

The main requirement is to present the location of tumour growth, cell alterations and spread in a realistic manner, and to educate on different treatment or examination approaches. To make these easy to understand and the application user interface easy to use, we need to create visual animations with audio and text, and a friendly simple user interface with interactions.

4.3 Usability

Usability is an attribute of the quality of a system.[11] Our application is for educational and research purpose. Therefore, both the contents and user interface must be easy to use and understand. The application has good flexibility for content extension also.

5 Solution

To handle multimedia content and user interface usability we selected Flash to implement application.

The Flash application is powerful in enabling interactive aspects in animations. The interactive aspect is very important to educational functions. These functions allow users to select content that they want to know, researchers could select content on micro level and others could select content on body or tumour level.

Flash content is easy to spread by Internet with web pages and its running requirement (web browser plug-in) is common. Graphics, audio, video and interactive components are easy to transfer by web in Flash and is therefore most suitable for educational purposes.

6 Application

6.1 Structure

Our application contains four main components:

- General Information

This component contains information on breast anatomy and physiology. It highlights the main structures involved in lactation (milk-production) and cancer development. It also depicts the vascular (blood) and lymphatic drainage of the breast and axilla(Figure 1).

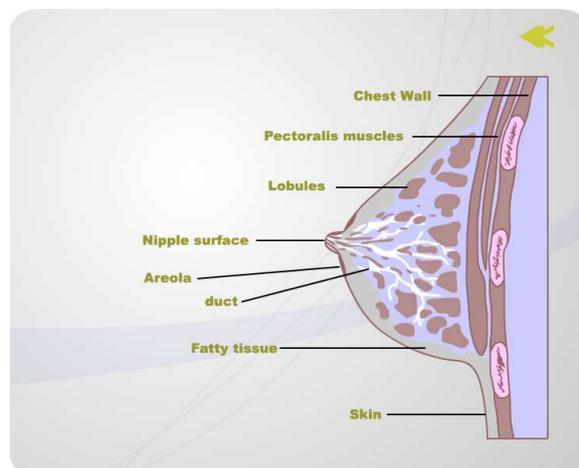


Figure 1: Screenshot of Breast Anatomy

- Cancer Biology

This component features a detailed account on the evolution of breast cancer. It defines the different stages of cancer progression from in-situ, invasive and metastatic disease. The metastatic behaviour and cascade involving the vascular and lymphatic channels and distant spread are illustrated(Figure 2).

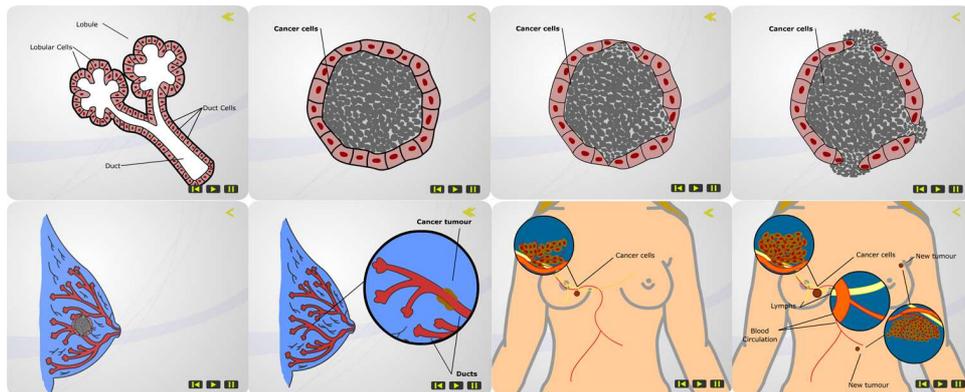


Figure 2: Screenshot of Cancer Biology

- Treatment

This component highlights the current treatment strategies being used. It addresses the role of breast conservation surgery, sentinel node biopsy, chemotherapy, radiotherapy and hormonal therapy. It also features novel molecular and biological developments that may revolutionise breast cancer treatment in the future.

- Diagnosis

This component outlines the symptoms and signs of breast cancer and the triple assessment used for breast screening. The role of current and new imaging modalities (mammography, ultrasound, magnetic resonance imaging (MRI)) and diagnostic procedures (fine needle aspiration (FNA), core biopsy) are explained. It also contains a patient video on performing a breast self-exam.

6.2 User Interface

The application provides a friendly and easy to use user interface(Figure 3). The contents are located into different category menus or submenus. The tree structure is easy to visit and transfer between them and easy to add new contents into. The user can control each animation or embedded movie by the use of some easy to use interactive tools. All controls can be done by mouse only.



Figure 3: Application User Interface

6.3 Programming

We use ActionScript 3.0 to handle the programming in our application(Figure 4). ActionScript is the programming language for the Flash Player run-time environment. It enables interactivity, data handling, and much more in Flash content and applications. ActionScript 3.0 code can execute up to ten times faster than legacy ActionScript code[12].

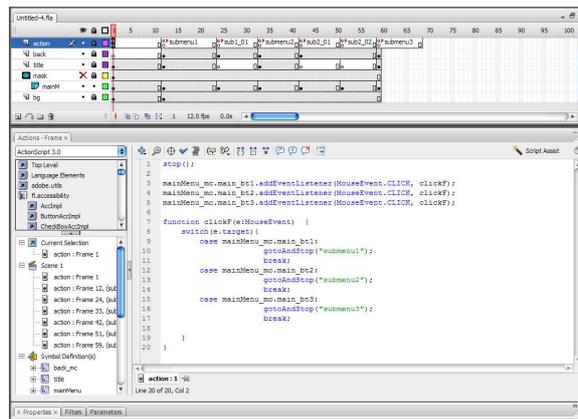


Figure 4: ActionScript in Application

The code shows how to handle the main menu buttons with event listener(Listing 1). "mainMenu.mainBt1" is the name of button, the function "clickF()" handle the frame change when get a mouse click event. "submenu1" is the name of frame that contains sub menu.

```
mainMenu.mainBt1.addEventListener(MouseEvent.CLICK, clickF);
mainMenu.mainBt2.addEventListener(MouseEvent.CLICK, clickF);
mainMenu.mainBt3.addEventListener(MouseEvent.CLICK, clickF);
mainMenu.mainBt4.addEventListener(MouseEvent.CLICK, clickF);
function clickF(e:MouseEvent) {
    switch(e.target){
        case mainMenu.mainBt1:
            gotoAndStop("submenu1");
            break;
        case mainMenu.mainBt2:
            gotoAndStop("submenu2");
            break;
        case mainMenu.mainBt3:
            gotoAndStop("submenu3");
            break;
        case mainMenu.mainBt4:
            gotoAndStop("submenu4");
            break;
    }
}
```

Listing 1: Main menu scripting

This is the code for sub menus actions(Listing 2). "submenu2.sub2Bt1" and "submenu2.sub2Bt2" are options in a sub menu. Function "gotoAnimF2()" will change current frame when buttons get mouse click event.

```
submenu2.sub2Bt1.addEventListener(MouseEvent.CLICK, gotoAnimF2);
submenu2.sub2Bt2.addEventListener(MouseEvent.CLICK, gotoAnimF2);
function gotoAnimF2(e:MouseEvent) {
    switch(e.target){
        case submenu2_mc.sub2_bt1:
            gotoAndStop("sub2_01");
            break;
        case submenu2_mc.sub2_bt2:
            gotoAndStop("sub2_02");
            break;
    }
}
```

Listing 2: Sub menu scripting

7 Conclusion

Multimedia technology provides multiple approaches for scientific visualization especially for medical aspects. Our application involves these technologies to make a high usability system for professional and general use. This multimedia application can be an easy to use pattern for both education and research.

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