Abstract 50

The Interior of a Pig's Vasculature: A Museum Exhibit

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Abstract

Coronary heart diseases (CHD) are one of the primary causes of deaths in the United States. It is commonly accepted that certain factors, such as a cholesterol high diet, increase the risk of coronary heart diseases. As a consequence, people should be educated to adhere a diet low in low-density lipoprotein (LDL or bad cholesterol). In order for children to become familiar with these facts, educational computer games can be employed to raise some awareness. This poster describes an educational museum exhibit that serves this purpose. In a game-like environment, children can practice their navigation skills, while learning about the various types of blood cells and particles within the blood stream. A geometric model of the arterial vascular system of the heart has been developed, which considers vessels of different sizes. An interactive flythrough using a standard game controller facilitates the exploration of the interior structure of the vasculature. A blood flow simulation including several different particles within the blood stream allows a player to explore their functionality. This computer game has been deployed as an interactive museum exhibit for children. The primary age group addressed by the science museum where it was displayed is 4-9 years. With proper guidance by the museum personnel and the instructional material provided at the exhibit the game is also suitable for slightly younger and much older children.

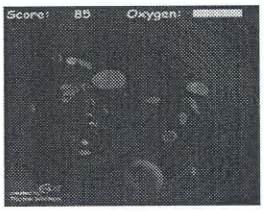

Figure 1: Screenshot showing the main display of the computer game including current score and status.

The implemented system simulates a submarine-style navigation through the blood stream inside an arterial vascular tree of a heart. The vasculature is based on a computed tomography (CT) scan of a pig's heart. The player has full control over the navigation by using a Logitech© WingMan® Cordless Rumblepad™ as input device. This controller provides two analog joysticks that can be used to achieve six-degrees-of-freedom input. In this application, the player controls forward and backward movement (acceleration and deceleration) with the left joystick while changing the orientation (left, right, up and down) by using the right joystick. Collision detection with the vessel walls ensures that the vasculature cannot be left. On collision with the vessel wall as well as with any of the particles within the blood stream force feedback is provided by using the rumble feature of the input device. In addition, audio feedback with different types of sounds allows the player to distinguish between the different types of collisions. Consequently, the player has complete manual control over the navigation while visual, audio, and force feedback provided by the system results in an easy to understand assessment of what is happening. This is especially important since the targeted audience are children at the age of 4-9 years.

During the game, a sufficient supply of oxygen is required in order for the player to survive. As oxygen is consumed, the level decreases over time. The amount of oxygen can be increased by collecting oxygen from the erythrocytes (red blood cells). This can be achieved by touching those types of cells to initiate an exchange of oxygen. By being immersed into the blood stream, the children can learn about the role of erythrocytes in the human body. In addition, the point score is increased according to how much oxygen is collected. The player wins when a certain point score is reached. In contrast to erythrocytes, leukocytes (white blood cells) as part of the immune system consider the player as an intruder. Consequently, the player's 'submarine' vessel gets damaged when getting in touch with this type of cell resulting in loss of oxygen.

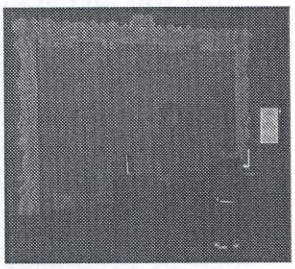

Figure 2: Visitor playing the game at the Discovery Science Center in Santa Ana, California.

The software is scalable in terms of vessel systems and the amount of geometry data that is used to represent the blood vessel system. It can be ported to various virtual environments (VEs). At this point, it has been tested on a regular desktop computer and a large projection screen at the museum site. Especially the projection screen, which was used for the interactive exhibit, allows a player to fully immerse herself/himself into the game. Overall, this computer game gives hands-on experience of the functions of the circulatory system of the heart and exposes the player to the various particles present in the blood stream. As a museum exhibit, it was very well received by the targeted audience, i.e., by children between the age of four and nine, and beyond. The learning experience in the virtual environment was validated in a conversation during another stage performance, which included a scientist dissecting a real pig's heart, where the children were asked to identify anatomical parts and discuss the importance of the circulatory system.

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