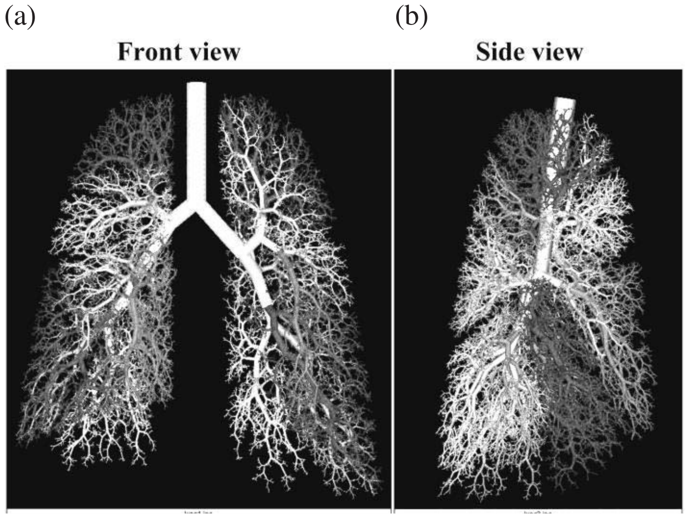

Fig. 14. Reconstructed lung airway, (a) front view and (b) side view. The right-left asymmetry of the front view comes from the effects of the trachea (white ducts) and the heart having asymmetric shapes. The grey levels of ducts indicate different lobes of lung (reproduced from Takaki and Kitaoka (1999); note that Kitaoka *et al*. (1999) contains similar results with slightly different conditions).

Reconstruction of airway system was made by the use of personal computer (Gateway 2000, EV700) with a software C++. An example of reconstructed lung airway is shown in Fig. 14.

Some applications of this reconstruction method are proposed. One is a diagnosis of lung cancer. It is difficult to judge whether a suspicious part is a cancer or a simple inflammation. In order to find a hint for diagnosis, Kitaoka *et al*. (1999) made a computer simulation to deform a part of airway, where either a cancer or an inflammation has appeared. Both cancer and inflammation attract nearby airway branches towards themselves, but in different ways; a cancer strongly attracts only those branches quite close to it, while an inflammation weakly attracts more number of branches. This difference of deformations would be detected by CT.

The end points in the airway are connected to another tissue made of many tiny sacks, called pulmonary acinus, which fill the space out of the airway. Morphology of this tissue has been misunderstood since many years, so that the pulmonary acini are arranged like a bunch of grapes. Recently, Kitaoka *et al*. (2000) began to claim that the pulmonary acini are not like the bunch of grapes, where many vacant spaces are left out of the grapes, but like a 3D labyrinth made of branching paths, which fills the space completely and whose exit is connected to an end point of airway. At first, this claim met strong objections among medical scientists, but it is now getting more supports.

We have reviewed the studies of branching systems in organs, which are aimed at how to reconstruct these systems. On the other hand, there is another problem of how a branching system grows in embryo of real animal. Here, an interesting paper by Honda and Yoshizato (1997) is cited here. Their observation revealed that a branching system was formed from an initial fine and uniform network through a process of selection, i.e. some elements of the network became thick while others shrank. This process is confirmed by computer simulation.

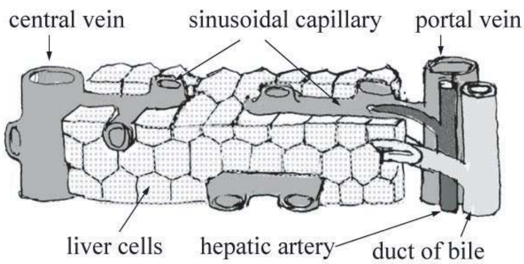

Fig. 15. Structure of a part of lobule for explanation of sinusoidal capillaries and cells (a rough sketch by R. Takaki from a textbook of histology (Fujita and Fujita, 1976)).

4.4 Reconstruction of blood vessels in liver

The liver is made of a lot of units called a lobule, which has also a complicated structure, so that it is connected to three kinds of ducts; first, the hepatic artery to supply energy and necessary material, secondly the bile capillaries to carry a liquid called bile and thirdly the portal vein to carry the blood from various parts of body in order to make the liver to detoxify it.

Figure 15 is a rough sketch of a part of lobule. The blood coming into the lobule is collected at the central vein (located at the center of the lobule) and is carried out. The hepatic artery and the portal vein are connected to the central vein through capillaries called “sinusoidal capillaries”. Therefore, the most part of lobule is occupied by liver cells and a network of sinusoidal capillaries. The blood coming to the central vein is carried to the hepatic vein and goes out of the liver.

There are two mathematical problems concerned to the structures of blood vessels in the liver; one is to simulate the branching systems of portal veins and hepatic veins, the other is to simulate the network of sinusoidal capillaries. The present author made some works on these prob-