2009 International Conference on Computer Engineering and Applications
IPCSIT vol.2 (2011) © (2011) IACSIT Press, Singapore

Angio Routing

V.Prasanna Venkatesh[1], V.Ranjana[2], V.janani[3], R.Madhav Prashanth[4]
[1,2] St.Joseph's college of Engineering
[3]Easwari Engineering College
[4]College of Engineering, Guindy

Abstract. It has always a great deal of efforts for the human race to operate the heart, which is the source of blood to the entire human body. Even with advancements in technology like robot-assisted surgeries, a heart operation has always been dreaded by the patients, mainly due to the laceration experienced during surgery and the affliction caused by the persisting scars.In this paper, we focus mainly on one type of heart surgery for countering heart blocks in the coronary artery, called the CABG (Coronary Artery Bypass Graft), generally known as the Heart Bypass Surgery. We aim to propose a system that combines a heuristic routing approach with available CABG mechanisms, to alleviate the complexities involved in the surgery. The routing mechanism involves a dynamic routing table maintained by different routers, to identify heart blocks and also predict a close replacement for the artery. These routers are classified as Primary and Secondary routers and are used to monitor different regions of the human body. We also introduce a new way of dividing the human body to map the artery location to the router table known as "segment mapping (SM)".

Key words: Coronary Artery Bypass Graft, saphenous vein, Radial Artery grafts (RA), Coronary Artery Disease (CAD), heuristic routing, variable address, dynamic routing table, Primary router, secondary router, segment mapping.

1. INTRODUCTION

The occurrence of heart problems and Coronary Artery Diseases (CAD) has grown tremendously over the past few decades. To counteract to this scenario, various different mechanisms and technologies have evolved that aid heart surgeries and assistance. Unfortunately, such technologies have still not been able to exempt mankind from the pain they experience during and after the surgery. In this paper we propose a system that not only aims to reduce the laceration of such surgeries but also minimize the complexities involved in it.

2. Existing mechanisms and concepts

The existing concepts and mechanisms that fall in the region of interest to the proposed system are as follows:

2.1 Coronary Artery Bypass Graft

The coronary Artery Bypass Graft refers to one of the surgical methodologies adopted to improve the blood flow in a patient suffering from Coronary Artery Disease (CAD). In such heart surgeries the arteries carrying blood to the heart perform with reduced efficiency. These arteries are replaced or grafted with a healthy artery or vein from another part of the body, generally chosen from the limbs or the mammary regions.

This process entails surgical cuts in the limbs and also incisions around the chest region that may be permanent and measure to several inches in length. Also, the operation itself becomes tedious to perform.

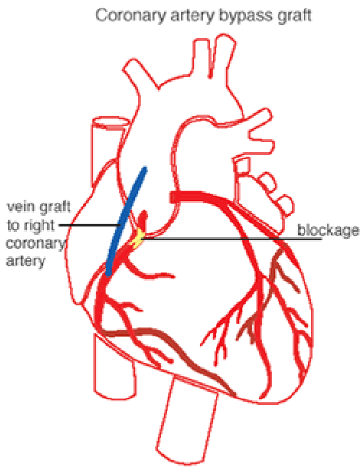
The coronary artery may get blocked or narrowed down due to deposition of fat and/or other substances present in excess in the blood stream. The artery or arteries that have got narrowed down are replaced by bypassing the identified region with another artery, called a *"graft"*. Usually, this graft is a length of vein taken from the leg (saphenous vein), although often a small length of artery from the chest wall (internal mammary artery) and/or occasionally the arm is used.

2.1.A Disadvantages

The following points depict the nature of problems encountered during or after the present procedure of CABG:

i. Sustained incision scars on patient's body.
ii. Delayed recovery period extending up to 3 to 4 months.
iii. Reduced hand-grasping power, especially after Radial Artery (RA) grafts.
iv. Edema and sensory disturbances after surgery.
v. Severe and sustained pain during and immediately after surgery.
vi. Complexity in performing surgery, both in time and requirements.

Fig.1. depiction of heart bypass



2.2 Heuristic routing

Heuristic Routing is a type of routing algorithm in which data, such as time delay, extracted from incoming messages, during specified periods and over different routes, are used to determine the optimum routing for transmitting data back to the sources. [2] A new heuristic routing technique involving variable address resolution was simulated using gene tracking methods where the addresses of nodes were mapped similar to the operations performed in a gene structure.

Heuristic routing procedure consists mainly of taking into account the time delay in a system. The routing table contains time-dependent attributes. This routing table consists of information about the present node from which data is being sent, next hop, which contains the node where data is received next and other attributes as required by the application.

3. Proposed System

In the proposed system we combine the advantages of two sets of completely divergent conceptions to provide a novel mechanism that could produce a contemporary dimension to heart surgeries. The existing CABG mechanisms are abated in complexity and alleviated afflictions from the patients' viewpoint. The use of routing algorithms provides a comprehensive and low-in-cost technique to easily identify blocks, and also the precise location for the graft to be chosen.

3.1 Basic concept

We propose a system where we use "routers" which are classified as Primary and Secondary routers and placed on the target's body. The routers send probes through the arteries in the form of echo signals. We use heuristic routing algorithms to identify arteries in the region near each router, which holds a routing table. The table updates the length, size and diameter characteristics of the arteries. The primary router present near the heart is used to detect any block in the artery. Once a block is detected the primary router automatically updates its table from the secondary routers. This enables the system to compare all the available arteries with the characteristics of the coronary artery. Here, we use the new idea called Segment-Mapping (SM). In this concept, we divide the entire human body into a number of segments. The computer-aided mechanism allows each router to be cognizant of the position of itself and the signals transmitted from it, with respect to each segment. Thus, the router can easily predict at what length the signal was reflected. By comparing this with the nearest segment, the length of the artery can be found and the system can provide its location precisely. The surgery now involves only removal of the specific artery at its location and placement of the graft in the coronary artery. The surgical incision would extend to a few millimeters and the process takes very limited time when compared to the existing system.

3.2 Architecture

The architecture of the proposed system is stratified into two main sections for suitable explanatory purposes. In these two divisions, the first section concentrates on the placement of the routers on human body, the construction of routing table and its related concepts. The second section analyzes the mechanism involving the SM technique to identify location of arteries.

3.2.1 Routing Mechanism

The routers are classified as primary and secondary routers. There exists only one primary router and many secondary routers. The primary router is placed over the region of human body over the heart. The secondary routers are placed at three different locations, which are the regions in the human body from which a graft is most commonly chosen. These three regions are: the mammary region (for the mammary artery), the leg (for the saphenous vein) and over the arm. Hence, use of three secondary routers would suffice.

3.2.2 Routing table

The routers are placed as shown above. Each router maintains a routing table that is based on the heuristic routing algorithm chosen. The heuristic routing algorithm used here is based on variable address routing. The mechanism is as follows:

i. Each router maintains its own segment location as 0 (zero).
ii. Routers send echo signals through the artery beneath it.
iii. Routers wait till they receive the signals.
iv. They calculate the following after receiving the signal:
    a. Round Trip Time (RTT) for each signal probe.
    b. Percentage of received signal to the transmitted signal.
    c. Time taken to receive the signal.
v. This information is in fact calculated and stored in the computer system to which the routers are wired.
vi. Primary router updates its routing table after each probe is completed.

The round trip time (RTT) for the i^{th} signal as:

$RTT_i = T_i - T_0$, (1)

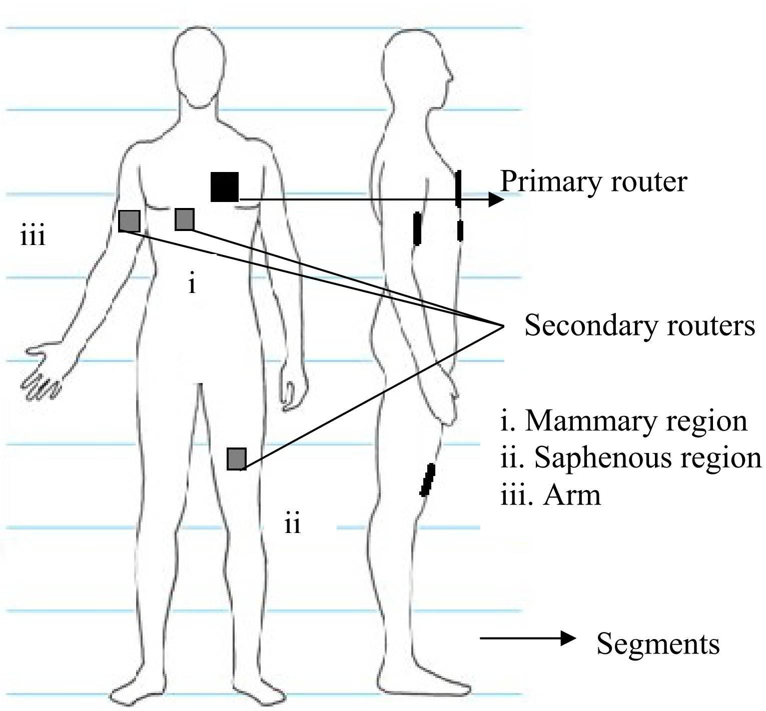
Where,
T_i denotes the time at the i^{th} instant
when a signal is received,
T_0 denotes the *zeroth* instant when the signal is sent.

Using this RTT value, the time taken for the signal to reach the other end of the artery can be calculated as *RTT (n) / 2*, for any signal '*n*'.

The ratio of the received signal to the transmitted signal is calculated as a percentage function. This is done by measuring the signal strength during transmission and reception.

For transmitted signal strength of 1, the received signal strength is measured using a RSSI (Received Signal Strength Indicator) circuit that measures the signal strength of the received probe.
The primary router calculates this percentage value and uses it to detect blocks or narrowed arteries in the heart.

Fig.2. A depiction of the router placement



Assuming the speed of the signal probe in blood stream be '*v*', the location of the block can be located as follows:

$L(n) = v(n) * (RTT(n) / 2)$ (2)

Where,

L(n) is the length of the artery,

V(n) is the speed of signal n, and

RTT(n) is round trip time of signal n.

Thus the routing table contains the following attributes:

i. *Present hop*, indicating current segment.
ii. *Next hop*, indicating the segment number of the next router.
iii. *RTT* (Round Trip Time).
iv. Ratio ® of received signal and transmitted signal (in percentage).

The following diagram provides a sample of the view of the routing table at any router *i*, for the signal *n*.

Assuming that the actual measured RTT of the signal is 30 *milliseconds*, 75% of the signal transmitted, is reflected back 5 ms before it should have. This would mean a strong indication of narrowed blood stream in that artery.

Fig.3. A sample of routing table

Present hop	*Next hop*	*RTT(ms.)*	*RSSI (r %)*
0	12	25	75

In the above depiction, received signal strength of 75% indicates that there is a high chance of a 75% block at a distance from the router monitoring the signal, given by the equation (2).

3.2.3 Segment-Mapping

The human body is divided into a number of segments in the computer system governing the entire system. This is done in order to provide the precise location of the artery or block discovered by the system.

The process of mapping the calculated lengths or distances of the arteries or the location of blocks, into a visual description of their positions is known as segment mapping. This is done by transforming the distance values obtained in the system into their corresponding segment locations, by knowing the actual segment value of the current router, that is, from its next hop value.

Utilization of the information of RTT in the routing table, the system calculates the time taken for the signals to get reflected and compares it with the actual time taken for a normal artery. Using this information, and the speed of the signal probe (*v*), it is possible to calculate the segment value of the block.

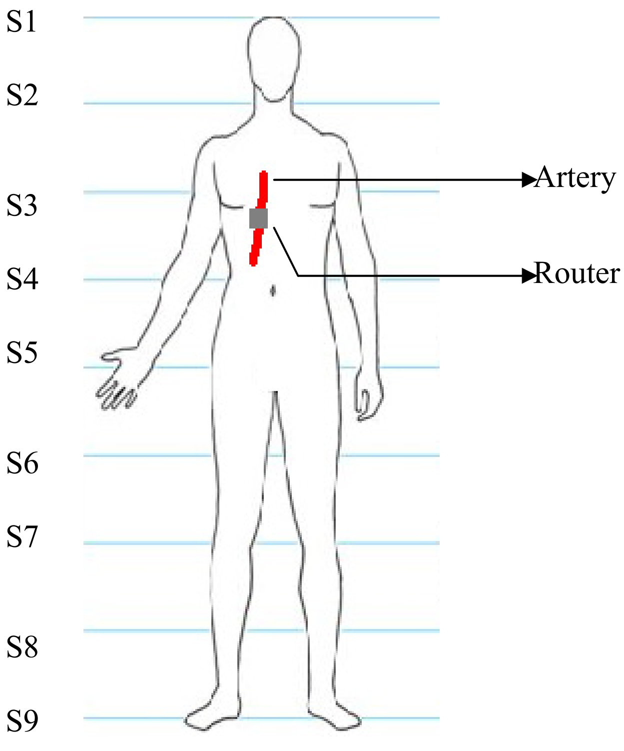
In the depiction below in *fig. 4*, the router is placed in segment S3 and the artery under monitor extends from S2 to S4. This will be calculated by the system and the location will be precisely determined and shown to the user. This visual depiction of the calculation gives a representation to the user as well as a reference for computer aided surgeries where the computer assistance can refer the location easily as S2 to S4, instead of storing the actual lengths, which would be a tedious process. This enables smaller incisions than done in existing systems. Hence, the proposed system overcomes the drawbacks of the existing surgical methodology.

4. Advantages of the proposed system

The proposed system presents us with the following advantages over the existing system:

i. Lesser complexity in surgeries.
ii. Time taken for the surgery itself can be minimized.
iii. Smaller incisions and scars in the patient's body.
iv. A lucrative technique for monitoring heart and its functions.
v. Low cost application mechanism.

Fig.4. Segment Mapping



S_i – segments, i = 1,2, … , 9

5. Scope for future research

The possibility of drawbacks in the proposed system can be mainly in the area of routing efficiency and segment mapping efficiency.

It is possible to improve the efficiency of the routing algorithm by including additional heuristic attributes to measure the factors contributing to slow down of signal speed in the blood stream, like blood glucose content, amino acids in blood and so on.

The segment mapping technique can be easily made more efficient. It is commendable to note that the efficiency of the system in precision will greatly increase by increasing the number of segments. This can provide a very accurate value to the location of the target attribute.

6. Conclusion and Future Vision

The scope for exploration in and by mankind is abundant. Combining technologies that exhibit parallelism provides tremendous potential for rapid development. The proposed system in this research paper can be combined with latest fields like nano technology, where in an external system proposed here, can be used to guide nano chips to perform grafting by itself from within the patient, that will provide room for no incisions, pain, affliction or agony. If this be made a reality, human kind would be at peace in totality.

References

[1]. A Heuristic Routing Mechanism Using a New Addressing Scheme Ravanbakhsh, M.Abbasi-Yadkori, Y.Abbaspour, M.Sarbazi-Azad, H.Sch. of Comput. Sci., IPM, Tehran; Bio-Inspired Models of Network, Information and Computing Systems, 2006.

[2]. Fast Four Heuristic Routing Algorithms in Optical Multistage Interconnection Switch Networks Mohamed Othman Farzaneh Abed, Journal of Information & Communication Technology Vol. 2, No. 1, (Spring 2008) 40-48

[3]. National heart, Lung and Blood Institute, U.S Department of Health and Human Services; www.nhlbi.nih.gov/health.

[4]. Analysis of atrial fibrillation after CABG using wavelets Maglaveras, N. Chouvarda, I. Dakos, G. Vasilikos, V. Mochlas, S. Louridas, G. Lab. of Med. Inf., Aristotelian Univ. of Thessaloniki, Greece; Computers in Cardiology, 2002

Authors:

1. **Mr. V.Prasanna Venkatesh**, *Department of Information Technology, St.Joseph's college of engineering, Chennai, India.*
   E-mail: vprasanna.1310@gmail.com
2. **Ms. V.Ranjana**, *Department of Information Technology, St.Joseph's college of engineering, Chennai, India.*
   E-mail: vranjana88@gmail.com
3. **Ms.V.Janani**, *Department of Electronics and Communication Engineering, Easwari Engineering College, Chennai, India.*
   E-mail: vjanani.23@gmail.com
4. **Mr. R.Madhav Prashanth**, *Department of Geo Informatics, College Of Engineering, Guindy, Chennai, India.*
   E-mail: madhavwas@gmail.com