Handover Decision Algorithm in Heterogeneous Wireless Networks

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Abstract – Technological advancements are growing at fast pace in each and every field and so do trends in the field of communication have undergone lots of changes. Wired communication that was earlier in great demand is now being replaced by the wireless communication. Mobility, scalability and easy access of the wireless technology are the reasons for the growing popularity of this type of communication. To add on to it, wireless communication offers many advantages over wired communication like higher reliability and lesser cost and lesser complexity. The quality of the wireless communication can be judged by continuity it provides to the user. The only hurdle that comes in the way when talking about the continuous service for the user is handoff. Handoff is the process of transferring an ongoing call from one base station to another without dropping that call. Handoff is generally observed when user is moving and the signal strength of the next base station exceeds the signal strength of the base station that is currently connected to the mobile device. A communication system capable of taking handoff decisions and avoiding call droppings is said to be more efficient and effective. In this paper, a fuzzy based handoff controller is designed that takes handoff decisions by employing some decision algorithms. This proposed controller is more efficient in taking handoff decisions than the existing controllers and the results are proved by verifying the simulation results in MATLAB.

Index Terms – wireless communication, handoff, mobile unit, BTS, Fuzzy controller, mobility, flexibility, scalability, handoff decision.

1. INTRODUCTION

With the advent of time, lots of changes have been observed in the technology. Drastic changes have been observed in the communication systems. Wired communication is the base of all sort of communications, it included use of wires or a physical link between devices was set up to enable communication between them. As the time passed, evolvements in the technology took place and so did the communication mediums changed. Wired communications were replaced by wireless communication that gave birth to cellular phone services. Wireless communication gained popularity because of its characteristics like scalability, flexibility, mobility and easy access to its services. The advantages that wireless communication have over wired communication are more reliability, less complexity and lesser cost because it do not involves use of any wires. Wireless communication provides access of communication to remote users as it has made communication possible at places where it was impossible to set up communication link using wires. Now, since each system has some pros and cons and so wireless communication also have some demerits. The problems in the network occur due to some human errors or sometimes due to environmental conditions like bad weather. One major issue that is to be taken care of in cellular systems is handoff. Handoff is a process that arises when the ongoing call is to be transferred from one base station to another. The region of the cellular network is divided into smaller regions for efficient network coverage and the network to the mobile units is provided by the base station. Whenever user is mobile, the call keeps on switching from one base station to another depending on the signal strength it receives from the base station. Handoff is this situation, when the call is transferred from one base station to another without dropping the call. The signal strength of the next base station is compared with the signal strength of the current base station and the call switches to one having maximum signal strength. This whole process should happen without dropping of the call. A wireless communication is said to be efficient if it faces minimum call droppings and the handoff occurs successfully in it.

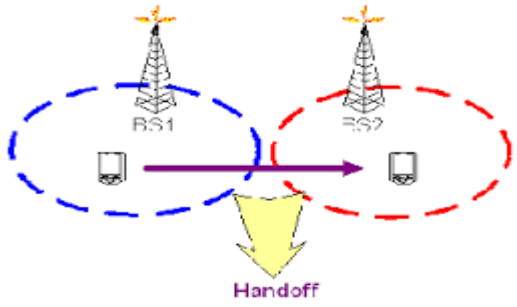

Fig. 1.1 Handoff in Mobile Networks

2. DIFFERENT PHASES OF HANDOFF

Since, handoff is the process of transferring an ongoing call so this may involve some steps that needs to be performed while initiating handoff in a system. It is necessary that the decisions

are taken after properly analyzing the system and its behavior. Handoff involves participation of two neighboring base stations so the decision of handoff should be taken such that it do not affects the service of the cellular system. The whole process of handoff involves three phases and these are described below:

i. Handoff Initialization: This phase deals with the initialization of handoff in time. The information about the various factors of the mobile unit are collected in this phase which will help in taking decisions later.

ii. Handoff Decisions: this is the second phase in handoff that deals with taking decisions whether handoff is required or not. In this phase the signal strength of the current base station is compared with the signal strength of the neighboring base station. The handoff decision is taken in the case if the signal strength of the neighboring base station exceeds the current one.

iii. Handoff execution: As the name implies, this is the last and the final phase of handoff. The execution of handoff occurs on the basis of decision made in the second phase. If the call is to be transferred to the next base station it is done in this step. The handoff execution should be such that the whole information is passed on to the next base station and the chances of call dropping are minimal.

3. TYPES OF HANDOFF

Whenever handoff occurs in a cellular system occurs these are of three types:

i. Soft Handoff: This is a make before break type of handoff. In this type of handoff the call with the next base station is first connected and then it breaks from the current connected base station. It is considered to be efficient handoff because in this chances of call dropping are less as the connections are first made.

ii. Hard Handoff: This is break before make type of handoff. In this type, the call from the current base station is first terminated and then it is connected with the neighboring base station. The user may experience call dropping in this case as the connection is first broken with the existing base station.

iii. Intersystem Handoff: This is a handoff that is initiated when the call is to be transferred to another MSC. This type of handoff is experienced when user moves in a roaming region.

4. FACTORS CAUSING HANDOFF

Handoff occurs in wireless systems due to following reasons:

i. Received signal strength from the current base station

ii. The speed at which the device is moving

iii. When the signal strength of the current connected base station becomes lesser than the signal strength of the neighboring base station.

iv. Amount of interference mobile unit obtains from the adjacent channels.

5. METHODOLOGY OF THE PROPOSED WORK

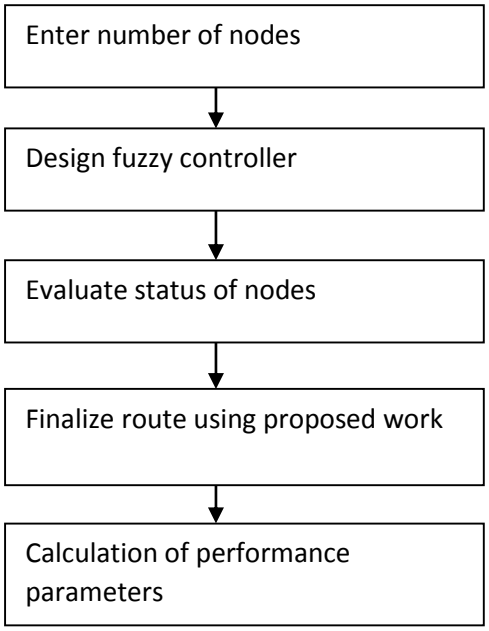

Fig. 5.1 Block Diagram of the proposed work

The proposed work in the paper takes the decision of handoff by combining it with the process of routing. The methodology of the proposed work is described in brief below:

i. First of all the user will define the number of nodes in a network. The number can be any large depending on the requirement of the user.

ii. The next step will be designing a fuzzy controller for taking handoff decisions; in this the output of the fuzzy controller will be defined on the basis of all possible combination of inputs of the Received signal strength, the load on the nodes and the distance between the neighboring nodes.

iii. The next step would be evaluating the status of the nodes defined in the network, the status of the

nodes will be either ready, waiting, yes or no depending on the nodes position to take handoff.

iv. The routing will be done in the next step. The routing process will consider the status of the node and the distance between the neighboring nodes.

v. The handoff decisions will be taken then by combining the output of the fuzzy controller and the routing process.

6. PROBLEM FORMULATION

As it is clear that handoff is the process of transferring a call from one base station to another during an ongoing call and when a user is mobile. Handoff decisions should be taken such that the signal do not drops and the call is not cut in between. A system is considered to be most efficient if it do not faces signal drop and successful handoff is obtained. Earlier handoff decisions were made on the basis of the signal strength. The signal strength of the current base station is compared with the signal strength of the neighboring base station. The call is transferred if the strength of the next base station is more than that of the current base station. The problem arises when the next base station did not had enough power to allocate to the new call. This again causes signal dropping or the call dropping resulting in bad performance of the network.

7. PROPOSED WORK

This problem of call dropping due to the next base stations inability to handle the call is overcome in the technique proposed in the paper. In the proposed work the handoff decisions are taken combining it with routing. First a fuzzy controller is designed that takes decision on the basis of the signal strength, load and the distance between the neighboring nodes. Then routing is done from the source to destination on the basis of status of nodes. The nodes status depends on their ability to take handoff i.e. whether they are ready to take immediate handoff or are they in waiting mode or they are not at all ready to take handoff. After analyzing the status the distance between the nodes ready to take handoff is considered. After considering all these parameters the decisions of handoff are made. The proposed technique is believed to be more efficient for providing better handoff decisions hence, helping in designing an efficient and effective cellular system.

8. RESULTS & DISCUSSIONS

The results of the proposed work i.e. handoff using fuzzy controller and the routing process are described below. The results are simulated using the MATLAB software.

First a fuzzy controller is designed that generates output on the basis of given input set i.e. value of RSS, load and the distance between neighboring nodes. The figure below shows the design of a fuzzy controller with three defined inputs:

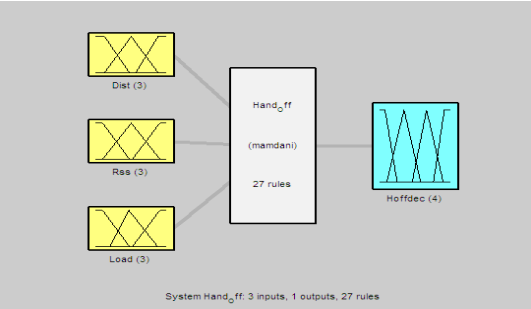

Fig. 8.1 Design of a fuzzy controller

The number of nodes of users choice will be located randomly on the network and their status whether they are ready to take handoff or not will be checked. The figure below shows the random location of nodes along with their status mentioned with them. HF implies the node is ready to take handoff, WT means the node is in waiting state and NH implies that node will not take handoff.

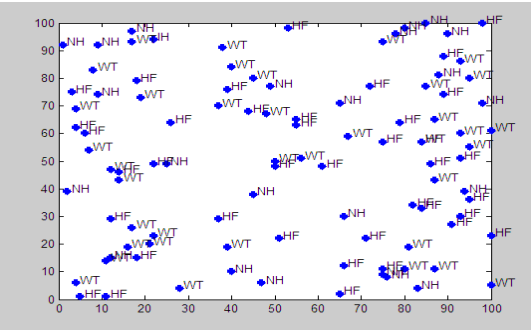

Fig. 8.2 Nodes located with their handoff status

The status of nodes will clearly show how many nodes are ready to take handoff and how many of them will not take handoff at all. The nodes having NH status will not take handoff. The figure below is in the form of a bar graph showing the number of nodes that have taken handoff.

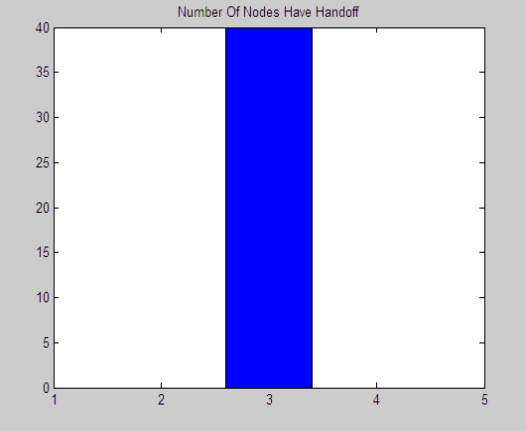

Fig. 8.3 Graph depicting number of nodes having handoff

9. CONCLUSION

The conventional decisions of handoff were taken on the basis of the output generated by the fuzzy controller. the fuzzy controller took decisions on the basis of the signal strength, load and the distance between the neighboring nodes. All possible input sets are given to the fuzzy controller and the output for each set is defined. The results obtained were efficient but were not desired. The proposed technique in the paper that combined routing with the handoff decisions increased efficiency of the wireless system. The proposed technique checked the status of the nodes before transferring the call or before executing handoff, which improved the efficiency of the system significantly.

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