www.ijaret.org Vol. 1, Issue III, April 2013
ISSN 2320-6802

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS.....

A Review on Various Fuzzy Based Handoff Decision Algorithms in GSM-R

Monika Khatter[1], Parikshit Singla[2]

[1]Student(M.tech) , [2]Assistant Professor
Doon Velley Institute of Engineering and Technology
Karnal Pin No. 132101
[1]monika.csc31@gmail.com, [2]par7901@gmail.com

Abstract: *In this paper we states two fuzzy logic based handoff decision algorithms and by using different parameter values we will provide the improvement in our unnecessary handoff initiation. In all algorithms we were using the average handoff factor. And the difference between two proposed algorithms was using the hysteresis margin of the handoff factor that are Compared with two conventional algorithms. In which two proposed algorithms were simulated under one scenario in Passenger Special Line in China. Proposed Algorithm could make handoff decision efficiently at high speed (270km/h-350km/h) of moving terminals in GSM-R.*

Keywords: *Handoff Decision, Fuzzy Logic, High Speed, GSM-R.*

1. INTRODUCTION

Handoff is one of the key operations in cellular mobile communication systems. It is the method through which the call is maintained continuously when Mobile Terminal (MT) moves from one cell area to another. The channel change due to handoff occurs through a change in time slot, frequency band, codeword, or a combination of these And GSM was adopted as Europe standard for trains communication and control in 1998 [1], and it is na med as GSM-Railway (Abbr. GSM-R). The GSM-R can support special requirements of high speed subscribers in railway, especially in high speed railway like Passenger Special Line in China,. the handoff decision algorithm in GSM-R should be more efficient and more exact than the one in GSM. Using the conventional handoff decision algorithms can not provide the good performance by using only the Received Signal Strength of Base Station when the MT (Moving Terminal) moves very quickly in high speed train, because more "Ping-Pong" effects will occur that produce unnecessary handoff. Until now, many handoff decision algorithms were analyzed for GSM in existing literatures. But, little published work has been devoted to the handoff decision algorithms in GSM-R network. A fuzzy logic rule base is created based on the known sensitivity of handoff algorithm parameters (distance, velocity, RSS etc.) by which we can provide good performance than the previous algorithm.

2. CONVENTIONAL ALGORITHM

Many of the existing handoff algorithms has probability of unnecessary handoff when it is not required, this is due to the signal strength reduces due to some environment reasons that created excessive load occur on the MSC and BS. This is the disadvantage. It reduces efficiency of the system. Unnecessary handoff as in ping-pong effect increases the signaling overhead on the network and lead to unwanted delays and interruption in call.

This section, we review two conventional handoff decision algorithms [6]. Both of conventional algorithms are based on only the RSS (Received Signal Strength) and are using the average window to diminish "Ping-Pong" effects caused by the fluctuant RSS, which is illustrated in Figure1

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS.....

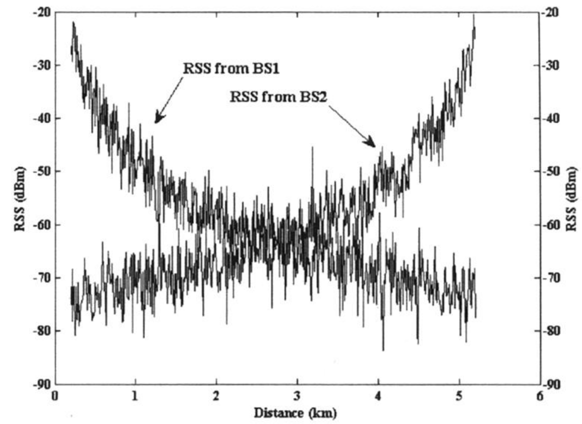

Figure1: RSS received from the current BS and the target BS

Difference between two conventional algorithms is using the hysteresis margin of the RSS to make the final handoff decision. Using the hysteresis margin allows a MT to make handoff decision only if the RSS received from the target BS (Base Station) is sufficiently stronger than the current one by the specified hysteresis margin.

2.1 CONVENTIONAL ALGORITHM I:-

In the existing conventional algorithm that uses only the Received signal strength received from the current Base Station and the target Base Station are $S_i(n)$ and $S_j(n)$ respectively, where *n* means the sampling index. The handoff decision occurs if the following in equation:

$$Y_j(n) > Y_i(n) \quad (1)$$

is satisfied, where both $Y_i(n)$ and $Yj(n)$ are the average RSS values. And, $Y(n)$ is subject to the following equation:

$$Y(n) = 1/N \sum_{K=n-N+1}^{n} s(k), \quad (2)$$

N where N is the average window size and k is the sampling index. In this paper, we chose N=4.

2.2 CONVENTIONAL ALGORITHM II:

This algorithm is mostly similar to the conventional algorithm I, and only difference is that the handoff decision occurs if the following in equation:

$$Y_j(n) > Y_i(n) + H \quad (3)$$

is satisfied, where both $Yi(n)$ and $Yj(n)$ are the average RSS values, H is the hysteresis margin of the RSS, and Y(n) can be got from the equation(2). In our simulation, we chose N=4 and H=2dBm.

3. PROPOSED HANDOFF DECISION ALGORITHMS

In this algorithm we will solve the problem of existing conventional algorithm to provide better performance and avoid unnecessary handoff in high speed railway. In a high speed railway there is a problem of call interruption or call blocking, load increases on the MSC(mobile switching center) when mobile terminal moves from one BS to another BS very firstly. So we make an algorithm in which we will use three parameter: distance of Mobile Terminal and Base Station, velocity of train and RSS (Received Signal Strength) implemented in fuzzy logic. We are using fuzzy logic because fuzzy system is easy to implement, provide intelligence to the system.

Two proposed fuzzy logic based handoff decision algorithms are introduced in this section. Both of them were based on the average handoff factor, whose value was chosen between 0 and 1, where the value closer to "0" was used for no handoff or the one closer to "1" was described as handoff. The handoff factor was the output of the proposed FIS (Fuzzy Inference System), which included three inputs: Distance from MT to BS, RSS from BS, Velocity of MT, where RSS is the most essential factor in handoff decision algorithms, Distance is easily got from devices, velocity is the key parameter in high speed railway. Using some other factors, such as capacity utilization of BS, signal interferences, etc, could help the results approximate the real ones, but the efficiency of proposed algorithms could be down because these factors are not easily and exactly got from the GSM-R. Here, we emphasize dynamic sampling distance in proposed algorithms. In GSM network, most subscribers are moving slowly when using GSM services, so, the sampling distance m is used for handoff decision in existing literatures. But, in GSM-R network, few subscribers are moving slowly. If sampling distance-lm is still used, the more unnecessary samplings would occur to produce

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS.....

"Ping-Pong" effects. So, dynamic sampling distance we chose was subject to the following equation (toward the direction of MT):

$$D=V*T \quad (4)$$

where D is the distance from MT to BS; V is the speed of MT (given constant in each simulation); T is the sampling time 480ms (similar to the one in GSM [4]).

3.1 PROPOSED ALGORITHM I:

The handoff factors got from the current BS and the target BS firstly were averaged by the average window, whose size N, was set to 4 for our simulation. Given that $HO\_Factor\_BS_i(n)$ and $HO\_Factor\_BS_j(n)$ are described as the handoff factor of the Current BS and the target BS, respectively. Then, if

$$HO\_Factor_i(n) > HO\_Factor_j(n) \quad (5)$$

is satisfied, the handoff decision occurs. And, HO_Factor(n) is got from the following equation:

$$HO\_Factor(n)=-1/N\sum_{K=n-N+1}^{n} HO\_Factor\_BS(k) \quad (6)$$

where k is the sampling index.

3.2 PROPOSED ALGORITHM II:

This algorithm is the enhanced version of the proposed algorithm (only the hysteresis margin of the handoff factor, H, was added). So, if

$$HO\_Factor_i(n)>HO\_Factor_j(n)+H \quad (7)$$

is satisfied, the handoff decision occurs, where H is the hysteresis margin of the handoff factor. Here, H was chosen by 0.02 which was equivalent to the H (2dBm) mentioned in section 2.2. And, HO_Factor (n) is got from the equation (6).

3.3 FUZZIFICATION

In the first step of the handoff initiation module is to calculate the context parameter like distance between BS and train, RSS, velocity of MT and feed into a fuzzifier. The fuzzifier transforms real-time measurements into fuzzy sets. Fuzzy sets contain elements that have a varying degree of membership in a set. For example, if signal strength is considered in crisp set, it can only be weak or strong. However, in a fuzzy set the signal can be considered as quite weak, medium or strong. The membership values are obtained by mapping the values obtained for particular parameter into a membership function.

3.4 FUZZY INFERENCE

The second step of handoff initiation involves feeding the fuzzy sets into an inference engine, where a set of fuzzy IF-THEN rules is applied to obtain fuzzy decision sets There were 3x3x4 "IF-THEN" rules in FIS to mapping the fuzzy inputs. To simply understand, we used the set {No_Handoff, Wait, Be_Careful, Handoff} to represent the fuzzy set of Decision which included {very low, low, medium, high}. The table of "IF-THEN" rules is listed below.

Distance	RSS	Velocity	Handoff Status
Near	High	Very High	No_Handoff
		High	No_Handoff
		Medium	No_Handoff
		Low	No_Handoff
	Medium	Very High	Wait
		High	Wait
		Medium	No_Handoff
		Low	No_Handoff
	Low	Very High	Be_Careful
		High	Wait
		Medium	No_Handoff
		Low	No_Handoff
Medium	High	Very High	Handoff
		High	Be_Careful
		Medium	Wait
		Low	No_Handoff
	Medium	Very High	Handoff
		High	Handoff
		Medium	Be_Careful
		Low	Wait
	Low	Very High	Handoff
		High	Handoff
		Medium	Be_Careful
		Low	Be_Careful
Far	High	Very High	Be_Careful
		High	Be_Careful

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS.....

		Medium	Wait
		Low	Wait
	Medium	Very High	Handoff
		High	Handoff
		Medium	Be_Careful

Table 1: "IF-THEN" rules of FIS

3.5 DEFUZZIFICATION

Fuzzy rules can be defined as a set of possible scenarios which decides whether handover is necessary or not. Finally, the output fuzzy decision sets are aggregated into a single fuzzy set and passed to the defuzzifier to be converted into a precise quantity during the last stage of the handover decision. The centroid of area method was selected to defuzzify for changing the fuzzy value into the crisp value (i.e. the handoff factor without averaging) [2].

4. SIMULATION

Two proposed fuzzy logic based handoff decision algorithms were evaluated in the one of many deployments in Passenger Special Line in China-Two BSs are set in straight line along the trajectory of high speed railway And, given that the handoff execution was successful when the handoff decision occurred.

4.1 SIMULATION MODEL AND ITS PARAMETERS:

In our simulation, Hata model from [3] was used as large scale propagation model. Besides large scale path loss, there is shadow fading, which affects the quality of the RSS and is subject to a zero mean white Gaussian distribution. So, the RSS received by a MT can be computed by the following equation [7]:

$$P_r(d)[dBm]=P_t[dBm]-PL(d)[DB] \quad (8)$$

where $P_r(d)$ is the RSS received by a MT at distance d. P is the power transmitted from the current BS; PL(d) is the path loss at distance d. And, PL(d) can be got from the following equation [8]:

$$PL(d)[dB]=\overline{PL}(d_0)+10n\log(d/d_0)+X \quad (9)$$

Where PL(d) is the path loss at distance d. $\overline{PL}(d_0)$ is the path loss at reference distance which is evaluated by Hata Model (using the open rural formula in our simulation due to the assumption that moving terminals were running in the open rural area along the railway); n is the path loss exponent. X is the shadow fading.

4.2 SIMULATION AND RESULTS

Under the specified scenario in our simulation, the probability of unnecessary handoff was calculated by the statistics method, which accumulated the number of unnecessary handoff at the beginning and computed the probability of unnecessary handoff at the dynamic slot (depending on the product of velocity and time) between two Base Stations at last. We simulated two conventional and two proposed algorithms in the specified scenario. Proposed algorithm will have the best perfornance because of getting the lowest probability of unnecessary handoff.

5. CONCLUSION & FUTURE WORK

In this Paper we review that the probability of unnecessary handoff could be down sharply, when both fuzzy logic and dynamic sampling distance were used for handoff decision algorithms in GSM-R network. The fuzzy logic method made the handoff decision algorithms more exact, and the dynamic sampling distance had contributions to decrease the number of unnecessary handoff requests directly when the MT moved at higher speed, such as 270 km/h-350 km/h. So, our proposed handoff decision algorithms could meet the special requirements of applications in high speed railway, especially when the MT moved at 270 km/h-350 km/h in Passenger Special Line in China.

In Our Future work we work on the implementation of the new tool which calculate the accurate value of all parameter and compared all the algorithms with the help of graph .

REFERENCES

[1] C. Briso, .C. Cortes, F. 1. Arques, 1. Alonso. "Requirements of GSM Technology for The Control of High Speed Trains", ***The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications,*** **volume 2, pp.792-793, (2002).**

[2] G. Edwards, R. Sankar. "Handoff Using Fuzzy Logic",IEEEGlobal Telecommunications Conference, volume

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS.....

1, pp.524-528, (1995).

[3] M. Hata. "Empirical Formula for Propagation Loss in Land Mobile Radio Services", *IEEE Transactions on Vehicular Technology*, volume 29, pp.317-325, (1980).

[4] B. Homnan, W. Benjapolakul. "A Handover Decision Procedure for Mobile Telephone Systems Using Fuzzy Logic", *The* 1998 *IEEE Asia-Pacific Conference on Circuits and Systems*, pp. 503-506, (1998).

[5] K. Kastell, S. Bug, A. Nazarov, R. Jakoby. "Improvements in Railway Communication via GSMR", *IEEE 63rd Vehicular Technology Conference*, volume 6, pp.3026-3030, (2006).

[6] C. H. Lee, C. 1. Yu. "An Intelligent Handoff Algorithm for Wireless Communication Systems Using Grey Prediction and Fuzzy Decision System", *The 2004 IEEE International Conference on Networking, Sensing and Control*, volume 1, pp.541-546, (2004).

[7] H. L. Nan, X. Wang, Z. D. Zhong. "Study on Algorithm of Cell overage Radius in GSM-R" (in Chinese), *Journal of The China Railway Society*, volume 27, pp.66-69, (2005).

[8] T.S. Rappaport. "Wireless Communications principles & Practice" (photocopy), Beijing: *Publishing House ofElectronics Industry*, pp.l 04-1 08, (1999).