

# Improve Receive Signal over Ku-Band Satellite Communications Based on Fuzzy Logic

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**Abstract**—This paper is the extension of the previous research work [1] to improve the BER over the regular satellite communication during rain attenuation performed. The fuzzy logic box was added into the system. The fuzzy box will determine the ambiguous signal during the attenuation performed. The fuzzy box use dB state, Voltage and Phase of the signal as the input parameters to determine the ambiguous signal for the correction signal. The varieties sets of input was performed by fuzzy box includes to obtaining the rule based, the simulation performed MATLAB. After june up process on fuzzy box, the two case will test by fuzzy box 1) without attenuation 2) attenuation (clear sky) final we obtain the purpose signal regulate for improving BER.

**Index Terms**— Rain –attenuation, fuzzy logic, Ku-Band satellite, DVB-S .

## 1 INTRODUCTION

Previous research work [1] introduced the development of Ku-band satellite communications which is mainly related to satellite communication [2] DVB-S [3], [4],[5],[6] in the satellite and DTH (direct-to-home) television services. There are many applications that obtain benefit by improving signal over Ku-band satellite communications via fuzzy logic, Where is previous research [1] results of simulation, it has a little improvement of BER percentage when rain attenuation performed. However most application need the signal transmutation to retrieve information, rapid of real-time reaction to obtain picture. The examples of such are education, entertainment, and business.

Vatcharakorn and Surasee [1],[7] show reported the important key point of needed to the receive signal over Ku-band satellite communication. And why it's required fuzzy logic, Where the QoS must be concerned and maintain .

Vatcharakorn and Surasee [1] show proposes the Digital Video Broadcasting- Satellite (DVB-S) [3],[4],[5],[6],[12],[15] as an infrastructure to transmit the satellite signal to the destination based on satellite communication standards [3],[6],[8],[19] In this paper, we apply DVB-S [3] as the fundamental structure for our analyzed.

In this paper we interest the DVB-S satellite communications system which is affected by the rain attenuation as illustrated in Fig.1. To improve receive signal over satellite communications in DVB-S, We propose the fuzzy logic to deploy over the system. Rain attenuation is a dominant source of attenuation over Ku-band satellite communication[9]. Because of the frequency of Ku-band was effected in rhythm of rain attenuation [7],[10],[11],[16]. In case of both of them are synchronized, the signal will loss or attenuated. These is vital problem to occur in Ku-band where high frequency is deployed [18].

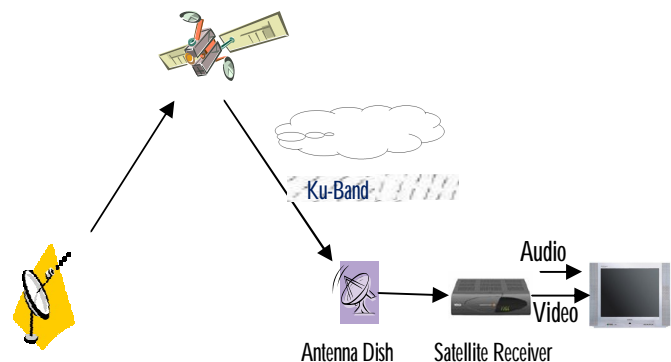


Fig.1 Satellite model [1].

### 1.1 Problem Statement

Rain is a dominant source of attenuation for Digital Video Broadcasting-Satellite (DVB-S )over Ku-Band (14/12 GHz) . The DVB-S technology, it was served attenuation problem as high frequency. Some times can not receive down link signal which is convey picture and sound . It need some mechanisms which can resolve attenuation over DVB-S.

In term of QoS, end user must see picture and sound from transmission link weather rain attenuation nor clear sky. Service must be strength and quality of signal must be maintained. In order to achieve this. We proposed a good process which can resolve the problem of rain attenuation over DVB-S to user. By applied fuzzy logic inside the exiting system

## 2 PAPER FUZZY-LOGIC-BASED UNIT COMMITMENT

Fuzzy logic is a conceptualized as a generalization of classical logic and a mathematical theory, which encompasses the idea of vagueness when defining a meaning. For example, there is uncertainty are 'fuzziness' in expressions like 'tall' or 'short' , since these expressions are imprecise and relative. Variables considered thus are termed 'fuzzy.' Fuzziness is simple one means of describing uncertainty[13]. Such ideas are readily

applicable to unit commitment problem.

The objective of every receive signal utility is to operate at correct receive bit signal from source. It use fuzzy logic to solve problem.

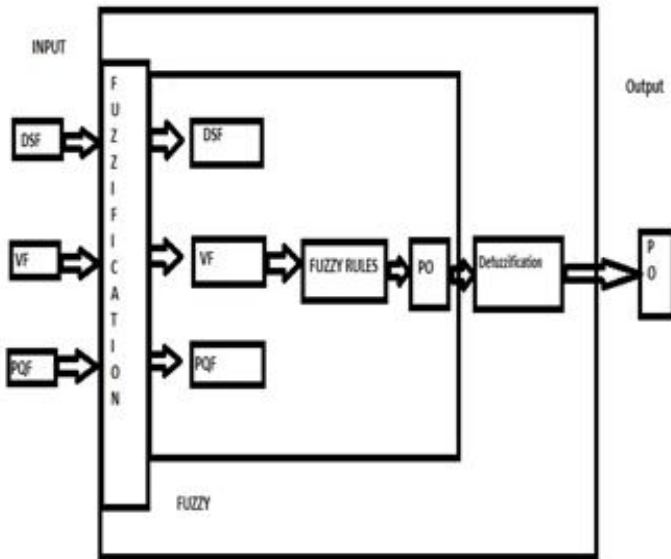


Fig.2 The overall system block diagram of unit commitment using fuzzy logic

- DSF: dB State Factor
- VF: Voltage Factor
- PQF: Phase QPSK Factor
- PO: Production Output

**2.1 Fuzzy Variables**

Signal has characteristic which run in sinusoidal form. It can write instead and expatiate with function of mathematics as below equations.

$$s(t)=A \sin(\omega t) \tag{1}$$

Then three parameters will select for fuzzy box. This parameter comprise of dB state factor (DSF) is the output of the signal, Second is Amplitude (A), where represent the strength of signal. Phase ( $\omega t$ ) which perform in QPSK factor. Then we map below parameters to the input parameter for fuzzy.

Fuzzy input variables

- dB State Factor (DSF) as  $s(t)$
- Voltage Factor (VF) as (A)
- Phase QPSK Factor (PQF) as ( $\omega$ )

Fuzzy output variables

- Production Output (PO)

dB state factor is considered to be the input of the fuzzy, because dB state factor is direct parameter that make effect to retrieve accurate information when signal from satellite admit

to the receiver. If it has high power as regular perform (clear sky) good quality of signal will obtain but in contrast when rain attenuation power, the power will drop.

Second is Voltage factor. It is taken to be the input of the fuzzy, because voltage factor is parameter that make effect it retrieve accurate information. If it has high voltage as regular perform (clear sky) good quality of signal will obtain but in contrast when rain attenuation voltage, the voltage will drop.

Third is phase QPSK factor. It is taken to be the input of the fuzzy, because QPSK is modulation for ku-band satellite by  $\omega t$  is phase QPSK factor and sensible to receive signal from satellite when it has rain attenuation. Therefore, If it has phase QPSK factor as regular perform (clear sky) good quality of signal will obtain but in contrast when rain attenuation phase QPSK, the phase QPSK will drop.

**2.2 Fuzzy Set Associated with Unit Commitment**

After identifying the fuzzy variables associated with the unit commitment, the fuzzy set defining these variables are selected and normalized. This normalized value can be multiplied by a selected scale factor to accommodate any desired variable.

The sets defining the dB state factor (DSF) are as follows:

DSF(dB) = {weak, middle, high}

The Voltage Factor (VF) is stated by the following sets.

VF(v) = {low, strong}

The Phase QPSK Factor (PQF) is defined by the following sets.

PQF = {outside, near, right}

The Production output, chosen as the objective function is given by,

PO = {low, near, strong}

Based on the aforementioned fuzzy sets selected from the given problem.

**2.3 Membership Function**

Base on the aforementioned fuzzy set, the membership functions are chosen for each fuzzy input and output variable. A shape membership function is chosen for all the fuzzy variables.

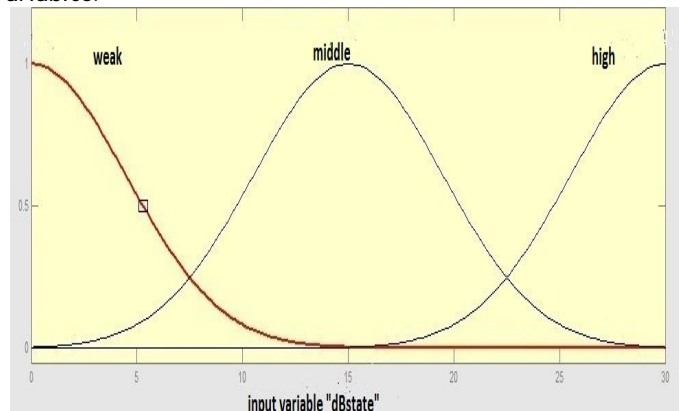


Fig.3 Membership function of dB state factor

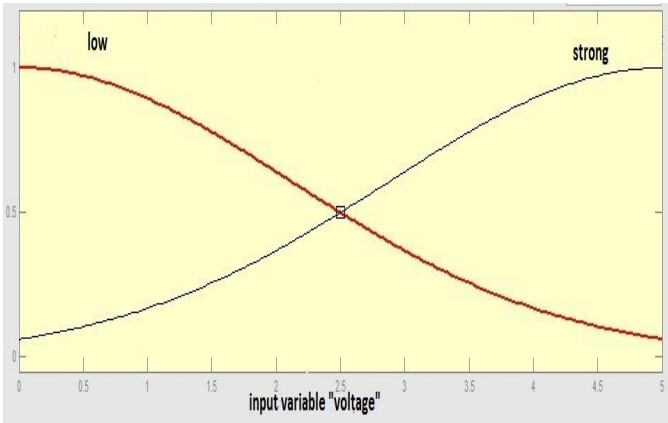


Fig. 4 Membership function of Voltage Factor

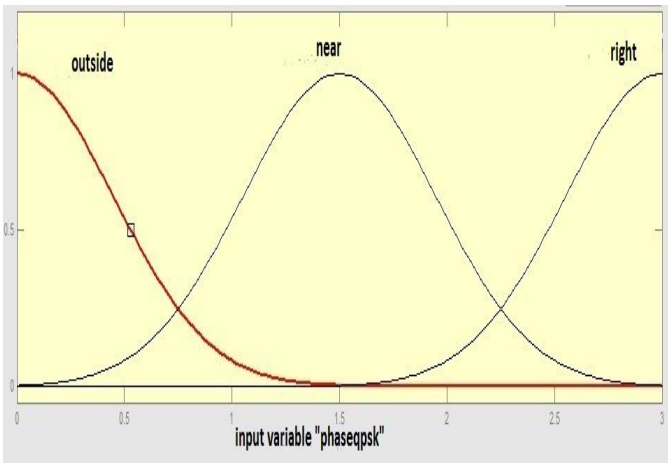


Fig. 5 Membership function of Phase QPSK Factor

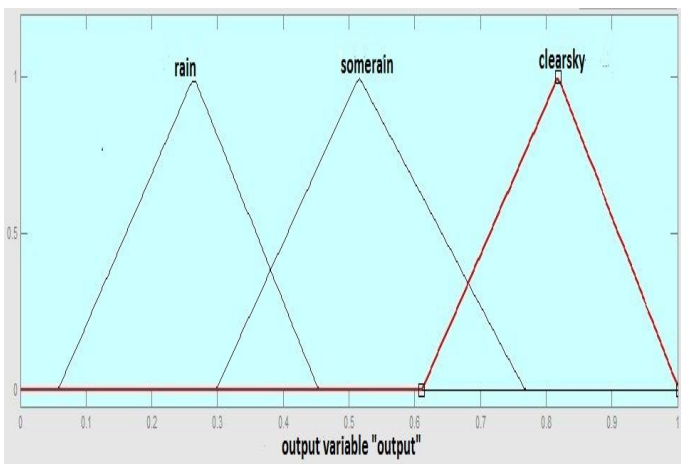


Fig. 6 Membership function of Production output

Fuzzy If – Then Rules

The fuzzy-logic –based approach ,decisions are made by forming a series of rules that relate the input variables to the output variable using If-Then statement . The if (condition) is an antecedent to the Then (consequence) of each rule. Each rule in general can be represented in the following manner:

*If (antecedent ) Then (consequence)*

dB state factor , Voltage Factor and Phase QPSK Factor are considered as input variables and production output is treated as the output variable. This relation between the input variables and the output variable is given as;

$$Production\ Output = \{dB\ State\ Factor\}or\{Voltage\ Factor\}or\{Phase\ QPSK\ Factor\}$$

In fuzzy set notation this is written as

$$PO = DSF \cup VF \cup PQF$$

We use above notation, fuzzy rules are written to associate fuzzy input variables with the fuzzy output variable. Base on these relationships and with reference to Figs. 3-6, a total of 18 rules can be composed (since there are 3 subsets for dB State Factor, 2 subset for Voltage Factor and 3 subset for Phase QPSK Factor (3\*2\*3=18)). For instance, rule 3 can be written as follows:

*Rule 1:*

If (dB State Factor is weak) or (Voltage Factor is low) or (Phase QPSK Factor is Outside) then (Production Output is rain)

*Rule 2:*

If (dB State Factor is middle) or (Phase QPSK Factor is near) Then (Production output is some rain)

*Rule 3;*

If (dB State Factor is high or (Voltage Factor is strong) or (Phase QPSK Factor is right) Then (Product Output is clear sky)

In similar manner total 18 rules can be formed.

Function for fuzzification [14]

A Gaussian membership function in defined by

$$G(u: m, \sigma) = \exp \left[ - \left\{ \frac{(u-m)}{\sqrt{2}\sigma} \right\}^2 \right] \quad (2)$$

Where the parameters m and σ control the center and width of the membership function.

A Triangular membership function with straight lines can formally be defined as follows:

$$\Lambda(U: \alpha, \beta, \gamma) = \begin{cases} 0 & u < \alpha \\ \frac{(u-\alpha)}{(\beta-\alpha)} & \alpha \leq u \leq \beta \\ \frac{(\alpha-u)}{(\beta-\alpha)} & \beta \leq u \leq \gamma \\ 0 & u > \gamma \end{cases} \quad (3)$$

After relating the input variables to the output variable, the fuzzy results must be defuzzified through what is called a defuzzification process, to achieve crisp numerical values.

**2.4 Defuzzification Process**

Defuzzification is final step in process fuzzy logic based. One of the most commonly used methods of defuzzification is the centroid or gravity method. Using this method, the production cost is obtained as follows:

$$Production\ Output = \frac{\sum_{i=1}^n \mu(PO)i * POi}{\sum_{i=1}^n \mu(PO)i} \quad (4)$$

Where

$\mu(PO)i$  is the membership value of the clipped output

$POi$  is the quantitative value of the clipped output

$n$  is the number of the point corresponding to quantitative value of the output

**3 CASE STUDY AND SIMULATION RESULTS**

In this research presents the analysis and simulation comparison between regular system and use apply fuzzy logic. Fuzzy logic simulation are obtained through MATLAB. The result obtained by the apply fuzzy logic is compared with solution obtained from regular system method.

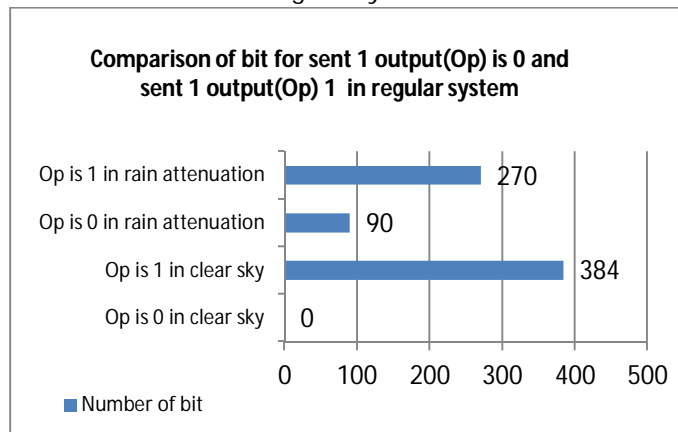


Fig. 7 Comparison of bit for sent 1 output is 0 and sent 1 output 1 in regular system

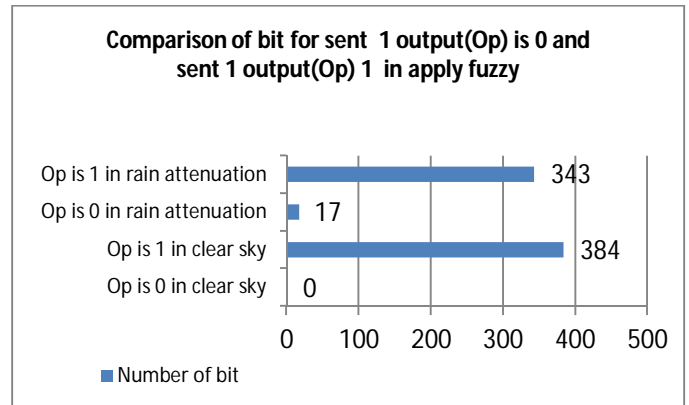


Fig. 8 Comparison of bit for sent 1 output is 0 and sent 1 output 1 in apply fuzzy

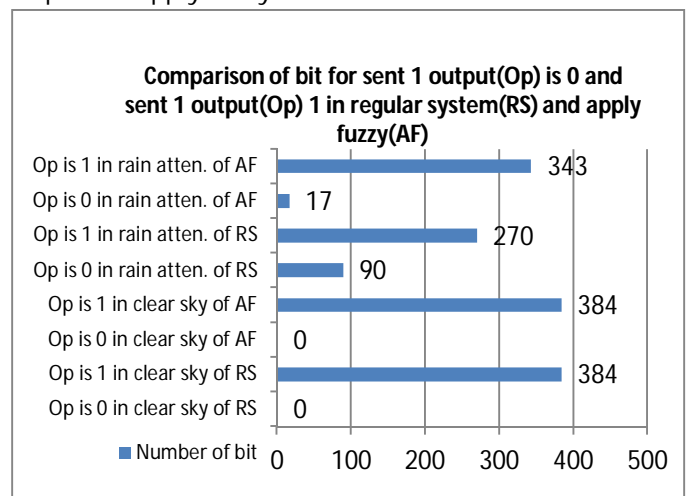


Fig.9 Comparison of bit for sent 1 output is 0 and sent 1 output 1 in regular system and apply fuzzy

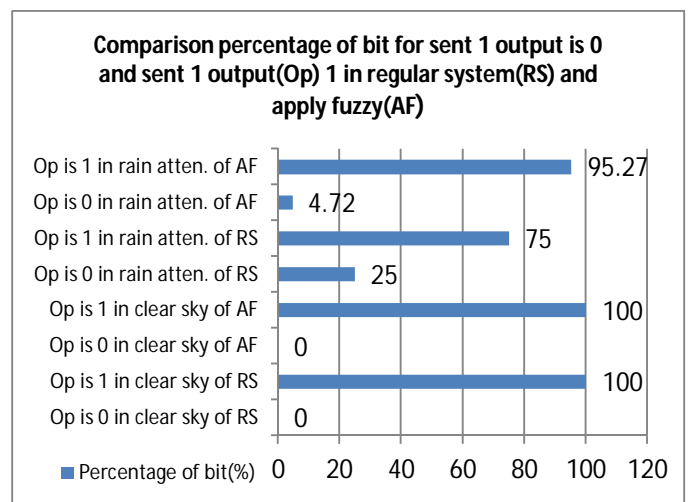


Fig.10 Comparison Percentage of bit for sent 1 output is 0 and sent 1 output 1 in regular system and apply fuzzy

The results from simulations will be evaluated based on receive bit, condition comparison in regular system and apply fuzzy base on clear sky and rain attenuation.

Fig. 7 represents the simulation results of receive signal system based on clear sky and rain attenuation scenario by comparison of bit for sent 1 output is 0 and sent 1 output 1 in regular system. In base clear sky output is sent 1 output 1 it has output 384 from 384 sample is 100% and in base clear sky output is sent 1 output 0 it has output 0 from 384 is 0%.

In base rain attenuation output is sent 1 output 1 it has output 270 from 360 sample is 75% and in base rain attenuation output is sent 1 output 0 it has output 90 from 360 sample is 25%. The summary results in sent 1 output is 0 in base rain attenuation more than sent 1 output 0 in base rain attenuation is 50%. It is condition value normal.

Fig. 8 represents the simulation comparison of bit for sent 1 output is 0 and sent 1 output 1 in apply fuzzy base on clear sky and rain attenuation. In output of bit for sent 1 output 1 in apply fuzzy outcome more than sent 1 output 1 in regular system 20.27% because use fuzzy logic method improve, and it can decrease bit for sent 1 output 1 in apply fuzzy base on rain attenuation.

Fig. 9-10 Summary simulation in apply fuzzy base rain attenuation it can increase it can increase percentage more than non fuzzy base rain attenuation is 20.27% because use fuzzy logic method to solve problem when it has rain attenuation. In section clear sky and rain attenuation it has outcome is same in sent 1 output 1 in apply fuzzy and regular system is 100% because is normal condition.

#### 4 CONCLUSION

This research indicated that the frequency of rain directly affected to QoS on the down link system. However this research find method to improve signal can receive the picture when rain attenuation by use fuzzy logic add in system. In simulation use fuzzy logic method it can improve receive bit in system more than regular system. In simulation results of receive signal system based on rain attenuation scenario by comparison of bit sent 1 output is 1. The results in apply fuzzy logic method better than regular system is 20.27%.

#### 5 FUTURE WORK

We will bring apply fuzzy logic method which improve resolved from research into image processing block which has ability to reconstruct the other bits to retrieve the picture while regular system show not thing on the screen during rain attenuation performed.

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