Cuckoo Search Algorithm for Satellite Communication Link Budget Optimization

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Abstract: ***In fast changing global Socio-economic development satellite communication act as backbone. Satellite connects one point to other point of earth. It provide communication capabilities spanning long distance & also in circumstances where other form of communication is inoperable. It is now used in controlling Power distribution & transmission with the support of supervisory control and Data acquisition system (SCADA). Satellite communication (SATCOM) increased the modernity and advancement of communication path. In this research, Cuckoo search algorithm improves the link budget performance in satellite communication system by the optimization. The effective cuckoo search algorithms find the parameters that provide the maximum (or minimum) value of a target function.***

Index Terms: ***Satellite communication, Cuckoo search, SCADA system***

I. INTRODUCTION

Modern System demanding monitoring and controlling in automation System. That's why SCADA used now a days is more automated and most important cost effective also [1]. The Remote control server (RCS) microwave communication network and remote telemetry unit (RTU) are considered as the backbone of the SCADA system.

RTU collect the information from substation & transfer the information to central host by microwave linkage [2]. But, for the large and critical geographical area, enhancement of communication system is required in the industries. The modernize satellite communications (SATCOM) is best suitable wireless media for SCADA [3].

Satellite communications generally consist of a satellite and several ground stations (transmitter/receiver). The satellite receives uplink frequency, repeats the signal, and transmits downlink frequency, transponder is very helpful in large amount of data transmission. But there are some limitations also; So SATCOM faces major loss [4]. To overcome those losses, the most used approach is to calculate link margin performance in transponder SATCOM system [5].

Therefore, a system which helps in minimize the noise and maximize the data transferring capacity is preferred.

II. RELATED WORK

Investigated various reliability characteristic of a satellite communication system [6]. Evaluated complete satellite system and the failure caused due to transmitter and receiver systems. For the credibility of the satellite communication systems, the MATLAB modelling and simulation is very helpful to assess the functioning of the various attributes. The sensitive analyses show that system sensitiveness increases as terrestrial system complexity increases. So, Power Transmission System is ready to come up with new ideas in Satellite Communication [5].

For the proper formation of production, wireless communication media is very popular way in SCADA industries. Satellite Communication is best option as a wireless media for maximum geographical area in remote and rural sites with high speed. SATCOM divided in three parts transponder, uplink and downlink and provides link margins against losses. The proposed work algorithm, which provides set of SATCOM links with desired quality of service requirements and sufficient uplink and downlink margins. The joint power control algorithm simulation results show highest link margin to tackle random uplink and downlink losses. The study proposes a wireless SATCOM system for SCADA water station [7]. Communication protection and security issues occurred in whole transmission process, so few features are suggested.The SATCOM play a very important role for the development of the country where the payload complexity increases the SATCOM design trade-offs. All the effective structure of satellite is accomplished before main design installation. Before the satellite is deployed the design of all the attenuation scenarios is performed. Here, the basics of the satellite link budget are introduced [8]. The gravitational search algorithm is combination of law of gravity and mass interaction for the rigorous testing of satellite link. So, its performance is very effective.

The present study explains the link between an earth station and user by Geo Stationary satellite with Ka Frequency band [9]. The simple architecture is preferred for future aspect, which is helpful in finding link budget performance. The application used helps in calculating the link budget in uplink and downlink. The design of the future communication satellite for Ka band is proposed by considering the simple architecture. Without Software simulation, can't check the viability of proposed system. The software is developed for checking the feasibility of the proposed system. The final conclusion shows some noise gap between uplink and downlink margin, such as 8.17dB and 8.2dB.

For the circuit simplicity and high-speed performance, new techniques of modulation and demodulation are introduced at high bit rate of multilevel digital carrier transmission [10]. System control plays an important part in control philosophy for link availability, which is used in high speed digital microwave, millimetre-wave and satellite communication systems.

III. CUCKOO SEARCH ALGORITHM

It is inspired by cuckoo bird (population-based algorithm) with the levy flight behaviour to find out best link, which is totally based on optimized carrier to noise ratio. For the communication performance improvement of industries, Cuckoo search algorithm is best optimization concept in SATCOM systems. By implementing this algorithm, unwanted parameter means noise can be minimized, and wanted parameter maximised. So carrier to noise ratio is also maximized.

Cuckoo search algorithm

Begin
Initialize the populations: n host nests(solutions)
$x_i(i=1,2,\cdots,n)$
Calculate the fitness value $F_i(i=1,2,\cdots,n)$
While *(Stop criterion)*
Generate a new solution (Cuckoo) x_k *via Levy flight and calculate the corresponding fitness value* F_k
Select a net x_j *randomly and the corresponding fitness value* F_j
If$(F_k>F_j)$
replace x_j *by* x_k
End if
Abandon a solution by p_α $(0<p_\alpha<1)$ *and rebuild a new solution randomly*
Keep the best solution
End while
End

The algorithm is shown above. As per Algorithm, after the search operation, lots optimized new links generated. So, while generating new links the search ability is performed thereby optimization rate is changed and more number of new links is generated after the search operation. Thus, the new link model is obtained to determine the optimal best total carrier to noise ratio value.

IV. EVALUATION AND RESULTS

In this research, MATLAB 2017 a is considered for the software simulation to obtain the best optimization value by cuckoo search algorithms. The design parameters are evaluated with the range values and compared with cuckoo search algorithms and their obtained values. The ranges are mentioned in the below table and is as follows,.

Table 1 Ranges of Design Parameters

DESIGN PARAMETERS	RANGES
Uplink frequency	5.8-6.9 GHZ
Downlink frequency	3.7-4.3 GHZ
Earth transmit power	25-30 dB
Earth transmit and receive antenna efficiency	55-75 %
Earth transmit and receive antenna diameter	2.6-4.6 m

The carrier to noise ratio for both uplink and downlink earth stations and overall satellite communication system is analysed for cuckoo search algorithms and reference satellite model is also included for the comparison purpose and is given as,

Table 2 Carrier to noise ratio of Parameters

CARRIER TO NOISE RATIO	Reference satellite Model	CUCKOO SEARCH
Uplink (dB)	104.8	151.600
Downlink (dB)	84.6	151.438
Total (dB)	85.4	149.506

The simulation is performed for the design parameters and comparison table is formed below.

Table 3 Comparison between PSO and CUCKOO Design Parameters

DESIGN PARAMETERS	RANGES	CUCKOO SEARCH-OPTIMIZED VALUE
Uplink frequency	5.8-6.9 GHZ	6.75 Ghz
Downlink frequency	3.7-4.3 GHZ	4.2 Ghz
Earth transmit power	25-30 dB	28.40 dB
Earth transmit antenna efficiency	55-75 %	62.04%

Earth receive antenna efficiency	55-75 %	66.90 %
Earth transmit antenna diameter	2.6- 4.6 m	3.22 m
Earth receive antenna diameter	2.6-4.6 m	4.11 m

V. CONCLUSION

In this research, an efficient optimization technique, cuckoo search algorithm is proposed for providing the best optimized link value in satellite communications. The result is simulated for uplink frequency, downlink frequency, antenna transmit efficiency etc. This algorithm gives the best carrier to noise ratio in all the earth stations including overall satellite communication systems and the evaluated results for different design parameters are more effective in terms of data transmission.

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