Innovative Systems for Enhancing Heterogeneous Networks Connectivity in Isolated Areas

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Abstract—*Areas affected by disasters prompted numerous countries to contemplate carefully to find effective means to decrease effects incident.In Fact the conventional methods have failed to achieve the desired goal. This paper provides an innovative approach system which enhances network communication and has the ability to provide the technical feasibility of a joint fiber-wireless (Fi-Wi) and free space optic (FSO) system utilizing aerial altitude platform system (AAPS). Nevertheless, this proposed technique is not free of obstacles specifically, when encountered high winds in low levels of the ground, a challenge due to the loss of the line of sight (LoS) between network deployment nodes. A smart communication platform system (SCPS) to overcome these constraints and to establish the ability to deploy sky meshes networks. In this research,Performance test results of the system showed the new approach that provides further reliability in the transmission single through the use of the compact of RF and FSO. In addition, the inventive technique design will improve the broadband propagation and reconnecting the affected areas.*

Keywords— Aerial altitude platform , free space optics (FSO), fiber-Wireless (Fi-Wi), disasters area, smart communication platform system (SCPS), Fiber-Optic Connection.

1.Introduction

Reliability assessment for communication approaches used in disaster's area; depend on the whether it achieved its objectives or not. The real challenge that faced disaster management operations centres is that the disaster area will lose most of the information

& communication technology ingredients due to the station and transmission towers damage between network deployments. A disaster information system by ballooned wireless Network can be employment [1].Current situation requires re-linking the area with the main network nods; utilizing aerial altitude platform stations (AAPs). Our research to address these challenges, but this solution also is not without obstacles, especially when facing strong winds that caused the lack of stability of communications systems that installed in the aerial platform balloon payload. According to Hariyanto, for the Emergency Broadband Access Network Using Low Altitude platform (EBAN), one of the challenges that the EBAN project faced was the problem in fluctuation of the balloon with winds [2], a challenge that impedes network deployment due to loss of the LoS. A Smart Communication Platform system (SCPS) bases station as a sky-tower proposed to overcome the limitations imposed as well as to its ability to deploy networks for a wide range. Case requires a high quality of service (QoS) to address the disaster-recovery scenario. Quality services that obtained by integrating FSO system with SCPS to intensification the transmission's bandwidth in the 'last mile' of the node's deployment. Figure.1 it shows the system t topology proposed in this research.

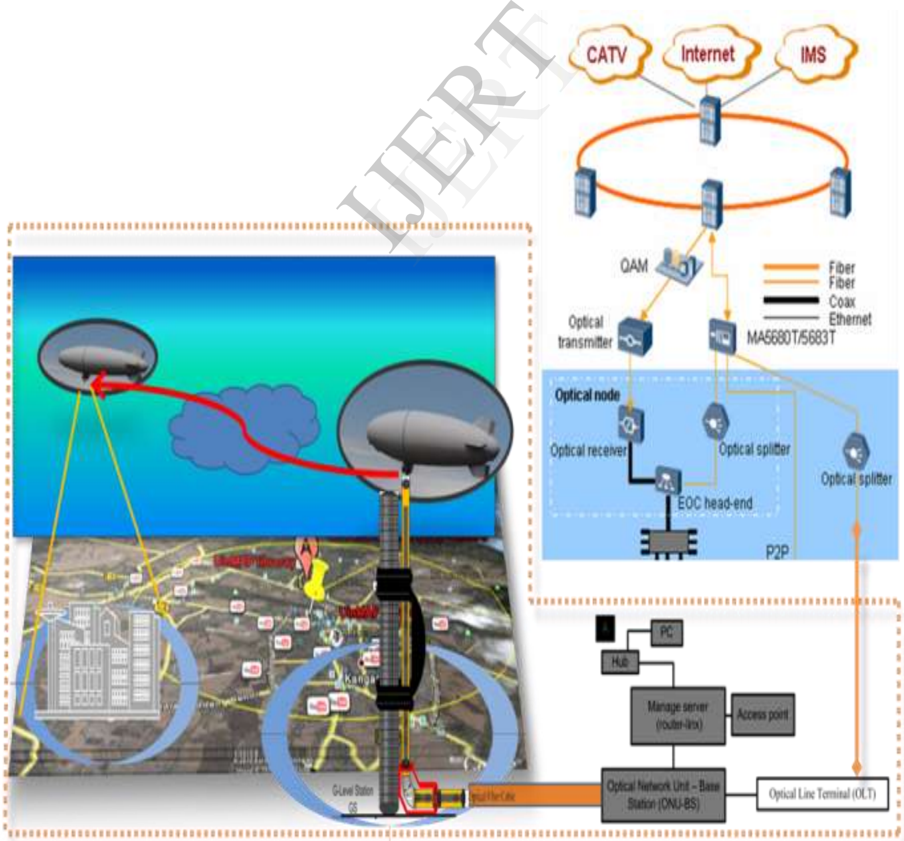

Figure1. Aerial Altitude Platform System (AAPs) Scenario Topology

2.Network Architecture Design

A. *smart communication platform system (SCPS) design*

SCPS is an integrated system that comprises the essential apparatus to be attached in the aerial altitude platform (tethered balloons); this system is characterized as a light in weight, low in cost, and capable of sense external environment changes (self–direction) according to the changes surrounding it. Figure.2 it designated the SCPS design that is used in the AAPS. For the explanation of SCPS innovation embodiments, description of all Ingredients is numbered according to Figure.2. Symbol N refers to the transparent plastic ball that outside the SCPS body and it's around it, for protection. The solar cells L1, 2 are fixed on the N. The platform box D2 comprising the control boards at the top level of the SCPS. The Global Positioning System (GPS) B2 is a space-based system that provides reliable location and time information for AAPS. GPS sensors with the board shield E3 has been linked to the micro controller A1, Embedded system hardware, I and personal computer memory card international (PCMCIA)– WAN I1 and LAN I2. Figure.5 It illustrates the dynamic part of the sub-platform with 3-motors C, which is designed to receive the signal that has been sent by the micro controller, thus to organize the movement of the communication system that provides [(IEEE 802. 11a in 5.8 GHz), (IEEE 802.11 b/g in 2.4 GHz)] and FSO which has been installed on the platform; clarify the mechanism of the FSO performance will be discussed in detail. The IP camera system G1 installed with D1 for the surveillance area. The control system for solar cell's L, which fixed inside the D2, the charger battery K1, K 2 is fixed too outside the D2 and inside the N. The Parts of a dynamics platform D1, was installed on the predicate link P, to link the SCPS with the N, the alarm lamp M1, 2 are fixed outside N.Robs rings Q to tie N to the balloons. To transform the impact of environmental factors, which affecting on the system stability; E1 is a 3-axis accelerometer is used [3] and is fixed to the D1 to interact with the outside forces' vector (R). The R vector can be measured by the accelerometer, to calculate the coordinate of SCPS, i.e., R x, R y, R z projection of the R vector on the XYZ plane. The R position for SCPS that the accelerometer value measures are sent to a gyroscope via the micro controller that is compatible to work with the sensor was used. The 3-axis gyroscope E2 is a device for maintaining the orientation based on the principles of the conservation of angular momentum.

The coordinates of the SCPS position are sent to the gyroscope to be rotated responding to that change, the gyroscope output data is processed by the micro controller, and then the signal is sent to motors; to correct the SCPS direction.

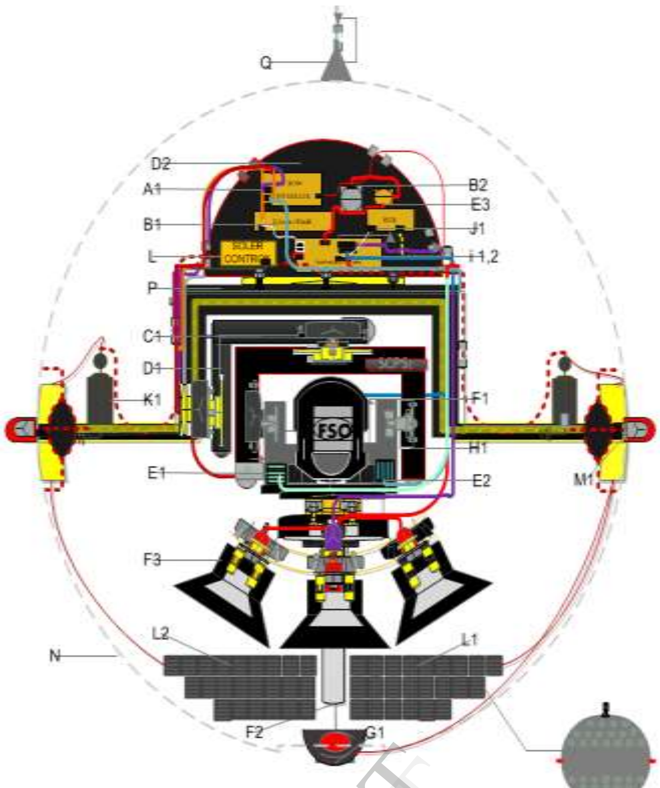

Figure2. Smart Communication Platform System (SCPS)

For converting the external sensing of the event, C programming language was used to translate the signal from the sensing system to a micro controller. Figure 3 describes the mechanism procedures of the smart communication system control (SCSC) that was used in the SCPS units. More detail can be found in our previous research [4].

Our Research was to use a two-node platform, i.e., 1) the main stage sky station1 (SS1) as the root node (RN). 2) The second node sky station two (SS2) to receive the signal transmitted from the RN; deployment architecture requires a LoS between the nodes, so that the data packets reach their destination. The deployment mechanism is the correlation point between the ground station (GS) and the nodes in the low level of deploymentwere used the following strategy:

1) *Radio frequency (RF) Cycle: the ground station (GS) connects to RN via the IEEE 802.11a an .In second step, the RN is linked to the RN via RF and all nods provide coverage isolated area by utilizing the IEEE802.11.b/g/n standard.*

2) *Optical cycle: the RN connects to SS2 through a FSO channel to increase the quality of service.*

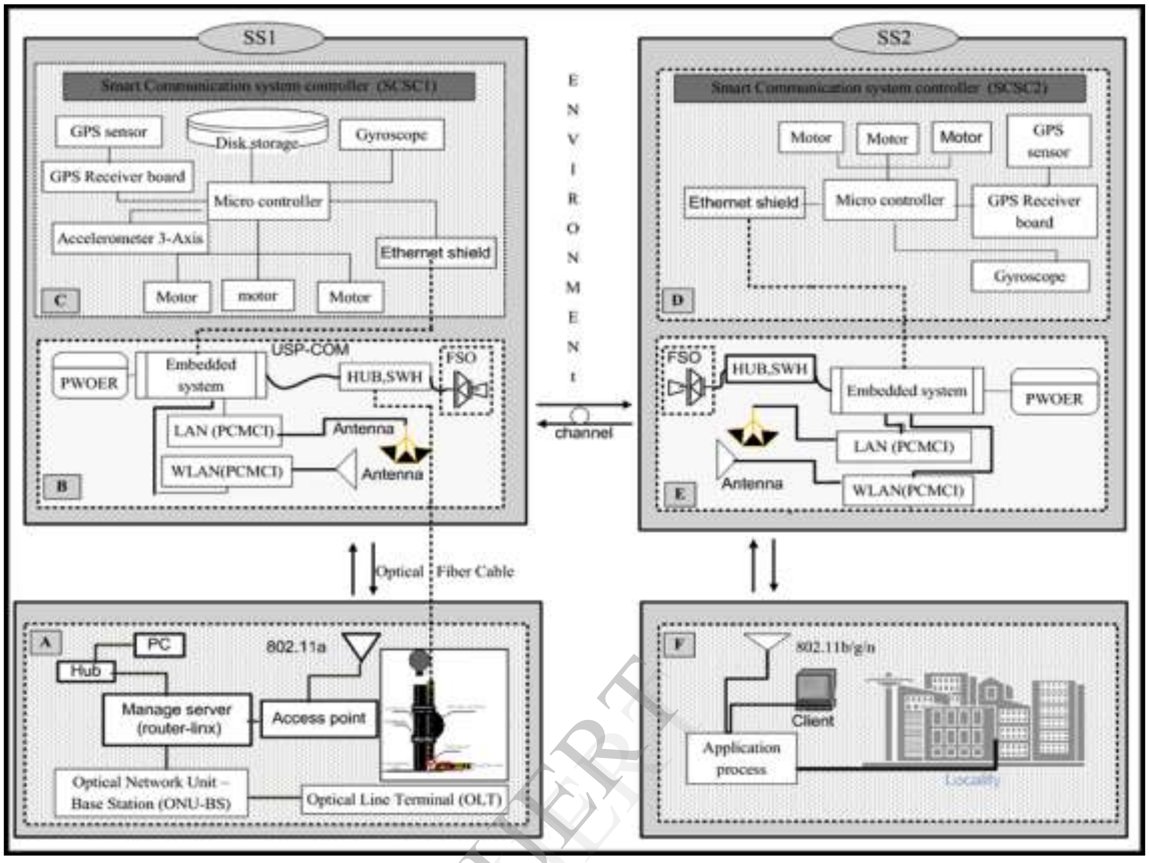

Figure.3 Network Architecture Design

Figure3. (A) Shows ground station, as the source that feeds the sky-network service, (B) and (C) illustrateSS1payload, section (D) and (E) which represents the payload of SS2, and F section shows the End-System.

B. free space optic (FSO) design

Free-space optics have emerged as a promising technology for next-generation, wireless, broadband networks [5][6].In free space network propagation, the process requires a correct directional path between network nodes, particularly in a mobile platform's issue to achieve LoS, for this cause SCPS necessity achieves the stability for the transmitter and receiver systems such as FSO system. FSO has a specific characteristic is the deviation angle limits. These limits cannot be ignored because it causing disrupted contact between both sides of the FSO link. According to the previous researches were to 0.45 mrad is the minimum acceptable angle of beam deviation that can be used, thus necessity of SCPS system control achieves the constancy for the platform within this limits requirement to ensure the LoS between the two FSO channels. This point is the focus of this paper.

To achieve the best results from the control system and guidance that return to SCPS requires evaluating the communications systems performance on the both platform side's nodes. The Bi-directional FSO transmission and receiving system requires a fundamental prerequisite is a LoS between both sides.

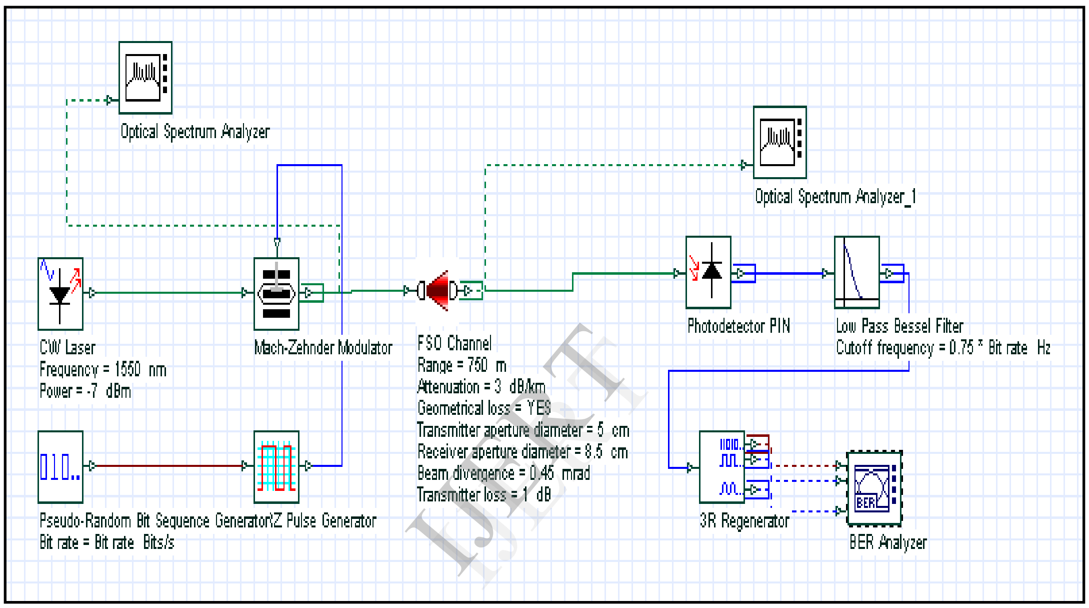

Figure.4 Essential components used in building the FSO system

One of the sensitive matters to be observed when using the FSO is a beam-divergence angle, especially when the FSO used and set up on a mobile platform because it is designed to work on fixed platforms.

In order to resolve this issue, The SCPS was designed to perform optical alignment of the fiber-optics modules by steering a beam to maintain the streaming of the data flow as well as to preserve the acceptable bit error rate (BER).

Figure.4 it shows the essential concept and the devices that were used to design the bi-directional system between SCPS in SS1 and SS2 using optical simulator software *"Optisystem™"*. The transmission part of SCPS-1in SS1 includes a pseudo-random bit generator, and non-return-to-zero (NRZ) pulse generator, a continuous wave (CW) laser diode, and a Mach-Zehnder Modulator, while the avalanche photo diode (PIN) and low-pass Gaussian filter were used in the receiver part of a SS2 propagate. The parameters of the FSO system were set according to the typical industry values in order to simulate a real-world environment as closely as possible. As was the case of the study described in [7], this approach provided reliable and secure, point-to-point connectivity.

Based on Table 1, the aperture angle between both SCPS nodes was simulated using the optical simulator; channel connectivity parameters that were used between two networks FSO nodes illustrated in Table 1.

The quality of the received signal depends significantly on the conditions of the free-space channel and the stability of the system. It is important to note that studies have been conducted in which a range of deviation angles was used to examine the performance of the SCPS and to achieve the maximum range of operation.

TABLE IParameters of the FSO Channel

Attenuation for Clear Weather	3 db/km
Diameter of the Aperture Receiver	8.5 cm
Diameter of the Aperture Transmitter	5 cm
Transmitter-Receive/ loss	1dB
Transmission power	-7 db
Frequency	1550 nm
Divergences Angle / Values	0.45 mrad
Low pass filter rate	0.75 * Bit rate

In order to determine and track the communication system performance and ensure that the system can revise the angle deviation located in the permitted range, A model design was applied in MATLAB environment accordance to the guidance and control system that shown in Figure 3.

3.Outputs and results

To evaluating the SCPS performance requires the following procedures:

Step I: *Find the acceptable limit of the deviation angle that could be handled by the FSO; this condition will use the range of the deviation angles until reached the major proportion of the BER close to the10e-9 [8].*

Step II: *According to the consequences become from step 1 for FSO channel configuration in "Optisysm™" adopt the angle to get the wider range of transmission*

Step III: *From all above the expected results will be used to inspect the SCPS performance.*

To scrutinize signals which received via BER analyzer that is used in *"Optisysm™",* the visualizer permits the user to demonstration BER an electrical signal automatically.

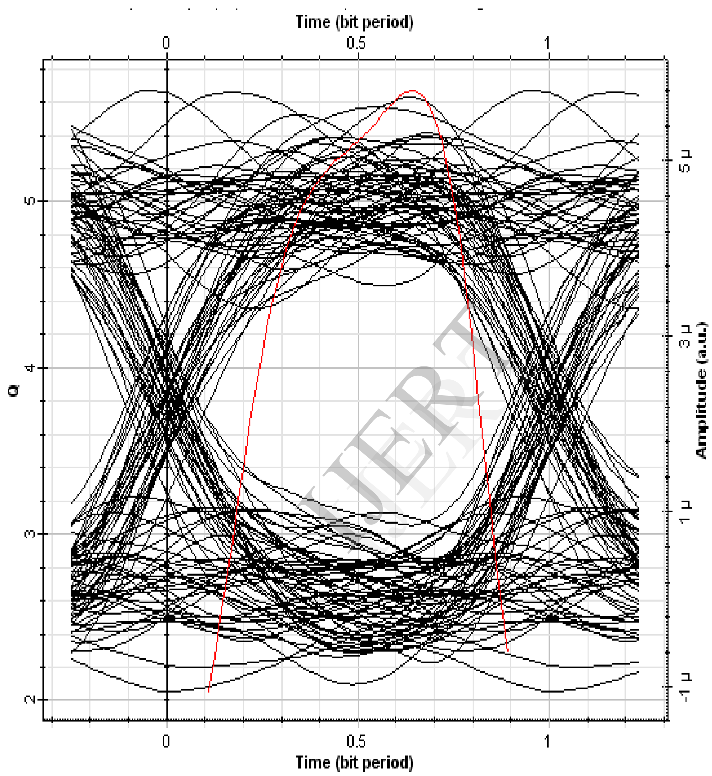

Figure.5.Min BER: At 750 m.

Figure 5 illustrate the BER in the eye time window; the eye pattern is a technique that provides an aggregation of signal measurement information, a narrow aperture eye pattern, which leads to more difficulties in differentiating between the (1) and (0) in the signal, and which assistances to assess the quality of the received signal. For analysis the results, should focus on the jitter deformation in eye window receive signal.

TABLE2. Angel Deflection at 1 mrad

Max. Q Factor	5.66932
Min. BER	7.16277e-009
Eye Height	2.13685e-006
Threshold	2.21283e-006
Decision Inst.	0.640625

Table 2 shows the correlation between beam divergence angles vs. minimum BER; therefore, any increase in divergence angle value, on the other hand, causes an increase in the BER. Thus, it can be concluded that the value of 0.45 mrad is considered the minimum acceptable angle of beam deviation that can be adopted to test the efficiency of the SCPS. According to the results of previous research in [4] that the maximum range which can be obtained is 465 meters, in this experimentation the design model developed by increasing transmission power of FSO sender part and frequency rate while keeping the divergences angle valueswithout change according to the parameters of table 2, thus increasing the range of transmission to 750 meters with an acceptable BER.

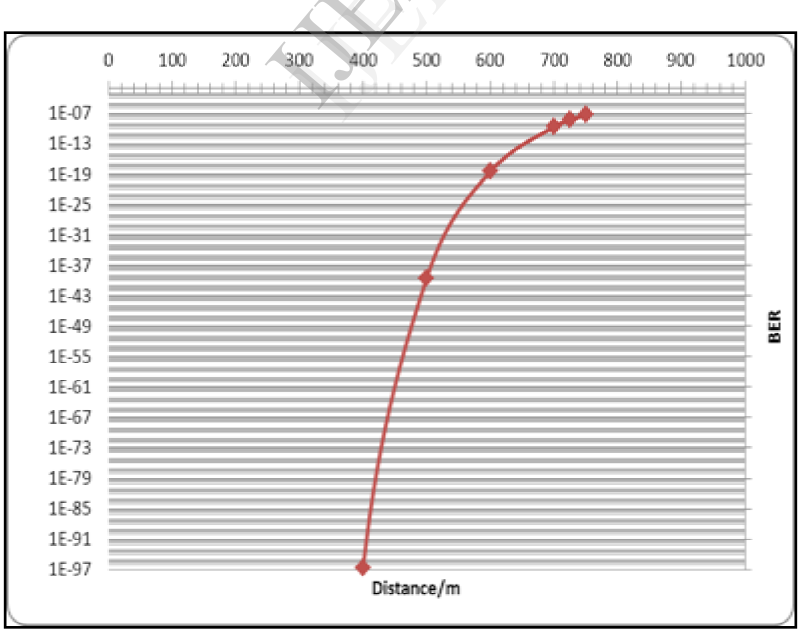

Figure.6.transmission distance limit

By the results found that the increase in the range transmission enhances network deployment and connectivity with other network nodes. Figure.6 illustrates FSO channel extension. Correlation between the components of the FSO channel determine the distance between both sides of the transmission system , under this concept has been determining the maximum transmission deployment range simultaneously with the minimum permissible BER.

In order to verify previous concepts, the results are extracted through the previous step, which in turn determines the SCPS efficiency performance in the third step. Figure.6 characterizes the verification of the stability performance; this Figure presents a model for the real-time experiment using Real-Time Workspace, which is provided with the MATLAB environment. In order to control the SCPS attitude, it is necessary to know the behavior of the SCPS guidance and stability. Specifically, we need to know the system's reaction to each direction change when supplied with changing angle. The angle was established in initial testing to be nearly identical to the change of direction for SCPS, which is a result of the impact of external factors and will be affected by the winds.

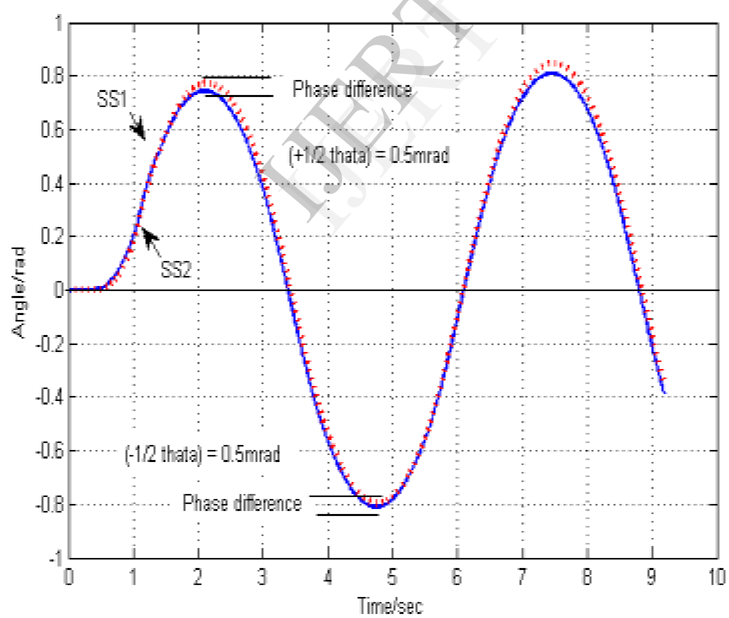

Figure7. Behaviour of the Two Systems

Figure.7 illustrates how the SCPS reduces the gap between its current position and the successive deviation angle, which changes according to the factor influencing movement input.

The output of the SCPS1 procedure algorithm will characterize as the first sine wave in Figure 6; SCPS1 sends its current position to the second node. In this case, SCPS2 is modifying the direction of the deviation angle for its current location based on new entries that were sent from SCPS1. The mechanism SCSC2 algorithm shown in Figure 3 enabled SCPS2 to modify its direction and track the movement of SCPS1 continuously. This behavior of procedure appears in the second wave signal of the same Figure.

Figure.8 close-up of Figure.7 shows the time logarithm within first two seconds. Phase difference is the amount of deviation between the two systems attributed to the LoS, thus systems must address the situation before the exceeded the limitless condition of beam deviation angle.According to research the unacceptable motion of the system should be θ angle which it not exceeded to 0.45mrad should θ angle be not exceeded 0.45mrad that mean (±1/2 θ) =0.21mrad because this ratio exceeded will lead to increasing the ratio of BER more 1 x10^{-9} where this value is not acceptable.

To evaluate system performance, we focus on the phase difference between the response systems, which have been highlighted as Figure.8 .Clearly shows that the control system responds to both systems located within the limits of the permissible deviation angle, therefore this is evidence that the FSO system that is installed on SCPS able to achieve line of sight between the two nodes.

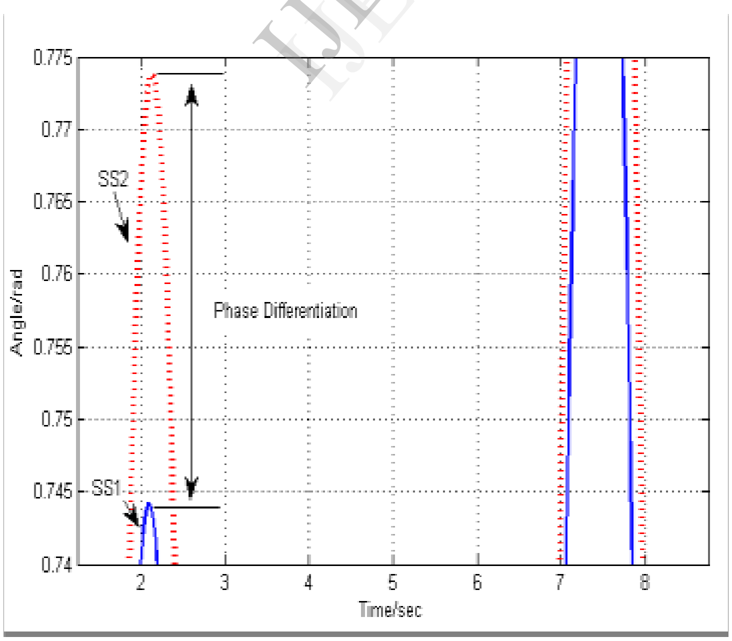

Figure8. Phase difference Between Two Systems

4.CONCLUSION

This study aimed at finding the best approach to enhance communications network in isolated areas, using AAPS to avoid destruction happening in equipment and communications towers. On the other hand, use SCPS for communications systems stabilizing and promote high-quality broadcasting's service through a system of FSO.In this research has been increasing the broadcast rangebetween network nodes.Development mechanism of FSO performance made it possible to strengthen the service to wider ranges thus resolving the congestion problematic of isolated areas.

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