

# Efforts To Overcome The Existing Impairments In Implementing Helicopter Satellite Communication System (HSCS)

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## **Abstract**

*Communication can be broadly classified as analog and digital. These two types only deal with terrestrial networks. But, when we want communication to be achieved with very high efficiency it is very much essential to deal with satellites. Satellite Communication is becoming more advantageous day by day. Almost in all the areas, the importance of satellite communication is being recognized. The role of satellite communication in the disaster management has played an important role these days. This has gained very high popularity because of the failure or delay of the organization to detect the disaster at the right time. Satellite communication is generally useful for information gathering during the disaster [1]. Helicopters are used in the satellite communication technology and this technique is called as Helicopter Satellite Communication System (HSCS). There are few technical issues existing in this system too. Thus to overcome these issues and make it more efficient many schemes have been implemented. One such scheme is hybrid modulation with Automatic Frequency Control (AFC). [2]*

## **1. Introduction**

Communication is the most important part of our daily life. Not only owing to one's life, communication also plays a major role when it comes to avionics. Avionics is the science which deals with aircrafts and rotorcrafts. Helicopter is the most important rotorcraft which is used in Indian Army, Navy and Air force. Hence communication is very much important between the crew members of the helicopter as well as the pilots of other helicopters. Thus to facilitate such communication, Analog Communication System was introduced. Analog Intercommunication System provides the direct mode of communication. The problems associated with the analog system are, deformation and the loss appearing in the signal and the proper control over the audio, that is, its volume and frequencies were not taken care of. Thus to overcome these problems, Digital Intercommunication System was introduced. Digital intercommunication system provides reliability and resistance against tightly packed voice signals. It also provides the communication of data from air to air, air to ground and ground to air using high frequency technologies such as Very High Frequency and Ultra High Frequency. The foremost aim of the Digital Intercommunication System is providing two way communication amidst the crew members (pilot and co-pilot) in the flight or helicopter (any aircraft or rotorcraft). In addition to this, the system has the provision to communicate the signals to the crew members at the ground station using a jack externally during the sustentation operations at any time necessary. This system is a chief control for all the communication equipment established on the Advanced Light

Helicopter. The Digital Intercom System connects itself with the various radio channels, warnings and other types of audio outputs. This system also provides the provision to communicate with the pilot and co-pilot of the same or different helicopters, and also with the Air Traffic Controller (ATC). [3] There were some of the problems associated with Digital Communication Systems too. Thus replacement of this old technology communication with Helicopter Satellite Communication is done in the recent years. Helicopter Satellite Communication plays a vital role in today's world because; helicopters are not just limited to one specific application. The Helicopters are used over a large area covering a wide range. They are used to acquire the information and broadcast the same in the cases of incidents such as disasters which take place over a large scale and also in the case of other emergencies. According to the present day scenario, the repeater stations are widely used to transfer the information such as video clippings and the photographs captured by the helicopter. Capturing of the videos using the helicopter is one of the best methods to obtain on scene information for relief and the management of disaster. [4].

There are few technical issues in this system. Many solutions are being provided to overcome these issues and declare the Helicopter Satellite Communication System (HSCS) as the best technique to provide communication using Helicopters.

## **2. Predicaments Associated With The Digital Communication System**

The high requirement of bandwidth is the major problem in these systems. The proportion or the amount of information which can be transmitted per unit time depends on the bandwidth of the media usually used in the respective transmission. The analog systems have less requirement of bandwidth when compared to the digital systems. This is because, the digital signals, for example, the square pulse, delta function and many other digital signals, have many rising and falling pulses. These pulses have a lot of variation in their voltages within a very small amount of time. Thus we can say that, almost within a very few milliseconds, there will be a huge variation in its voltage. Because of this reason, these signals have very high frequency during their rise and fall. As the frequency increases, bandwidth also increases. Thus they occupy very large bandwidth. High power consumption is also a major issue in digital systems. The digital circuits consume a lot of power. This can be proved by the power dissipation in integrated circuits that is, in digital VLSI (Very Large Scale Integration). With regard to the integrated circuits, three major causes for the large power utilization are given by- utilization of the power dynamically, utilization of the power statically and utilization of the power in the short circuit. Improvement or rise in the power density and fall in the hardware measurements of the transistor are the stamp of authentication of the present day computer chips. Both of these technologies are increasing the thermal conductivity management challenge inside the chip and the package surrounding it. Both of these technologies are increasing the thermal conductivity management challenge inside the chip and the package surrounding it, as well as escalating research related progress on the materials which possess very high conductivity. The management of the thermal conductivity is largely acknowledged as an important characteristic of the computer design, due to which, the temperature significantly affects the performance of the device. Adding on to this, the lifetime of the device can be reduced extremely because of the excess thermal stresses which take place at the interfaces. [5]. Hardware complexity in the digital systems is another hurdle for the communication. The logic gates serve as an important factor in the designing of a digital circuit. These circuits put together manifest a digital system. The major problem while designing any kind of digital circuit is the hardware complexity of that circuit. When the concept of conventional gate logic is adopted in the design of the digital circuit, then the utilization of more number of components is the major challenge which it has to face. Thus these systems have more complex circuitry and require a sophisticated device making. [6]. The digital systems can be easily broken or damaged, that is, even if a small amount of digital data is unable to be recovered or if it is not interpreted exactly, the meaning of the large amount of data can change completely.

## **3. Role of Satellite Communication For Disaster Management**

Whenever the earthbound communication resources are inadequate it means that there is a huge damage caused to the infrastructure or it can also be due to the enormous traffic. Hence we cannot depend entirely on the earthbound or the terrestrial communications for the disaster management operations. And it is also essential that for the disaster management operations the communication should be very flexible and reliable as it is the part of emergency communications. Thus everyone who desires to have such type of communications is able to experience perfect working of the communication system every time and everywhere under any circumstances. Furthermore, the broadband communications have been playing an important role in increasing the communications during the emergencies. By considering the radio links as a basis, the systems which are based on the satellites have a lot of benefits which include reliability, availability, robustness, quickness, deploy ability and accessibility from any location. The Satellite Communication System is a core network which is used for disaster management and its recovery which includes the topology of the satellite network, configuration of service and also for the technical applications. The communication provides the favorable path for managing the critical situations such as occurrence of the disaster and also helps to provide relief during these emergency situations. [7]

#### **4. The Satellite Communication System Employing Helicopters**

##### **5. How Exactly The System Looks Like?**

The continuous prevention of the radio waves being reached to the destination in the Helicopter and Satellite Communication is mainly due to the blades of the Helicopter. These helicopter blades intervene or interrupt the helicopter directly by communicating with the satellite in order to check whether the antenna is situated right under the blade of the helicopter. The time break is about 6.93 milliseconds and the amount of interception taking place is for 39.1 milliseconds. By picturing the case of the helicopter transmission, the system which usually transmits at the exact time of the blade has to be designed and this is considered to be an alternative to solve this complicated issue. [4]

##### **6. The Designing Requirements For Helicopter Satellite Communication System**

While designing the system based on Satellite Communication and Helicopter, the most important conditions to be followed were; 1. The system which has to be designed must be very small in size; 2. The system to be designed should not be bulky and heavy, instead light weight is preferred; 3. A very effective link must be established between a helicopter and the satellite for the communication to take place, and it should be irrespective of the helicopter direction; 4. The power due to transmission should not harm the pilot, co-pilot and other crew members; 5. The transmitting power should be maintained such that it should not prevent the radio waves reaching the destination due to the blockages in the rotor blade; 6. The video capturing objectives must be based on the positioning function. [4]

##### **7. Technical Issues Ceasing To Implement The System**

- Avoidance of the shadowing due to rotor blades;
- Satellite tracking;
- Polarization tracking;
- Avoidance of interference with other satellites [1]

##### **8. Helicopter Videoing**

The technique of capturing the video using helicopter is the most popular method to obtain the information for emergency communications such as disaster management. A new system has been developed which captures the information related to the disaster and immediately accounts for the transmission of this information. Such a system is called as Ku band utilization in the satellite communication with helicopter. As we have already discussed about the major issue in such type of communications, that is, interruption due to rotor blades of the helicopter, there are techniques proposed to overcome these drawbacks. These techniques are called as time diversity transmission technique which is applicable in the forward link, and the other technique namely blade synchronized transmission technique which can be applied at the return link. The estimation of the position is also implemented for on scene videoing pictures. [8]

## 9. Techniques To Improve The Efficiency of Hscs

In this system, there exists two major issues and they have to be addressed properly; 1. Rotor blades of the helicopter is the major part which is leading to the blockage of the received signal; 2. The Doppler Shift in the system which accounts for the fluctuation of the carrier frequency. New techniques have been proposed to overcome these two drawbacks. There were many other techniques which were implemented to overcome these issues; but they were inefficient. The continuous blockage of the signal received can be cancelled by using a hybrid modulation scheme with Automatic Frequency Control (AFC). This technique is better when compared to the use of former diversity technique based on time, as this increases the amount of data transmitted per unit time; whereas AFC transmits the original amount of data per unit time. [2]. Most of the communications in the helicopter are handled by a radio which operates in very high frequency range and it has the limits such as its coverage area and the range at which it can operate. As the amount of area occupied by the relay station which is established on the ground is only around 40km (radius), there is a huge requirement for many numbers of such stations to be established. If we consider an idea of establishing relay stations, it doesn't work out in the areas covered completely with mountains or sea. Thus to overcome all these geographical limitations, the satellite itself is made as a relay station in this system. Whenever the helicopter is outside the terrestrial frequency range, the pilot operations must be undertaken with a very high efficiency because even it includes the satellite communication with the Air Traffic Controller. [2]

This system which is based on Satellite and Helicopter comprises of the two important stations; one at the ground and one at the helicopter. Communication between the two stations is considered to be bidirectional and it can be achieved using a transponder. The transmission link is established between these two stations, that is forward and reverse link. The location of the Antenna should be such that it should not interfere with the rotor blades of the helicopter. It would be considered the best way if it is situated at the tail of the helicopter. Some of the experiments have proven that, as the antenna is located at a large distance from the main rotor blades, then the amount of interruption of signal with the blades would be avoided. [2]

Establishing a system which communicates using the satellite technology with a helicopter is a tedious task, because the rotor blades of the helicopter is the major obstruction in such systems, as this leads to the Doppler shift. Thus because of these major impairments, many applications such as Global Positioning System, degradation in the performance of bit error rate and the discontinuity in the received signal over the recovered carrier. [2]

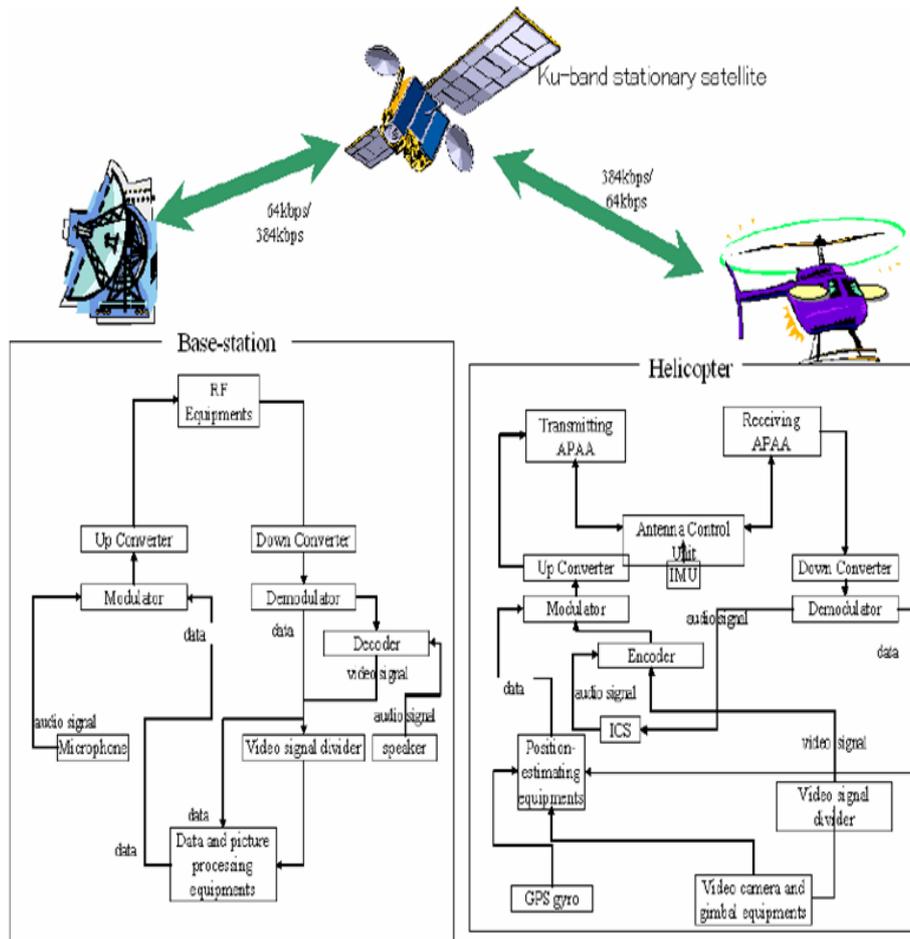
## 10. Results And Discussions

The transmission from the helicopter can automatically stop when 1. The tracking error angle becomes large 2. The receiving level becomes below the limited value 3. The posture of the helicopter inclines beyond the anticipation 4. The onboard equipment fails. The final flight test included the following ventures.

- Verification of the satellite tracking performance
- Measurement of the communication quality

- Operation check of transmission protection
- Picture transmission and position fixing. [1]

The parameters of simulation in order to calculate BER is given below:



**Figure1. Diagram showcasing how exactly the communication takes place by adopting the Principles of satellite communication in the Helicopter**

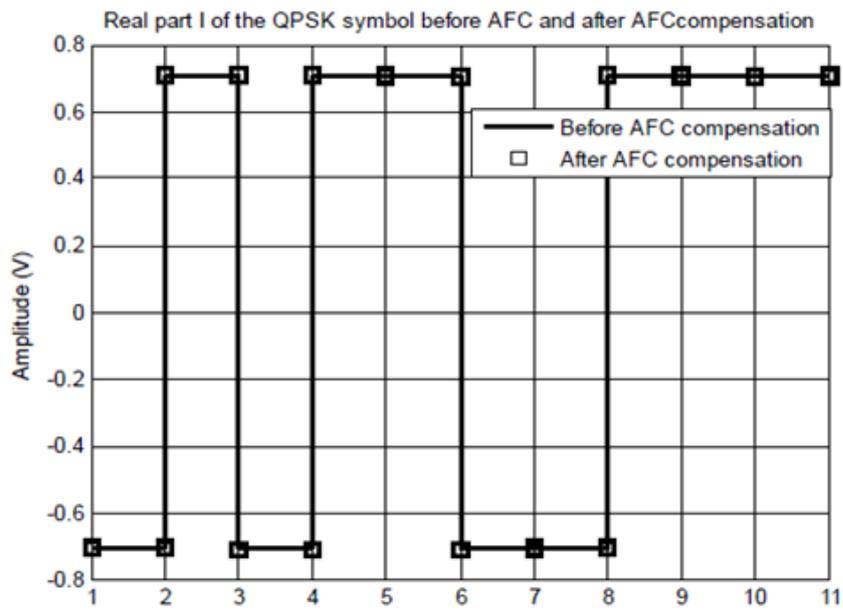


Figure 2 Phase symbol before and after AFC

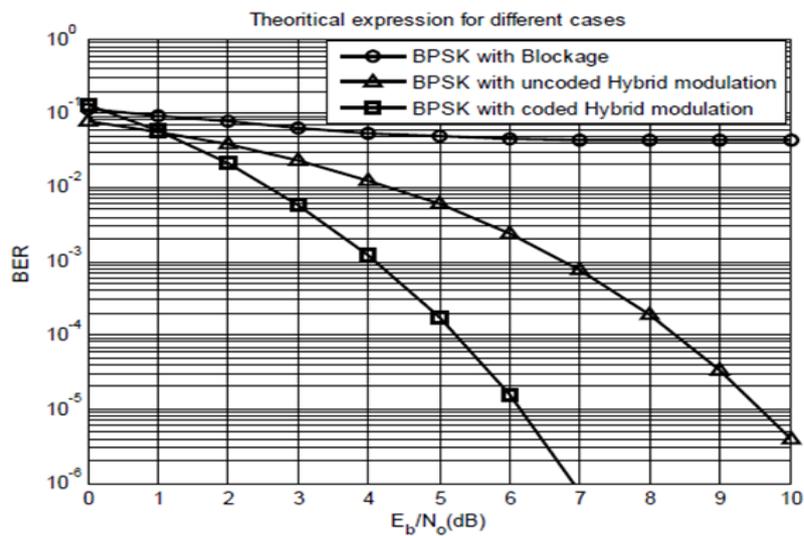


Figure 3 BER behavior for different schemes

Table

I	
<b>Helicopter</b>	
Rotor revolutions	$\omega = 6.45 \text{ rev/s (387 rev/min)}$
Blades	$M = 4$
Maximum speed	$V = 68.4 \text{ m/s (246km/hour)}$
Maximum acceleration	$A = 3.09 \text{ m/s}^2 \text{ (11.1km/hour/s)}$
<b>Modem</b>	
Modulation	BPSK with time diversity
Time diversity factor	$L = 2$
Information data rate	$R_b = 3600 \text{ bit/s}$
Carrier frequency	$f_c = 12.5 \text{ GHz}$
Demodulation	Coherent detection
<b>Forward error correction</b>	
Code	Convolutional code with
Viterbi decoding	
Rate	$R = 1/2$
Constraint length	$K = 7$

## 11. CONCLUSION

The difficulties in analog as well as digital communication systems led to the development of new technology in communication era which is called as Helicopter Satellite Communication System (HSCS). Thus the helicopter satellite system was developed successfully and it was also demonstrated for the first time. The key technologies of the HSCS for disaster control operations were experimentally demonstrated. The developed HSCS system provides a real time information collection and transmission directly via a satellite. Research and Development aiming at small-size, light-weight and wide-band HSCS is proceeding. Continuous research and development collaborated with disaster management bodies will be carried out. [1] This paper concludes that the Helicopter Satellite Communication system is one of the best ways to realize communication. A novel modulation scheme based on hybrid techniques for the accurate cancellation of the periodic or continuous blockage in Helicopter Satellite Communication System is implemented instead of conventional time diversity scheme. The proposed AFC scheme incorporates adaptive modulation in an efficient way. The traditional time diversity scheme increases the transmission bit rate to reduce errors, but in the novel AFC scheme, similar type of signal is made to transmit just by changing the number of time slots. [2]

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