INVESTIGATION OF THE EFFECT OF TEMPERATURE AND HUMIDITY ON THE TRANSMISSION OF RADIO WAVES

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1. ABSTRACT

Radio waves are generated by a transmitter and detected by a receiver which operate over a range of frequencies. Radio waves are usually transmitted across 2 different locations over a large distance and hence the outdoor weather conditions may affect the transmission of radio waves, due to temperature. This paper aims to observe the relationship of temperature against the efficiency of transmitting radio waves across a distance. This will also study the effects of temperature on radio waves or what type of radio waves are transmitted most efficiently in a certain temperature to mitigate any major problems in real life contexts when important and classified information is transmitted.

HYPOTHESES

Hypothesis 1: The higher the temperature, the stronger the transmission of radio waves
Hypothesis 2: The lower the humidity, the stronger the transmission of radio waves
Hypothesis 3: Experiment conducted at a greater distance will have the same result as with shorter distance

2. PROCEDURE

Procedure for temperature and humidity

1. For temperature, use the measuring tape to measure 50m and Place radio antenna 50m away from the transmitter, both on ground level
2. For humidity, use the measuring tape to measure 3m in a room and place antenna 3m away from transmitter, both on ground level
3. Use the thermohydrometer to check the temperature and humidity of the area
4. For 1 Min, use the transmitter to transmit radio waves with a frequency of 145.00kHz
5. Use software cubicSOIR to measure the signal strength for 145.00kHz radio waves
6. Use the record function in cubicSOIR to have a audio file of the 1 min process
7. For Temp, Repeat step 1-5 with different temperature (by taking data sets at different times of the day) and ensure humidity level is the relatively the same (50-52%)
8. For Humidity, Repeat step 1-5 with different humidity (by using a mist diffuser in the room) and ensure temperature is the same (by adjusting aircon temp)

Data analysis

1. Calculate the average power (P) in dBm by taking the average of the 3 readings
2. Calculate power in W by using the formula $P = P_{dBm} - 10 \times \log_{10}(P_{dBm} / 1000) - 10 \times \log_{10}(P_{dBm} / 30) / 10$
3. Calculate 1/P by taking the reciprocal
4. From the formula $P = P_{dBm} - 10 \times \log_{10}(P_{dBm} / 1000) - 10 \times \log_{10}(P_{dBm} / 30) / 10$
Where $P$ = Power, $K$ = Constant, $T$ = Temperature, $Pr$ = Atmospheric Pressure, $H$ = Relative humidity
Therefore now we can plot a graph of 1/P against T and 1/P against H

4. DISCUSSION + EXPLANATION

From the results above, firstly it shows that the greater the temperature, the weaker the transmission of the radio waves, which is agreeable to the research done by the University of Jyvaskyla, Kokkola University Consortium Chydenius. Next it also shows that the greater the humidity percentage in the air, the weaker the transmission of the radio waves. This differs from the research done by the University of Jyvaskyla, Kokkola University Consortium Chydenius which states humidity has a very low impact on transmission of radio waves. According to a combined research paper by Universities from Germany, UK, Netherlands and Sweden, higher temperature increases the refractive index of a medium, therefore this means that for a voltage, a higher temperature will reduce the current and the power of the device. Therefore for radio transceivers, it means that a rise in temperature will reduce the signal to noise ratio (SNR). The decrease in the signal to noise ratio leads to lower and shorter link quality. This causes lower throughput, higher delay and weaker transmission. Moreover, warmer air is found near the surface of the earth. If the transmitting antenna extend into a duct of cool air, the radio waves enters at a low angle, and the radio signals are absorbed by the water molecules in the air. Thus, if the relative temperature is lower, it creates a greater difference between the cool and warm air, allowing the signal strength to be stronger.

According to a research done by a Joseph from the University of Calabar, Nigeria, it states that humidity is directly related to pressure. From the results, we see that signal strength is inversely proportional to the humidity percentage in the air. Radio waves is a type of electromagnetic wave and has the same characteristics as light. Hence if a beam of light is directed into a water channel, we will observe that the intensity of the light or strength will decrease as the depth of the water channel increases. This is due to the collision with the water molecules and the increasing pressure and the radio waves are absorbed by the water molecules in the air. Similarly for radio waves, with the increased humidity, it increases the air pressure and increases the number of water molecules in the air, leading to a weaker transmission of radio waves. Therefore the higher the water particulate concentration in the air can cause diffusion, reflection and scattering of radio waves, leading to attenuation.

5. CONCLUSION + APPLICATION

In conclusion, both temperature and humidity have an effect on the transmission of radio waves. Conclusion 1: The temperature is inversely proportional to the strength of radio waves. Conclusion 2: The relative humidity in the air is inversely proportional to the strength of radio waves. Conclusion 3: The distance of experiment does not affect the relationship between temperature and signal strength. Therefore from the information, I conclude that the ideal state for the most efficient transmission of radio waves is at a lower temperature and lower relative humidity in the atmosphere. However, the special observations are that for high humidity and temperature, the results are negative, and that below certain temperature and humidity there is lesser effect. Therefore, only between a certain range of temperature and humidity, will the effects of the efficiency of transmission of radio waves be more prominent.

Firstly, this can be applied to the deployment of internet or radio. The deployment must be considered in view of the temperature and climate. In areas such as Singapore, where humidity and temperature are higher, the effectiveness may be degraded. Therefore this experiment’s conclusion can aid in the development of different protocols concerning transmission of radio waves. Secondly in the development of warehouse storage and inventory systems, the humidity and temperature of the warehouse may affect the range of the signals. As such, these factors have to be considered when constructing and developing these systems. Therefore with this research it allows developers to find which is the most suitable climate for transmitting signals, and even implement new protocols related to network connectivity and management, for more efficient transmitting of information through radio waves.

7. REFERENCES


8. LIMITATION AND FUTURE STUDY

Limitation is that the experiment conducted is done in VHF (Very High Frequency) and may not be applicable for all radio frequencies. Another limitation is that the temperature did fluctuate by around 1 degree during the recording of data, which may have an effect on the results. However to improve, for future studies, I would like to do further research on what other factors affect radio waves such as which frequency is most efficient and transmits the strongest radio waves and if different types of materials will affect the strength of the radio waves and cause most interference. I would also like to try out other frequencies or ranges for future research, to see if the frequency range would cause a difference in the results obtained in this research paper.
