Cost Effective Tri-Band Mobile Phone Jammer for Hospitals Applications

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Abstract—Wireless Telecommunication services are becoming a part of our everyday life because they support a lot of services. However, they are often misused in environments such as hospitals where some patients would require quietness or sometimes they distract medical practitioners from carrying out their duties of saving lives. Therefore, there is a need to use a jammer that prevents mobile phone from working in such an environment. Hence, this paper proposes a cost-effective tri-band mobile phone jammer for hospitals applications. The jammer is designed, constructed, test and found very effective in terms of jamming signal within the bands.

Keywords—Cell Phone, Jammer, Mobile Phone, Hospital

1. Introduction

In the last decade, wireless phones has achieved significant global penetration in both developed and developing countries [1]. They are now becoming an important and essential tool in our day-to-day activities because of their use in communication, entertainment, education, e-commerce, e-banking etc. They are used; to watch videos and play music for entertainment purpose, to access documents and watch online tutorial for learning, to perform online financial transaction and to exchange and disseminate information among others. However, the widespread use of these mobile phones or mobile stations (MSs) presents some problems and could also pose a threat in certain scenarios especially in hospital environments. A number of such cases are when the sound of ringing cell-phones becomes distractive, annoying or disruptive to health workers who are saving lives [2]. A possible preventive measure is to setup and install a device in a place that will regulate or inhibit the using of a cell-phones and render them inactive. Such a device can be a mobile-phone jammer. It can also be called a “GSM jammer”. This can categorize as some electronic devices/system that hinder communication between mobile device and base station [2].

Generally, a cell phone-jammer is a device that block signal from mobile by creating interference such that it prevents transmission and reception power at the certain frequency [3]. They can concurrently jam services in a number of frequency bands, so they could be a dual, tri or quad-bands Jammer which are very effective against intelligent phones that can automatically switch between different frequencies bands when interfered with in a bid to get service connection. Mobile Jammer works by either blocking the uplink transmission of mobiles or by blocking the downlink transmission of Base transceiver stations (BTSs). Either one has same effect of hindering both since the phone would assume a “no service”. This is because it can only receive from one of the frequencies [4]. Less amount of energy is needed to interfere with the signals from the BTS to MSs than the signals from MSs to the BTS, since the BTS is located at a farther distance from where the jammer is than the cell-phone and as such would have a weaker signal compared to that of the cell-phone [1]. Although, power control is possible when weak signal is being received by the MS, however, the Jammer must on the other hand be matches its power to commensurate the increase in the transmitting power of the MS [5]. The jamming cancels out the communication when all the mobiles located in close proximity to where the Jammer device is deployed are effectively blocked and denied access to the cellular network [6]. Early Jammers were initially developed and used by the military in wartimes to disrupt an enemy's communication or send false information in an attempt to mislead an enemy [5]. It is important to note that in most countries of the world, mobile Jammers are unlawful devices and their usage are prohibited, with the exception of law enforcement agencies such as the military and security use. This work therefore, provides a detailed insight into the Design, Construction and Operational analysis of a device that would effectively jam the signal transmitted from MS providing the GSM and WCDA services.

2. RELATED WORKS

Jammers are classified into different types. In this work, we would be focusing on type "A" jammers. This uses the Denial of Service technique. therefore, this section provide an executive summary of the related works in table 1.

Table 1: Related Works

PUBLICATION	LOCATION	COMMENT
P. Naresh, P. R Babu and K. Satyaswathi (2013) [1]	Hyderabad, India.	This design implemented a pre-scheduled timer with a mobile Jammer. When the ON time reaches, the Jammer is activated through a relay and blocks all GSM and CDMA services within a 5 – 7 m range. The device was successfully able to jam cell-phones using these services.
S.K. Mahato and C.Vimala (2014) [3]	Tamil Nadu, India.	The designed Jammer was able to block 2G and 3G services. However, the challenge faced in this work was that the amplification process did not achieve proper output gain to jam the target services due to issues with the power amplifiers. Because of this, their project is partially designed till date.
D.S Madara, E. Ataro, and S. Sitati (2016) [5]	Moi University, Kenya.	The mobile Jammer was able to block cell-phones using 2G and 3G networks. But the jamming device had a poor frequency selectivity and the jamming range was smaller than expected. Also the tuner circuit had poor calibration, this makes difficult to block all frequencies in the applicable bandwidth.
Ahmed Jiswari (2014) [6]	Jordan	The designed Jammer was able to block GSM 900 services. However in this design, the right amount of current was not provided to the VCO and the Power amplifier which consequently prevented tuning to the desired frequency range for the VCO and also limiting the output power of the Jammer. This limited the jamming range to 10 meters instead of the intended 20 meters.
J.G. Martins et al (2016) [8]	Abuja, Nigeria.	The designed dual band GSM Jammer used a directional Yagi-uda antenna

PUBLICATION	LOCATION	COMMENT
		instead of the conventional monopole antenna. The Jammer was able to achieve a maximum jamming distance of 16.72 meters when the antenna is at an angle of 10 degrees and a minimum distance of 3.12 meters at an angle of 120 degrees
A. Mahmoud et al (2015) [9]	Egypt.	Their cell-phone Jammer works in both the GSM 900/1800 bands and tested Egypt. After full testing, a heat sink was later implemented with the RF power amplifiers in this design to reduce overheating during operation.
A.O. Oke, A.S. Falohun and A.A. Adigun (2016) [10]	Oyo, Nigeria.	The designed Jammer used a different jamming technique by first detecting mobile phones operating in the GSM900 band, and upon detection transmits a jamming signal to block the service within a 2.5 m range. At GSM 900 it was capable of detecting and blocking all the services.

3. METHODOLOGY

The proposed jamming device consists of three (3) major sections that makes up the Jammer circuit. These include the Power supply, the Intermediate Frequency (IF) and the Radio Frequency (RF). Fig. 1 illustrates the general overview diagram of the Jamming system.

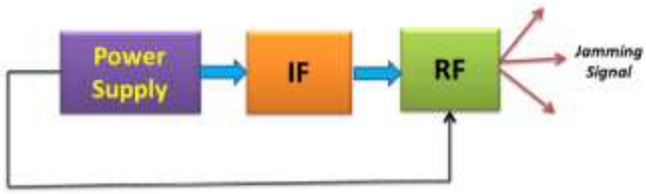

Fig 1. Block diagram of the Jamming device

The circuit schematic for each of these sections and the various electronic components that makes up these sections are critically chosen and selected. Also detailed calculations and measurements is carried out before assembling these different electronic components (resistors, capacitor, transistors, diodes, voltage controlled oscillators, amplifiers, antennas etc.) that forms the Jammer circuit. The range of frequencies that are jammed in this work is provided in table 2: The Network providers considered were: Airtel, MTN. Globacom and 9mobile networks.

Table 2: UP-link and Down-link frequencies for GSM 900/ 1800 & UMTS 2100.

SERVICES	UPLINK FREQUENCY RANGE (MHz)	DOWNLINK FREQUENCY RANGE (MHz)
GSM 900	890 – 915	935 – 960
GSM 1800	1710 – 1785	1805 – 1880
UMTS 2100	1920 – 1980	2110–2170

4. DESIGN SPECIFICATION

4.1 Path Loss

In this paper, we employ the free space path loss model (FSPL). Generally, path loss can be determined using the mathematical model defined in equation (1), that is.

$$FSPL\ (dB) = 32.45 + 20log\ d + 20log\ f \quad (1)$$

where d is the jamming distance in km and f is the operating frequency in MHz.

4.2 Jamming to Signal Ratio (J/S)

The Jamming-to-Signal ratio (J/S) of a target system is another important parameter in mobile jamming. It is the ratio of the jamming signal power at a specific receiver to the strength of the target signal at that same receiver [11]. This ratio is an indicator that shows the degree of vulnerability of a system to interference. The larger the J/S ratio of a system, the greater it's jamming rejection capability [12]. The J/S ratio can be calculated by the use of Friis equation for free space transmission.

$$\frac{J}{S} = \frac{\frac{P_J G_J G_R \lambda^2}{(4\pi d_J)^2}}{\frac{P_T G_T G_R \lambda^2}{(4\pi d_S)^2}} \quad (2)$$

$$\frac{J}{S} = \frac{P_J G_J}{P_T G_T}\frac{{d_S}^2}{{d_J}^2} \quad (3)$$

$$J/_S\,(dB) = P_J + G_J - P_T - G_T + 20\,log(d_S) - 20\,log(d_J) \quad (4)$$

where; P_J, P_T, G_J, G_T, d_J,and d_S are the Jammer output power (dBW), Transmitter power (dBW), antenna gains (in dBi) of Jammer and transmitter, distance (in meters) of jammer to receiver and then transmitter to receiver respectively. Applying some mathematical rearrangements, J/S can also be obtain using the equation (5).

$$\frac{J}{S}(dB) = \frac{P_J G_{JR} G_{RJ} R^2{}_{TR} L_R B_R}{P_T G_{TR} G_{RT} R^2{}_{JR} L_J B_J} \quad (5)$$

where; R_{TR} and R_{JR} is the distance between the transmitter and receiver, and Jammer and receiver, L_R and L_J is the signal loss in of the communicating device and signal Loss by the Jammer. B_R is the bandwidth of the Receiver and B_J is the bandwidth of the Jamming.

4.3 Signal to Noise Ratio (SNR)

Every radio device has a limit to which they can accommodate noise present in any signal. This is known as the SNR handling capability of the device. It is the wanted signal divided by that of noise [13]. The received signal power is considered along with noise power to determine the SNR at the receiver input [14].

4.4 Maximum Receive Signal Power

The maximum receive signal power refers to the best or strongest level of signal a mobile station can possibly receive from another radio device in the cellular network e.g. the Base station. Table 3 show the maximum power for each band [15].

Table 3: Bands and Maximum RSSI

SERVICES	MAXIMUM RSSI
GSM 900	-15 dBm
GSM 1800	-23 dBm
EDGE	-26 dBm
GPRS	-26 dBm
WCDMA	-25 dBm

4.5 Power Calculation

The mathematical models to determine the receiver jamming power and the Jammer output power is given in the equations (6) to (7).

Jamming power at mobile receiver,

$$J_r \geq RSSI_{max} - SNR_{min} \tag{6}$$

Maximum Jammer output power, $J_O = J_r + FSP$ (7)

<u>For GSM 900</u>

Maximum RSSI, $RSSI_{max}$ = -15dBm

Minimum SNR, SNR_{min} = 9dB

Jamming power at mobile receiver , $J_r \geq -15dBm - 9dB$

<u>For GSM 1800</u>

Maximum RSSI, $RSSI_{max}$ = -23dBm

Minimum SNR, SNR_{min} = 9dB

- Jamming power at mobile receiver, $J_r \geq -23dBm - 9dB$

  $J_r \geq -32dBm$

5. SYSTEM IMPLEMENTATION

This section presents implementation of the Tri-band cell-phone Jammer. The figure 2 depicts the different parts of the Jammer which are developed individually and assembled to form the whole jamming system.

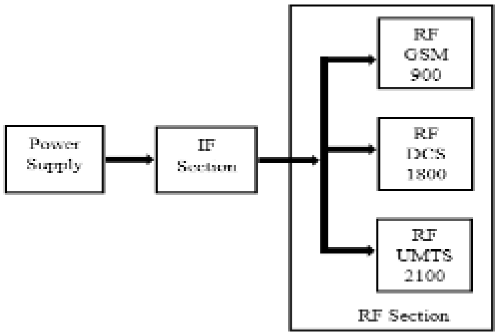

Fig. 2: Block diagram of the Tri-band cell phone Jammer.

6. TESTING, RESULTS AND ANALYSIS

After the successful design and simulation of the Jammer circuit, the design was shifted to a Vero-board to connect all the electronic components. The constructed Jammer device is shown in figure 3.

Fig. 3. Complete Tri-band cell-phone Jammer.

7. TESTING OF THE JAMMER

The testing of the cell-phone Jammer was a full successful as developed device was able to block the four major Mobile operators in Nigeria namely MTN, Globacom, Airtel and 9mobile as shown in Figures 4-6. Although the average jamming range of the system was approximately 10 meters, which is less than the design specification. This limitation can be attributed to the use of telescopic antennas by the jamming system instead of duck antennas that have a good gain. Also the RF power amplifiers that increase the strength of the jamming signal were not able to get the precise voltage supply as specified in their data sheet, as 3.3 volts was provided to them instead of the required 3.5 volts.

During testing, the Jammer was able to block the target services on an average of two (2) minutes after being turned "ON". Further testing confirmed that, the relationship between the distance between the Jammer and the base station increases proportionally thus blocking more numbers of cell-phones. This is due to the fact that the signal strength at cell-phones are at their strongest when close to the base station, and the farther these cell-phones are from the base station, the lesser the amount of power reaching them, thus having a weak signal strength.

The figures 4-6 show the effect of testing the Jammer on different mobile networks. It can be clearly seen that when the Jammer is "OFF", network services on the different cell-phones were available, but after turning the Jammer "ON", these services disappears or becomes unavailable.

Fig. 4. 9mobile and MTN services before and after the Jammer was "ON".

Fig. 5. Airtel service before and after the Jammer was "ON".

Fig. 6. Globacom service before and after the Jammer was "ON".

8. CONCLUSION

This project work presents a detailed insight into the implementation of a tri-band cell-phone Jammer that uses the denial of service jamming technique to inhibit the operation of cell-phones. The aim and objectives initially set out for this work has been achieved as the designed Jammer was relatively able to block GSM 900/1800 and UMTS 2100 services within its jamming range. Further testing of this device shows that its effective jamming distance reduces when tested close to a base station and as we move farther from the base station, this distance increases.

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