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Development of unauthorized cell-phone usage sniffing system using embedded system

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***Abstract-* The advent of wireless technology and advances in telecommunications has brought great advantage to the human society and helped to contribute to globalization. While this is laudable, the unauthorized use of this phone has contributed to some of the social vices seen in the society, such as examination malpractices, computer hacking, interference with sensitive health equipment, and organized crime within and outside correctional facilities. In a bid to curbing some of these excesses, a good mechanism is required to detect indiscriminate use of mobile phone in public places to avoid public indiscipline. In this work, a mobile phone sniffer is designed using appropriate computer aided design (CAD) tools multism 11.0.The code is written and embedded using Intel 8051 Microcontroller series. The sniffer can detect signals of all brands of mobile phones in an active mode and inform about the detected signals through a blinking Light Emitting Diode (LED) and a Buzzer.**

Keywords— mobile phone sniffer, active mode, computer hacking, correctional facilities, multiple sniffers and embedded system.

Introduction (Heading 1)

Cellular communications is one of the fastest growing and challenging telecommunication applications today; it represents a large and continuously increasing percentage of all new telephone subscribers around the world. In the long term, cellular digital technology may become the universal way of communication [1], [2]. It plays a vital role in business, in the economy, and in the personal and family lives of individuals [2]. As a result of its being mobile, mobile phones can, amongst other things, save lives and provide security by making it possible to summon help quickly in an emergency. It enhances access to law enforcement agent, medical providers and bank services without the need to move around. The advent of the cell-phone technology with the relentless push towards micro- miniaturization of devices increases the risk to exploit and misuse this technology for diabolical and illegal purposes [3], [4]. For example, cell phones hidden in a meeting room, or on a person, allows a competitor to listen in or record illegally vital protected information. In hospital settings, Electromagnetic Interference (EMI), due to the presence or use of cell phones near sensitive electronic equipment may cause important patient-care equipment to fail to perform properly, putting patients at risk. The use of mobile phones as aids for cheating in examinations has somewhat become a menace. Consequently, a very real need exists today for individuals, businesses, institutions and the government to take measures to detect and identify the unauthorized use of cell-phones within the bounds of any controlled premises.

I *The Cell Phone Problem*

In recent years, there has been growing recognition of the problem of contraband cell phones inside correctional facilities. These phones can be used to operate both internal and external criminal enterprises, threaten witnesses, harass victims, orchestrate uprisings, and undermine prison security by coordinating the activities of separated inmates[5] . Advances in compact wireless devices and high-bandwidth data services also pose an increasingly significant problem. A single individual could upload large quantities of data or photos using a cell phone smuggled into a correctional facility. A need clearly exists to monitor and control cell phone use within correctional facilities [6], [7], [8]. Based on the aforementioned studies; it was evident that many searches have been carried out on communicational, structural and hypothetical design and construction of mobile phone.

II *DESIGN FLOWCHART*

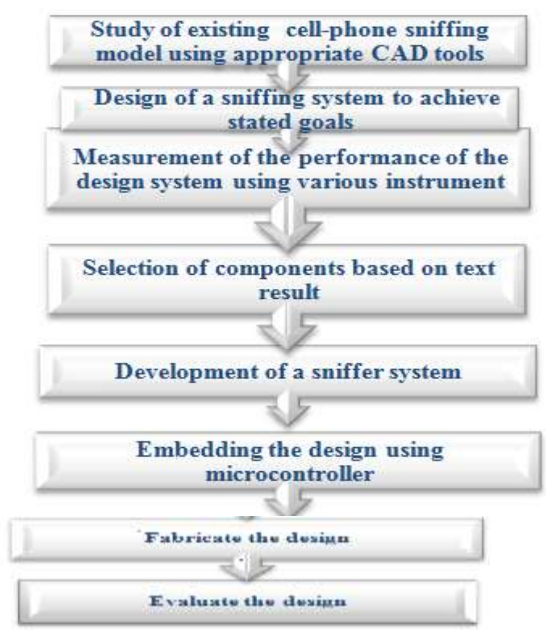

Fig 1 Flow chart of the design

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III *Stability Considerations*

The main way of determining the stability of a device is to calculate the Rowlett's stability factor (K), which is calculated using a set of S-parameters for the device at the frequency of operation. The calculations are long winded and it is much quicker to simulate using Computer Aided Design (CAD) tools.

Two Stability parameters K & |Δ| can be calculated to give us an indication to whether a device is likely to oscillate or not or whether it is conditionally/unconditionally stable.

The parameters must satisfy $K > 1$ and $|\Delta| < 1$ for a transistor to be unconditionally stable.

In the case of this design, there is a need to determine the stability factor at 0.9GHz and 3GHz (Mobile communication frequencies range from 0.9 GHz to 3 GHz.) [9]It is important to also check the stability factor from low frequencies up to the f_T (total frequency) of the device as instabilities may occur at other frequencies even though the device is stable within the pass-band. In this study, the Rowlett's stability factor (K), is determined using frequency analyzer on Multism 11.0 version within the frequency 0.9GHz to 1.8GHz (the frequency band allocated for mobile phone subscribers in Nigeria).The k and Δ stability factor for frequency covering the mobile phone channels were simulated for Operational Amplifier used in this design and presented in Table 1 below.

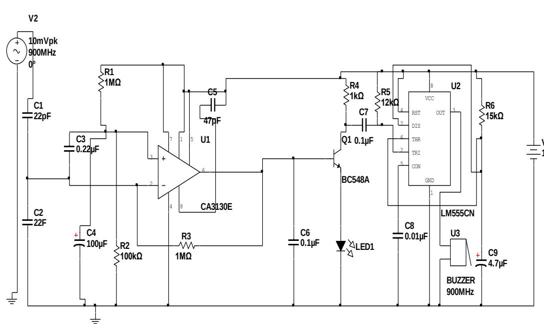

Fig 2.The developed sniffer circuit

IV *Simulation Parameters*

Figure 3 shows the generated radiofrequency waveforms as captured on Multism .This represents the output waveform of the device when there was mobile signal transmission.

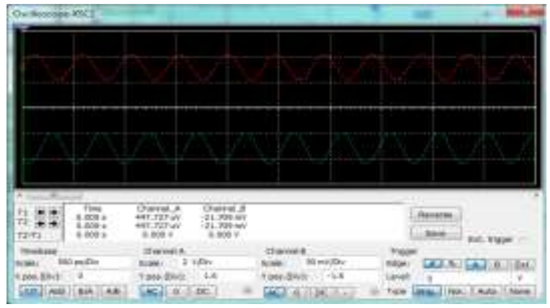

Fig.3.Oscilloscope showing the input and output nature of the signal

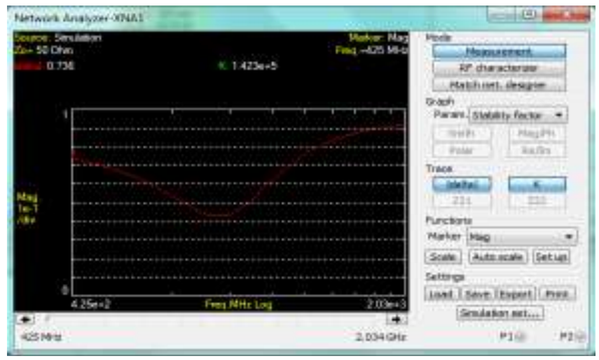

Fig. 4. Network analyzer for Rowlett's stability (K

From the result obtained for Rowlett's stability (K) shown in figure 4, the Op- amp used in the designing of the sniffer is said to be unconditionally stable.

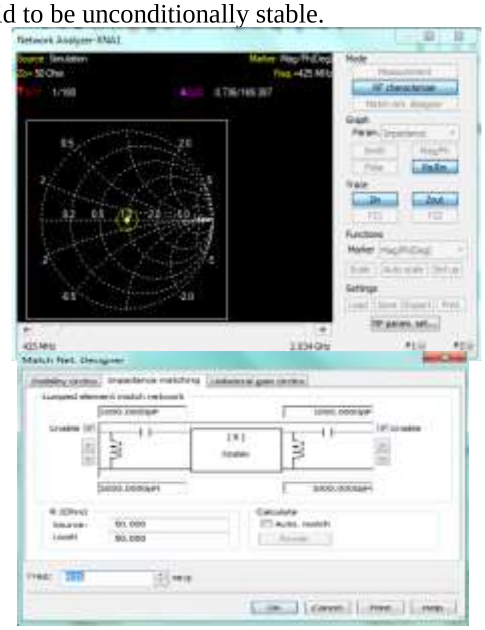

Fig.5. Network analyzer for Match Net. Designer (impedance matching)

The designed sniffer using the Op –amp CA3130 is considered"unconditionally stable", meaning the amplifier does not oscillate in the presence of any passive load or source impedance. In this case the impedance matching option can be used to automatically modify the structure of the RF amplifier to achieve maximum gain impedance for the sniffer to be developed.

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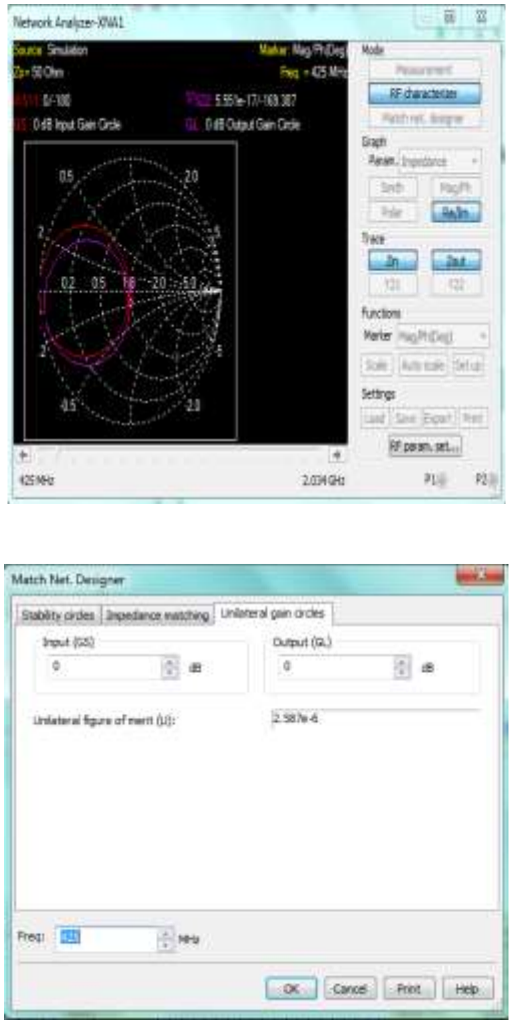

Fig.6 Network analyzer for Match Net. Designer (unilateral gain circles)

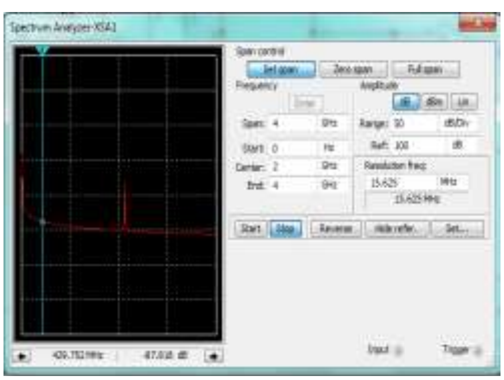

Fig.7. Spectrum analyzer (Amplitude in dB) versus frequencies

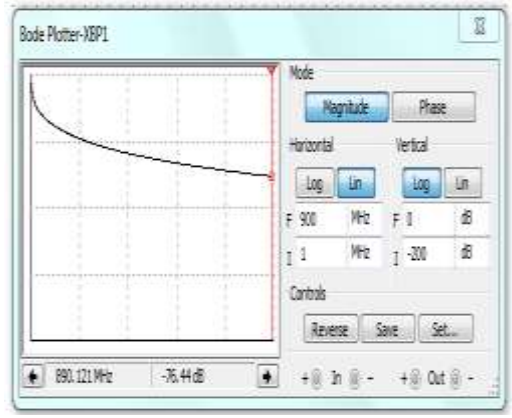

Fig.8. Bode plotter for frequency versus voltage gain in magnitude.

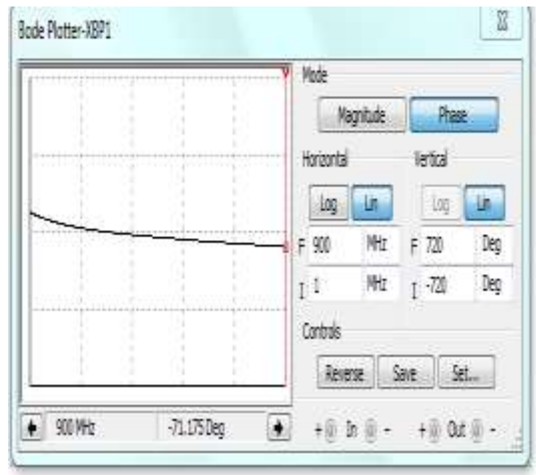

Fig.9. Bode plotter results for the sniffer gain in phase.

V Results

Several tests and measurement were carried out on the developed sniffer; some of the results obtained are shown in tables 1 to 4, all these tests are to properly examine the performance of the developed sniffer to know its functionality

TABLE1. SIGNAL DETECTION FROM DIFFERENT BRAND OF PHONES.

RESULTS OF THE TEST CARRIED OUT ON THE SNIFFERS BUILT		
Types of phones	DISTANCE (IN RADIUS) OF PHONES TO SNIFFER (m)	Remarks
Nokia 1100, 3210, 3310 Sony Ericsson Z530i Nokia 3210,3310 Siemens's MC60, 1112, 8310 Sagem My X1, My X5. Blackberry etc..	0.5	Sniffed
	1.0	Sniffed
	1.5	sniffed
	2.0	sniffed
	2.5	sniffed
	3.0	sniffed
	3.5	sniffed
	4.0	sniffed
	4.5	sniffed
	5.0	sniffed
	5.5	sniffed
	6.0	Not sniffed

Table 1 shows the effect of having different types of mobile phones with their different frequencies. Mobile phones were place at various distances to the developed sniffer. The objectives of this test are: to know the actual maximum range of the developed sniffer, in terms of detecting the RF signals emitted by each mobile cell phone at the time of various activities of the mobile phones. The test is also to determine the effect of the different frequencies of the mobile phone on the sniffing capacity of the sniffer. It was observed that each phone tested was able to sniff cell phone activity up to a distance of 5.8m. However, sniffing activity stopped when the phones were placed at a distance of 6m from the sniffer. The sniffer was sniffing all brands of cell phones provided the phones are within a radius of 5.8m. It is not surprising that the sniffer is able to detect all form of signal from the different brand of cell phone since they all generate RF signals

TABLE 2.THE EFFECTS OF DIFFERENT ENVIRONMENTS ON THE SNIFFER.

	ENCLOSURES	OPEN SPACE	
NAMES	REMARKS	DISTANCE radius(m)	REMARKS
VEHICLE	sniffed	1.0	sniffed
BUILDINGS	sniffed	2.0	sniffed
BAGS	sniffed	3.5	sniffed
	sniffed	4.0	Not sniffed
	sniffed	5.8	Not sniffed
	not sniffed	6.0	Not sniffed

Table 2 shows the effect of different environment on the sniffer when there are cell phones in active mode. The places considered for the test of the sniffer are divided into two: enclosures and open space. For enclosures, vehicle, building, bags were considered while for the open space, a football field was used. The objective of this test is to study whether the environment would have effects on the performance of the sniffer with different distances considered during the test as shown in table 2.Different vehicles were used with their inside lengths varying from 2.4m to 3.6m. During the test all glasses were wound down, the sniffer sniffed throughout the whole length of all the vehicles considered, but some false alarm were noticed. The test was also conducted with the vehicles glasses wound up, with the same result. The sniffer was later tested in the open football field, where no false alarm was noticed. From the tests conducted, it was noticed that the sniffer is sniffing inside those vehicles very well, whether with glasses wind up or down. The sound of the buzzer was higher and the LED1 was brighter than when the glasses of the vehicle were wind down. The following conclusions were drawn: that the sniffer with respect to first place (vehicle) is sniffing well, and the false alarm noticed was as a result of some phone activities of the untargeted cell phones since those users were within the range of the sniffer tested, also the RF is higher inside the vehicle when the vehicle doors and glasses were wound up, this shows that the RF signals from mobile phone is more concentrated in an enclosure than in an open place, [9], [10].

The second type of environment place considered was inside building. Buildings used during the test of the sniffer were 750 capacity lecture theatres, 250 capacity lecture theatres, and 100 capacity classrooms. The tests were conducted for different cell phone activities. The performance of the sniffer in the building at various distances from 0.5m to 15m to the sniffer was determined. The objectives of the tests are to determine the maximum range of the sniffer in the building like examination halls and others and to know the level of RF in some of the building considered in terms of sniffer indicators (high sound firm buzzer and bright glow from CED1). The results show that the sniffer is able to detect signal up to 5.8m inside the buildings considered. The smaller the building (enclosure) the more concentrated the RF signals from the mobile phone and the higher the buzzer sound of the sniffer and the glow of the LED1

The third environment considered as enclosure was bag. The sniffer was first placed inside a bag while the cell phone was outside. Cell phone activities were detected by the sniffer at various distances considered with buzzer indications. The cell phone was later placed inside the bag while cell phone sniffer was placed outside. The sniffer was able to detect cell phone activities through different distances up to 5.8m which is the maximum radius of coverage of the sniffer. The results of these tests show that the sniffer sniffed the activities well in all the three tests and covered the maximum range of the sniffer.

TABLE 3. SNIFFER AND LINE OF SIGHT IN THE OPEN SPACE

Distance(line of sight)	Remarks
1.0	sniffed
2.0	sniffed
3.0	sniffed
4.0	sniffed
5.0	sniffed
6.0	not sniffed

The result in table 5 is to determine the distance the sniffer can cover when considering line of sight (LOS) during mobile cell phone activities .From the result obtained as compare to the result obtained in table 3, the phone sniffer covered a radius of 3.5m outside the building in an open space, but for table 5 for line of sight the sniffer covered a maximum distance of 3.7m during the cell phone activities, it can be concluded from the test that when there is LOS to the sniffer, the sniffing range increases.

TABLE4.: EFFECT OF THE MOBILE PHONE DISTANCE ON THE SNIFFER BEEPS PER MINUTE AND BEEP

NO OF PHONES	NO OF BEEPS PER MINUTE	BEEP SPEED RATE(BEEP/ SEC
0	-	-
1	120	2.0
2	124	2.0666667
3	128	2.13333333
4	132	2.2
5	136	2.2666667

The objective of the test result presented in Table 3 is to determine the effects of number of active mobile cell phones on the beep and speed rate of the sniffer. This experiment was conducted using oscilloscope connected to the sniffer and the signals shown on the oscilloscope indicated the number of beeps per minute. The beep rate is obtained by dividing by 60 to get the number of beep speed rate which is in beep per second. In this experiment, all the mobile phones were located at 0.1m radius from the sniffer. The numbers of mobile phones were varied from one phone to five phones. The results of the speed rate obtained varied from 2.0 per second to 2.266667 per second.

V1 Conclusion

A cell phone sniffer was developed that is capable of sniffing active mobile phone signals of different brands during different activities of mobile phones .The sniffer can cover maximum range of 5.8m (radius) in enclosures without barrier since RF signal radiation is concentrated in building than in open space and for an open space, the developed sniffer can sniff active phone signals at a range of 3.5m.This range is greater than the range of the commercial model even when placed in an enclosures. Efficiency of this sniffer developed in terms of range as compare to former models is far better; also in terms of cost. The developed sniffer can be employed in any restricted area where the use of mobile cell phones is not allowed. Such restricted areas include banking hall, conference venues, companies, examination halls, religious places like mosques, correctional facilities (prisons), etc. If this solution is implemented, it would greatly reduce the risk of cellular phones getting into secure facilities.

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