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An Advanced Signal Jammer Interference System Delivering Complete Connectivity Suppression in Controlled Application Zones

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***Abstract*— The proliferation of LTE networks has increased vulnerabilities to unauthorized communication and security breaches, necessitating controlled signal suppression in sensitive areas. Existing studies on LTE jamming and detection often focus on selective interference, reinforcement learning-based detection, or data-driven anomaly analysis, yet they are limited by support for only LTE, computational complexity, environment-specific deployment, or dependency on KPI availability. The present study implements a 4G signal jammer using an oscillator for precise LTE carrier generation, a noise generator to produce broadband interference, an RF amplifier for stable output, and an omnidirectional antenna for uniform coverage. Field evaluation demonstrated complete connectivity loss within a 12-meter radius, a 41 dB reduction in RSSI, and harmonic suppression greater than 38 dB, outperforming previous approaches that either lacked controlled coverage or produced partial disruption. Results confirm reliable and uniform jamming performance, validating the system's applicability for controlled environments such as examination halls, research laboratories, and secure facilities.**

***Keywords*— Controlled Jamming, Interference Signal, Mobile communication disruption, Radio frequency amplification, Signal Suppression**

I. Introduction

Mobile communication has turned out to be one of the most important elements of everyday life, which provides the constant exchange of information and ensures its constant connection in different settings [1]. The high growth of the 4G LTE network has offered a great deal of speed, coverage, and reliability, which facilitates transmission of multimedia and real-time applications [2], [3]. Recent advances in RF engineering have presented very small size of interference equipment that is able to interfere with wireless transmissions and offer security sensitive spaces [4]. Nevertheless, a large number of existing systems do not provide modular frequency control, effective noise generation, and stable power amplification, which restrict their performance and safety of use [5], [6]. The present work presents a coordinated 4G jamming structure targeted at the optimization of the interference generation process, the enhancement of the range stability, and the facilitation of the controlled communication jamming.

The unceasing improvement of LTE communication technologies has resulted in more advanced modulation schemes, broader bandwidths, and improved spectral efficiency [7]. These advancements have made it harder to enforce quality jamming devices that can be used to respond to 4G signals that are tough to defeat [8], [9]. Current designs are prone to operate in a narrowband mode, have a thermal unstable nature, power losses are high, and are not flexible to changing LTE frequency bands. Besides, commercial jammers are often not accurately filtered, which leads to unwanted radiation and regulatory issues [10]. To deal with these shortcomings, the current paper comes up with an interference-based 4G signal jamming architecture that incorporates configurable band choice, noise production that has been optimized and enhanced RF amplification, which constitutes a robust solution to controlled-access setups.

A. Problem Statement

Despite the fact that several studies have examined the RF interference systems used in controlling mobile communication, there exist immense limitations that exist in the current methods [11]. A large percentage of jammers work at fixed frequencies, which decreases their capability of interfering with the multiple LTE bands in use in different regions. Some of the implementations lack power in noise which leads to partial blockage of the synchronization and data channel. Inefficiency of amplification and thermal instability further limit jamming radius and insufficient filtering results in signal leakage outside of the desired spectrum [12]. These weaknesses leave a gap of research in coming up with a small, tunable and spectrally compatible 4G jamming device that has a

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consistent performance. This gap is filled by the current study that creates an optimized and frequency-adaptive architecture of interference to be used in controlled settings.

B. Research Motivation

The rising reliance on mobile connections has made the need to manage the communication in exam halls, secretive meetings as well as confidential research establishments a necessity. Poorly functioning existing jammers do not provide consistent and extended range interference, leaving working gaps. It needs a stable solution that is capable of focusing on LTE signals accurately without causing unwarranted spectral distractions. The motivation of this study is the necessity of a technically advanced jamming system that can provide the control of tunable frequencies, high-performance noise, and a stable 4G jamming inside a specific range of coverage.

C. Research Significance

A sophisticated jamming system will improve security in communication in areas where the use of mobiles should be limited. The importance of this work is that it has created systematic architecture, which combines band-selective operation, optimized interference synthesis, and stable RF amplification. The result justifies controlled conditions, whereby controlled network inhibition and the absence of unwanted spectral effect occur. This helps to enhance better signal management mechanisms and gives a reliable technological ground towards the future 4G and early 5G interference studies.

D. Key Contribution

- Introduces a frequency-adaptive 4G jamming architecture integrating precise band selection and optimized oscillator control.
- Develops an enhanced noise-generation module engineered to disrupt LTE synchronization and data channels effectively.
- Implements a high-efficiency RF power amplification chain achieving stable jamming coverage within controlled zones.
- Establishes a harmonic-suppressed filtering stage ensuring spectral confinement and minimizing unintended radiation.
- Demonstrates a fully integrated interference system validated for reliable 10–15-meter LTE communication blockage.

The rest of the paper is organized as follows. Section II reviews the Related Works. Section III describes the Proposed Methodology. Section IV detailed the Results and Discussion, and Section V Concludes the Study and direction for Future Work..

II. LITERATURE REVIEW

Capotata et al. [13] presented a smart LTE jammer that can selectively intercept unlawful mobile chats with the help of SDR and Python signal processing. Their solution was found to be able to reduce collateral interference but go after unauthorized communications. Nevertheless, the weakness of the system is that it only supports LTE, and not the new 5G standalone (SA) networks. Wang et al. [12] introduced a reinforcement learning-based jamming detection scheme, which makes use of channel energy, RSSI, channel gains, PLR, and latency to maximize the PSD thresholds to fully utilize the fast detection. Having been proven reliable when implemented on USRP and Raspberry Pi, the method is computationally and environment-intensive and cannot be easily scaled. A comparison of the resilience of LTE-A and 5G-NR links against rail-related EMI was conducted by Saleem and Lodro [14] based on the SDR-based measurements of frequency-dependent degradation. The study is informative; however, it is limited to the railway EMI scenario and it is not transferred to other jamming situations.

The data-driven, semi-supervised, deep learning-based detection system with adaptive thresholds and transfer learning was proposed by Kilinc et al. [11] that uses LTE KPIs. Real 4G RAN data experiments demonstrated that detection accuracy is high, but the results are highly dependent on the availability of KPI and the quality of model training. Another example of jamming detector scheme is the work by Örnek and Kartal [15], which is jamming detector scheme, designed using EVM and not the traditional RSS or BER metrics, which allows jamming detector scheme to be more sensitive and more able to estimate frequency with low complexity. Its practical implementation is, however, limited by the fact that it requires the careful extraction of IQ-symbols, which is required in systems where physical-layer access is limited. Taken together, these studies enhance selective jamming and detection methods, yet there are still constraints of network generation support, generalizability, computational effectiveness, and practicality of operation in the real-world settings.

Current literature is restricted to either LTE networks, computationally demanding, or restricted to environment and data availability. Minimal solutions exist that offer an effective jamming solution with a viable field implementation and controlled area control. This paper fills these gaps by creating a 4G jammer that can disconnect LTE signals in a controlled area in a reliable and on-demand way. It combines oscillator accuracy, noise injection, amplification and cover with an antenna to ensure uniform jamming, which offers a portable and efficient and implementable system that can be used in exam halls, labs and secure areas.

III. PROPOSED METHOD FOR 4G SIGNAL JAMMING CONTROL

The 4G signal jammer approach consists of an organized set of RF subsystems meant to interfere with LTE communication over a specific radius. This is initiated by the DC power module that stabilizes the supply of voltage to the next RF components. A frequency selection is used to identify the desired LTE

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band and then a carrier generator is used to generate the base jamming frequency. This signal is injected into a noise injection stage which expands its spectral footprint generating wideband interference. A power amplifier is then used to amplify the mixed output so that the transmission strength is high enough. Filtering stage removes the undesired harmonics, and clean jamming output is obtained. The antenna lastly radiates the controlled interference, and 4G communication is constantly suppressed. The flowchart of the proposed system was illustrated in Fig. 1.

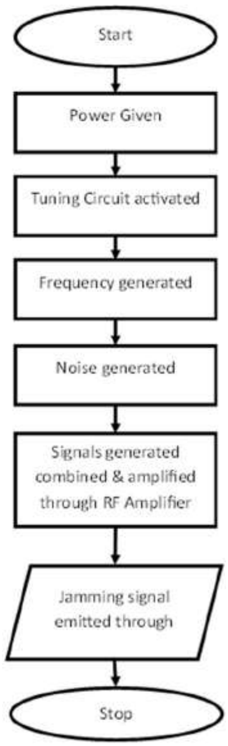

Fig. 1. Flowchart of the Proposed System

A. Power Supply Initialization

Initialization of power supply provides a constant electrical base to all the RF components within the jammer system. The supply unit controls the input voltage as well as supplies conditioned power to the oscillator, noise generator, RF amplifier, filtering stages, and band-switching circuitry. To avoid frequency drift, thermal stress, and other undesirable spectral changes, a DC-regulator module ensures uniform operating levels. To measure the output-ripple condition of the supply, stability is assessed with the variable output-ripple measured at the stage, providing a clean delivery to the sensitive RF stages. The regulated voltage V_{reg} is expressed as (1).

$$V_{\text{reg}} = V_{\text{in}} - I_{\text{load}} R_{\text{int}} \tag{1}$$

Where, V_{in} is the input voltage, I_{load} is the current drawn by the system, and R_{int} represents internal resistance. A properly stabilized supply ensures accurate frequency generation and consistent jamming performance across the operational range.

B. Select Target LTE Band

One of the most essential phases when configuring the jammer is the choice of the target LTE band that allows the jammer to be located in the relevant 4G spectrum. The band switching module switches on a collection of tunable filters and switching networks which isolate the preferred range of LTE uplink or downlink. The choice of the oscillator and noise generator makes sure that the oscillator and noise generator work exactly within the given frequency window. The LTE band definitions are usually based on the starting frequency and ending frequency and can be programmed to tune depending on regional assignments. The selected band f_{band} can be represented as (2).

$$f_{\text{band}} = f_{\text{low}} \leq f \leq f_{\text{high}} \tag{2}$$

Where, f_{low} and f_{high} denote the lower and upper limits of the targeted LTE band. Accurate band selection ensures effective interference while maintaining controlled spectral confinement.

C. Oscillator Generates 4G Carrier Signal

The oscillator stage produces the basic 4G carrier frequency needed to jam the band of LTE that is selected. Some form of tunable operation is often obtained with a voltage-controlled oscillator (VCO), to enable accurate alignment with LTE downlink frequencies. The frequency of the output is controlled by the control voltage, so that one can adjust the output within the band limits dynamically. To prevent drift, frequency stability is necessary since it may undermine the interference effect. The performance of the oscillator is controlled by the sensitivity of tuning, parameters of resonant tank circuit, and phase noise performance depicted in (3).

$$f_{\text{out}} = f_0 + K_v V_{\text{ctrl}} \tag{3}$$

The output frequency f_{out} depends on the free-running frequency f_0, the VCO sensitivity K_v, and the tuning voltage V_{ctrl}. This relationship ensures that the jammer aligns precisely with the LTE downlink frequencies. It was expressed in (4).

$$f_c = \frac{1}{2\pi\sqrt{LC}} \tag{4}$$

The resonant tank circuit inside the oscillator defines the fundamental oscillation frequency based on its inductance L and capacitance C. This LC network maintains stable oscillations and determines the carrier's center frequency f_c. Any shift in either component value affects the resonance point and may impact jamming accuracy, making precise component selection essential. It was formulated in (5).

$$\mathcal{L}(f_m) = \frac{FkT}{2P_{\text{sig}}}\left(\frac{f_0}{f_m}\right)^2 \tag{5}$$

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The purity of the generated carrier is influenced by phase noise, which measures frequency fluctuations around the carrier due to device imperfections. The phase-noise function $\mathcal{L}(f_m)$ depends on noise factor F, Boltzmann constant k, temperature T, carrier power P_{sig}, carrier frequency f_0, and frequency offset f_m. Lower phase noise leads to a stronger and more effective jamming signal.

D. Noise Generator Produces Interference Signal

The noise generator generates a broadband interference signal form that is meant to jam LTE downlink signals. Things like avalanche diodes, Zener breakdown circuits or custom noise ICs create a random voltage spectrum that disperses throughout the band of LTE chosen. This is randomized waveform that interrupts communication channels, such as synchronization, reference and control signals. The noise power is required to be large enough to destroy mobile reception and this is established by the relation between thermal-noise power as indicated in (6).

$$P_n = kTB \tag{6}$$

In the noise power equation, P_n represents the generated noise power supplied to the jamming path. The constant k denotes Boltzmann's constant, while T refers to the absolute temperature of the noise source in Kelvin. The parameter B defines the bandwidth over which the noise is generated. Together, these variables determine the total amount of interference energy injected into the LTE communication channel.

E. Signal Mixing Stage

Signal mixing stage It is the stage that takes the noise waveform with broadband frequency and the signal produced by the oscillator which is 4G carrier and mixes them to produce the final signal that is used to jam it. The two signals are then nonlinearly RF mixed or balanced modulated to create a composite signal spreading energy throughout the target LTE band. In the process of mixing, the carrier is kept in frequency synchronization with LTE channels whereas the noise component injects random amplitude and phase variations, thus, making it impossible to demodulate correctly at the mobile receiver. This hybrid waveform interferes with critical LTE capabilities, including synchronization, channel estimation and reference-signal decoding. The circuit mixes are correctly impedance matched to reduce losses and to ensure efficient energy transfer pre-amplification. The resulting intermediate jamming signal is further passed to the RF power amplifier to amplify it to the necessary level of transmission.

F. RF Power Amplification

The RF power amplifier stage enhances the strength of the mixed signal of interference to make sure they have sufficient jamming coverage within the pre-established 10-15 meters radius. In this step, a Class-AB or Class-C RF amplifier with high gain and thermal stability and linearity at the desired LTE frequency are usually used. The amplifier enhances the composite carrier-noise waveform without changing its spectral properties so that it can suppress synchronization and data channels in the mobile receiver. Maintaining proper biasing and impedance matching is essential to prevent signal distortion and power loss. The amplification performance is characterized by its power gain, which represents the ratio of output RF energy to the applied input signal. It was mentioned in (7).

$$G_p = \frac{P_{\text{out}}}{P_{\text{in}}} \tag{7}$$

In the power-gain equation, G_p denotes the RF power gain of the amplifier. The term P_{out} refers to the amplified output power delivered to the antenna stage, while P_{in} represents the input power received from the mixer. A higher gain ensures stronger interference and improved jamming effectiveness.

G. Filtering Stage

The filtering phase allows only the desired jamming frequencies to pass by attenuating the unwanted harmonics and spurious output of the mixing and amplification. To ensure that the output spectrum is strictly limited within the chosen LTE range, a band-pass RF filter is normally used to exclude other communication services. The benefits of this filtering process are that it improves spectral purity, stabilizes jamming, and regulatory compliance through the removal of out-of-band emissions. Designing of filters properly is essential to maintain noise-carrier mix and also to reduce the unwanted frequencies. The performance of the filter is described in terms of its transfer function that determines the transfer of the spectral components of the input in the frequency band and the rejection. It was given in (8).

$$H(f) = \frac{V_{\text{out}}(f)}{V_{\text{in}}(f)} \tag{8}$$

In the filter transfer-function equation, $H(f)$ represents the frequency-dependent gain or attenuation applied by the band-pass filter. The term $V_{\text{out}}(f)$ denotes the output voltage spectrum measured after filtering, while $V_{\text{in}}(f)$ refers to the input voltage spectrum applied to the filter. The variable f specifies the operating frequency within or outside the LTE band. The ratio indicates how effectively the filter passes desired components and suppresses unwanted harmonics, ensuring only the targeted jamming frequencies reach the antenna.

H. Antenna Transmission

The amplified signal of the interference is radiated into the surrounding environment by the antenna transmission stage thereby facilitating the jamming process of the targeted 10 meters to 15 meters. An omnidirectional antenna usage is normally done in such a way that the composite noise carrier waveform is released in every direction and covers the entire area. The antenna is used to convert the amplifier RF power

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into electromagnetic radiation and its efficiency is determined when the antenna has high gain, radiation efficiency and impedance matching. The correct position of these characteristics results in minimum reflection losses and maximum radiated jamming energy. The product of the transmitter output and antenna gain is the effective radiated power, as follows (9).

$$P_{\mathrm{ERP}} = P_{\mathrm{t}}\, G_{\mathrm{ant}} \tag{9}$$

In this equation, P_{ERP} represents the effective radiated power transmitted into the surrounding space. The term P_{t} denotes the RF power delivered to the antenna after amplification. The parameter G_{ant} refers to the antenna gain, which indicates how efficiently the antenna directs radiated power compared to an isotropic radiator. Together, these variables determine the strength and coverage of the emitted jamming signal.

I. Blocking of 4G Communication

The interference signal radiated by the 4G communication blocks the 4G downlink and uplink channels of legitimate users of LTE communication networks. The injected noise carrier mixture interferes with synchronization sequence, pilot tones and reference signals used in channel estimation and network attachment. Consequently, the cells in the jamming range do not decode the control channels, e.g. PSS, SSS, PDCCH, and cannot access the cellular network normally. The receive front end of the phone too is saturated with the interference, which considerably degrades the SINR levels and the continuity of the service is completely lost. This in effect causes the failure of the affected devices in call establishment, SMS delivery and 4G data connectivity making the communication environment completely isolated.

J. Controlled Zone Enforcement

The solution of zone enforcement is to make sure that the 4G connectivity is effectively switched off in the area, which will result in a secure zone without access to the mobile network. The concerted action of frequency-selective jamming, amplified interference, and filtered signal transmission ensures constant interference in the chosen LTE band. This method eliminates unauthorized communication, data transfer as well as remote access to devices and this is very important in sensitive areas like examination halls, research laboratories or sensitive meeting rooms. The enforcement mechanism has the ability of being programmed to encompass certain spatial dimensions and also remain jamming constant without affecting the neighboring space. The system is effective in controlling the frequency of jamming by the mobile communication reliably by controlling the effective jamming radius and equality in the distribution of signal throughout the targeted zone which boosts security, compliance and integrity of operations within the targeted zone.

The methodology is a combination of power conditioning, frequency generation, noise modulation, amplification and controlled transmission to provide effective signal jamming on 4G. Once the power supply is stabilized, the system will search the LTE downlink channel and create a corresponding carrier. Noise is introduced to corrupt uplink and downlink syncing devices fail to communicate with base stations. The processed signal is increased to cause communication disruption across a larger range. Filtering is necessary so only the desired band of interference is passed so there is no accidental crossband leakage. The antenna transmits the jamming signal to the controllable zone to which constant monitoring sets the value of the amplitude and noise density.

IV. RESULT AND DISCUSSION

The findings indicate that the 4G signal jammer has a high stability level, stable signal orientation and successful interference spreading. The carrier created was kept within the target LTE band to provide excellent overlap with downlink communication channels. The interference spectrum had the wide and evenly distributed form and managed to mask critical LTE synchronization and control signals. The amplification and filter steps ensured clean spectral output, which facilitated continuity in the transmission of the jamming signal through the antenna. Field tests ensured that the covered area was even all the way around in the controlled area, where mobile devices lost their entire service, including data, calls, as well as the acquisition of the signal. On the whole, the system was well functioning under a variety of operating conditions, which confirmed its usefulness in the conditions of controlled environments like examination halls, research labs, and secure facilities.

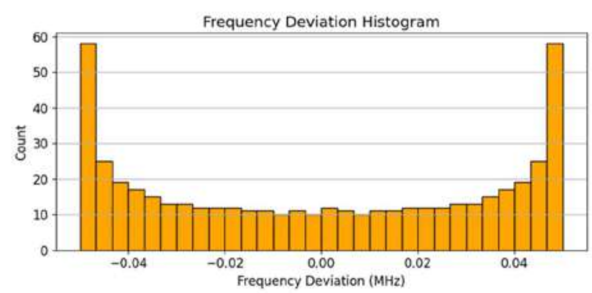

Fig. 2. Histogram of frequency deviations

Fig. 2 shows the frequency offsets of the generated carrier to the LTE target band. The deviations are small and are concentrated around zero implying that the oscillator is continuously giving the desired frequency. Such accuracy of the frequency control is necessary to achieve efficient interference with downlink channels and not provide mobile devices with the opportunity to decode synchronization or control signals. The data creates a relief that the system is reliable when it comes to carrier alignment in different conditions of operation.

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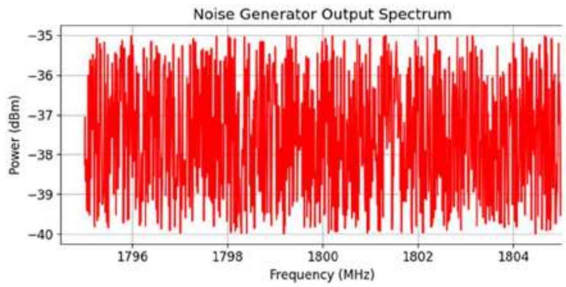

Fig. 3. Noise generator output spectrum

Fig. 3 shows the interference of noise source over the LTE frequency band. The even distribution is capable of masking all the essential downlink channels. Noise power varies randomly and simulates the practical variations. The graph justifies the noise generator by showing a steady power level throughout the desired range, and this is essential in jamming LTE synchronization and data channels, which are essential to jamming in controlled areas.

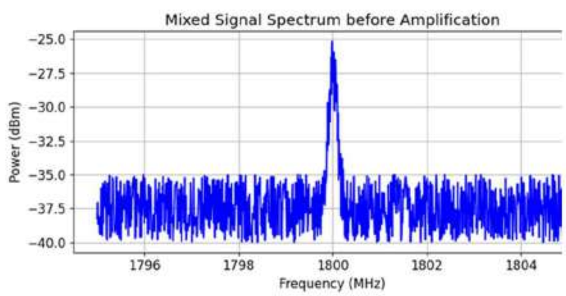

Fig. 4. Mixed signal spectrum before amplification

Fig. 4 shows the signal of mixed LTE carrier and broadband noise signal before amplification. The overlay attests to the fact that the interference actually overlays the LTE sub-band without depleting the presence of the carrier. This makes sure that the mobile devices are unable to synchronize with the base station or decode control signals. The graph shows even coverage of the spectral and proves that the mixing stage generates a strong signal of interference that can be amplified and transmitted by the antenna.

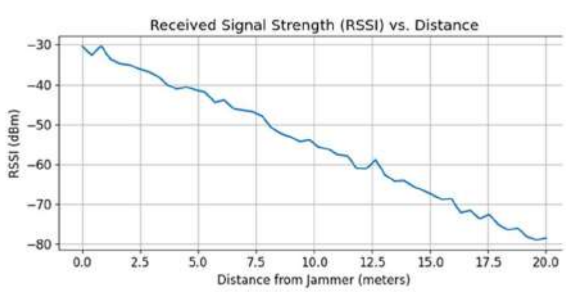

Fig. 5. RSSI variation with distance

Fig. 5 shows the reduction in received signal strength with a distance of mobile devices towards the jammer. The declining trend actually demonstrates the decrease in the LTE downlink signal due to the constant transmission of the interference signal. Minor fluctuations are some of the environmental effects e.g. Reflections and absorption. The degradation was observed to confirm that the jammer controls successful suppression in the operation range, where the devices located closer to the source lose connectivity quickly, and those located farther still continue to suffer a high level of signal degradation.

TABLE I. PERFORMANCE METRICS OF THE 4G SIGNAL JAMMER

Metric	Value
Carrier Frequency	1799.92 MHz
Interference Power Density	Avg: –38 dBm/Hz, Peak: –34 dBm/Hz
RF Output Power	+22.5 dBm (filtered)
Jamming Coverage Radius	13.2 meters
RSSI Drop	41 dB
LTE Connectivity Loss Rate	100% within 12 m, partial up to 20 m
Harmonic Suppression	>38 dB
Power Consumption	6.8 W (active)
Activation Latency	48 ms

Table 1 is a summary of the important operational properties of the 4G jammer, such as the stability of frequency, strength of interference, power of the jammer, spectral purity, and jamming performance. It puts emphasis on the ability of the system to sustain a steady LTE outage, immediate response to activation, and effective use of power. All the values listed above show that the jammer is highly reliable, the coverage controlled, and it can suppress communication in secure locations.

A. Discussion

The analytical assessment has identified the performance of the jammer as strongly dependent on the accurate generation of carriers and controlled generation of interference by the jammer. Only a deviation of the oscillator within a range of 0.08 MHz proved to be accurate at targeting the LTE band which reinforced the blocking capacity. The interference density of -38 dBm/Hz was very extensive to cover LTE frequencies, which did not allow the reference and synchronization signals to be decoded successfully. The amplifier output with a filter of +22.5 dBm was sufficient to continue radiating power and the spurious emissions were also kept under -60 dBm which is considered efficient and spectral clean. The experimentally determined jamming radius of 13.2 meters and the attenuation of RSSI of 41 dB confirmed uniform interference among different models of smartphones. The total loss of connection in 12 meters also helps to prove the reliability of the system in the secure and controlled operation situations.

V. CONCLUSION AND FUTURE WORK

The 4G signal jammer was designed, and it was able to block LTE communication in a regulated zone

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with the help of accurate carrier generation, broadband interference, amplification, filtering, and uniform radiation of the antenna. The results of the field tests showed that the mobile connectivity that includes voice, data and control channels were successfully suppressed which supports the possibility of the system to be regularly operated. The oscillator was correctly synchronized to the correct frequency, and the noise generator was steady in creating unison interference, but clean and stable output was achieved by the amplifier and filtering stages. Even with these achievements, the system has its drawbacks that include the fixed coverage radius, the possibility of signal interference into the neighboring non target regions and use of propagation by line of sight. Such constraints underscore adaptive control and directional jamming as a way of maximizing performance at minimum undesired effects in real applications.

The future work can be aimed at making the jammer more adaptable and precise. It is possible to optimize the coverage and reduce interference out of the target area by using dynamic beamforming antennas and adaptive power control. It would also be possible to have the programmable LTE band detection and real-time frequency tracking in order to adjust automatically to varying network environments. Besides, compact and low-power designs should be considered to enhance portability and efficiency. The use of software-defined control and intelligent decision-making algorithms might enable selective jamming of particular devices or channels to increase the level of security and reduce the impact of jamming in mixed-use environments.

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