Development of signal strength meter for GSM signal

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Abstract- In this study, a stand-alone signal strength meter is developed for diagnosing the quality of GSM signals. The meter consists of a sim808 module, memory card shield, microcontroller, and Liquid Crystal Display unit, and 12 V, 60000mAH lithium battery. A C-programming with Arduino platform is adapted to communicate with the sim808 board, memory card shield, LCD, and microcontroller (Arduino mega 2560). A sim808 library was used to extract the Received Signal Strength Indicator (RSSI), the coordinator, the number of satellites in view, and the satellite is used in computing the basic position parameters. The signal strength obtained ranges from -115 dBm to -51 dBm when compared with the Samsung Galaxy A10s phone signal strength and developed device show a good correlation (0.99) with the standard device.

Keyword: Signal Strength, sim808, microcontroller, Quality of Signal

1. Introduction

Long-distance communication has been a dispute throughout history before the advent of modern communication. The challenge reduces the breakthrough that electricity can be used to transmit a signal. This signal could be sent faster than any mode of communication. Nevertheless, the modern communication system varies with time of the day because of topography and weather and has its drawback such as barrier that reflects the signal away from reaching its targeted audience [1]. In the present day, cellular mobile network versatile has acquired higher predominance in the media transmission area because of its movability and simplicity of activity. Cellular mobile network versatile has gone past voice administrations to information, video, and control signals for distantly worked frameworks. The properties of the phone versatile radio channel can be sorted into two to be specific: narrowband and wideband properties while the narrowband comprises mainly of the received power of the propagated signal and the path loss, the wideband concerns delay spread, angles of arrival, and impulse response.

Since the wideband age of the cell portable radio also called Global System for Mobile Communication (GSM) is depicted by the narrowband properties and this framework is the system that is generally conveyed in the greater part of the developing countries Nigeria inclusive, the focal point of study in this work is on narrowband properties. GSM is one of the revelations with the fast turn of events and the most requesting telecom applications on the planet today [2]. The power density of the GSM signal relies upon three fundamental factors: the transmitted power of the base transceiver station, the distance between the Base Transceiver Station (BTS) and the Mobile Station (MS), and the obstacles within the surrounding. The receiving antennas of electronic devices are remotely associated with the mobile network Base Station (BS) transmitters as the gadgets are moved about. Remote signs
communicated from the BS transmitters are essentially influenced by the nature of topography of the climate [3], the characteristic features of the transmitter antenna [4] such as antenna height, gain, etc.

Wireless propagation is profoundly site-specific and varies considerably based on the speed of the mobile terminal, frequency of operation, and the parameters like antenna height, antenna gain, transmitter power, path loss, other losses, and receiver sensitivity [5]. Quality of call establishment is based on received signal strength. The received signal strength depends on the distance away from the transmitter, obstacle, transmitter power, receiver quality. GSM signal strength is influenced by many physical mechanisms, including free-space path loss, terrain blocking and reflection, foliage absorption, Ionospheric reflection and absorption, rain loss and reflection, clear air absorption, Doppler shift, and multipath fading [6]. The focus of this paper is to address the aforementioned drawback by developing of signal strength meter for GSM to assess the quality of particular signal strength, the number of satellites in view, and the satellite in use at a certain distance from its transmission station.

2. Methodology

2.1. Basic Block Diagram of Signal strength for GSM signal

The development of the signal strength for the GSM signal device consists of the Arduino ATmega 2560 microcontroller, sim808 module, memory shield, display unit, and power unit as shown in Figure 1. The Global Navigation Satellite System (GNSS) network combines with numerous satellites to give information signals to a GPS device. GPS/GSM module, LCD Display, and Power supply interface with a microcontroller to give a complete configuration of signal strength for GSM signal. Arduino ATmega 2560 consists of an ATMEGA328P microcontroller (MCU), which is the central processing unit as it switches all other peripheral components agreeing to the command given. GPS receiver in signal strength device is the principal components since it gets the topographical Coordinates from the satellites in a GMT with the date, longitude and latitude, the measure of satellite observed and the number of satellites in utilized. Figure 2, shows the schematic diagram of the developed device.

![Figure 1: Basic Block Diagram of Instrument](attachment:image1.png)
2.2 Sensing Unit: Software Implementation with Pin Connection

The Sim808 module was actuated by the Arduino programming through the sim808 specified pin for the switch. Pin 9 allotted to compose the comparing programming code to control ON and OFF. sim808 module has libraries defined software serial communication on pins D15 (RX to TX connection) and D16 (TX to RX connection) of Arduino ATmega 2560. The sim808 programming sequential development where the digital I/O pins were assigned to communicate with GPS and GPRS module was utilized to configure the module. The baud rate set for the activity was 9600 for both Serial and Sim808. Serial.begin() begins the serial communication with Arduino software serial monitor that sprung up when the code uploaded to Arduino IDE for observing the output observed after choosing "Both NL and CR" at 9600 baud rates. The function sim808.begin() began serial communication with Arduino and the GPS/GSM module with a delay of 100 milliseconds imposed. The loop() incorporated the fundamental program that concluded how to control the device again and again. The sim808.available() checked the presence of information in pins 10 and 11. The module would return a-1 if no data were detected and the sim808.read() read the returning information from the serial port. The processed information will be displayed on the Liquid Crystal Display and stored on the memory Secured Data Card.

![Figure 2. Schematic Diagram of Developed Device.](image-url)
3. **Testing and Examination**
When the power is ON, the microcontroller and SIM808 modules LED turn red ON. The module detector is pressed and holds on till the sensing signal LED starts blinking and released. The process takes about 3 minutes initially searching for GPS information. The information gathers from the device was compared with that of the Galaxy A10s. The signal strength measured Postgraduate (PG) Physics Laboratory at The Federal University of Technology Akure is shown in Table 1 at every 10 minutes interval. The result is in good agreement; the correlation is closed to unity. The ANOVA test in Table 2 shows that there is no significant difference between the readings of the signal strength of the two devices. The P(value) is 0.93 and greater than the $\alpha$(value) of 0.05. The sample data from the developed GSM signal strength device is presented in Figure 3. The time series for the MTN signal strength is presented on a typical day (11/4/2021) at a latitude of 7.298738° and longitude of 5.134275° in Figure 3.

| Time(minutes) | Developed Device (dBm) | Samsung Galaxy A10s (dBm) |
|---------------|-------------------------|---------------------------|
| 0             | -80                     | -79                       |
| 10            | -80                     | -79                       |
| 20            | -70                     | -71                       |
| 30            | -72                     | -71                       |
| 40            | -56                     | -56                       |
| 50            | -76                     | -75                       |
| 60            | -76                     | -76                       |
| 70            | -74                     | -74                       |
| 80            | -66                     | -67                       |
| 90            | -65                     | -66                       |
| 100           | -77                     | -78                       |
| 110           | -73                     | -74                       |
| 120           | -61                     | -63                       |

**Table 1: Validation of GSM Signal Strength Device**

| Time(minutes) | Developed Device (dBm) | Samsung Galaxy A10s (dBm) |
|---------------|-------------------------|---------------------------|
| 0             | -80                     | -79                       |
| 10            | -80                     | -79                       |
| 20            | -70                     | -71                       |
| 30            | -72                     | -71                       |
| 40            | -56                     | -56                       |
| 50            | -76                     | -75                       |
| 60            | -76                     | -76                       |
| 70            | -74                     | -74                       |
| 80            | -66                     | -67                       |
| 90            | -65                     | -66                       |
| 100           | -77                     | -78                       |
| 110           | -73                     | -74                       |
| 120           | -61                     | -63                       |

**correlation**

0.992291
Table 2: ANOVA Test to Examine the Relationship between the Reading of the Signal Strength of the Two Devices

ANOVA: Single Factor

| Groups     | Count | Sum  | Average | Variance |
|------------|-------|------|---------|----------|
| Column 1   | 13    | -926 | -71.2308| 54.02564 |
| Column 2   | 13    | -929 | -71.4615| 46.9359  |

ANOVA

| Source of Variation | SS       | df | MS         | F         | P-value | F crit |
|---------------------|----------|----|------------|-----------|---------|--------|
| Between Groups      | 0.346154 | 1  | 0.346154   | 0.006857  | 0.934691| 4.259677|
| Within Groups       | 1211.538 | 24 | 50.48077   |           |         |        |
| Total               | 1211.885 | 25 |            |           |         |        |

Figure 3: The Floatation of MTN Signal Strength with Time on a typical day 11/04/2021.
4. Conclusion

The development of a signal strength device has been achieved which can be installed anywhere to obtain GSM signal strength data. Comparison of the device with Samsung Galaxy A10s phone shows a correlation of about 0.99 and ANOVA test carried out shows that there is no significant difference between the readings of the signal strength of the two devices. The P(value) is 0.93 and greater than the α(value) of 0.05. To obtained signal path loss more this device can be produced alongside some atmospheric parameters at a cheaper rate.

5. References

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