Improving Radio Frequency Signal Reception for Technical Vocational Education and Training Activities

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Abstract- For the implementation of technical, vocational education and training (TVET), the internet must be accessible and reliable. The two most often used technologies for providing internet access are GSM and Wi-Fi. Signals within the radio frequency (RF) range are sent using these technologies. RF signals experiences penetration loss as they come across non-transparent medium to a free zone, thus, reducing the signal's power. Buildings penetration loss is a well-known subtype of this loss. This paper presents a technique that enhances and improves RF signal reception. For transmission and reception, different kinds of dipole antennae were designed. The transmitted RF signal is captured by the receiving antenna. The system uses an LM386 IC-based amplifier circuit. After being upgraded, the signal is transmitted by the sending antenna and received by the users. The program was evaluated using a software called RF Signal Speed Detector. When compared to the non-enhanced signal, the enhanced RF signal's strength increased over the four indicated location deployments. The percentage improvements are 37.5%, 65.6%, 78.78%, and 164.7%. respectively.

Indexed Terms- Radio Frequency, Signal Speed Detector, Transmission, Enhanced RF, Antenna and Amplifying Circuit.

I. INTRODUCTION

Daily, wireless and mobile infrastructures are assuming a prominent position in contemporary economics. Applications for wireless communication include those in medical, entertainment, telecommunications (both fixed and mobile), and Multimedia, mobile, etc. The advancement of technical, vocational education, and training (TVET) depends on these activities. ICT integration into TVET systems should be handled urgently, according to Ramadan et al. (2018), since it is an implement for required technological progress preparation for technical institutions and craftsmen. Additionally, the use of ICT in TVET will reposition global-manpower-demands focus, entirely, from skilled-based to ICT-capable workforce. Saud et. al. (2011) and Olabiyi et. al. (2012) opined that radio frequency transmissions power the ICT's communication component. Everywhere, both indoors and outdoors, radio frequency transmissions, or signals in the frequency ranges of mobile phones, are employed (Onwuka et al., 2018). Customers expect a high level of service quality and coverage in these settings. There are many benefits to having a strong telecommunications signal, including the ease with which users may do commercial activities like internet browsing, effective phone calls, and other GSM activities (Aiyelabowo and Mathew, 2019).

When indoor, users of radio frequency (RF) transmissions do not enjoy networks of high-quality due to signal blockages brought about by building materials. Penetration loss occurs when RF signals traverses through non-transparent media to zones that are free. The building material penetration loss, which impacts the strength of the signal received within the building is a well-known example of this penetration loss (Reception from outside to within) Elechi (2015). Movement of a mobile device from the outside of a building to inside of one result in an increased attenuation of the received signal. This increase in attenuation is caused by building penetration loss.

Elechi & Otawosie, 2016, Elechi, 2015, and Elechi et al., 2017, all states that the following factors have an impact on the received RF signals strength received in buildings:

- Frequency of Transmission
- Height
- Building Architecture and Interior Design

Signal losses come from the aforementioned impact. The building's height and the building's penetrating material are the two main causes of these losses. Due to inadequate signal boosters, poor environmental conditions, such as foliage, trees, and tall buildings, wireless systems have become acclimated to receiving weak signals.

Several literary works have been produced to lessen this impact on RF waves. According to Aliyu et al. (2017), a cell phone booster is an electronic device that boosts a cell phone's signal. To enhance the RF signal, a different author designed an antenna booster that works in the 2.4GHz and 5GHz range of the frequency spectrum. Typically, antenna-based boosters are made to swap out the stock antennas on wireless routers.

This study presents an electronic component, constructed to be an amplifier circuit, which amplifies the RF signal transmitted from the RF source. The system detects the block/attenuated signals boosts it, and retransmits it to the various users.

II. METHODOLOGY

The site survey and the hardware implementation were the first two steps in the system design process. The following duties are part of the site survey: viewing and considering the structure and layout of the surrounding region; locating access points that will increase signal strength to the desired coverage area; identifying the position of the system installation; observing the locations that have high-attenuation tendencies, physical construction, environment obstacles, and foliage; measuring the distance between cables; and identifying the location of the physical access points (i.e., the placement of antennae). RF signal speed detector application software (SSDAS) was used to measure the signal strength in the specified areas. Figure 1 illustrates the pattern of signal strength readings template of the SSDAS.

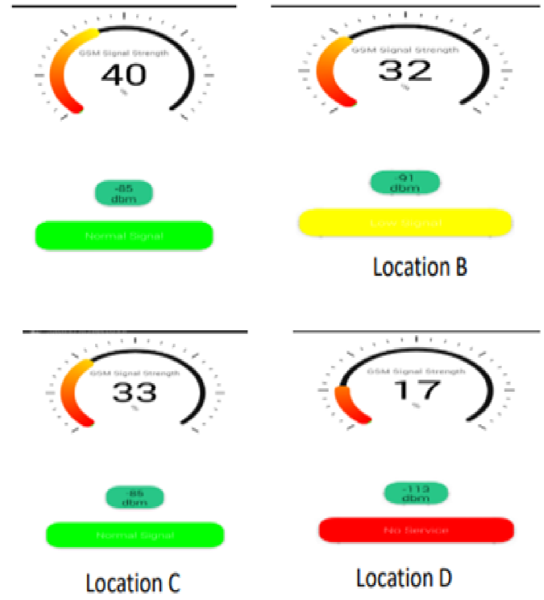

Figure 1: Readings taken at survey

- Hardware Implementation

Figure 2 illustrates the many components of the system. Receiving antenna, signal splitter, amplifying circuit, sending antenna, and power supply are among the components.

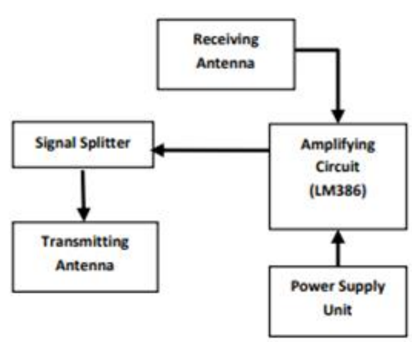

Figure 2: System block diagram

- Power Supply

The amplifying circuit is powered by this device. It features a bridge rectifier, rectifying capacitors, a 220/12 V transformer, and power regulators.

The capacitors performs the function of filtering, getting rid of the ripples in the bridge rectifier's pulsing dc output. The LM7812 regulator keeps the output of the bridge rectifier to 12 V, which powers the amplifier circuit.

- Antenna Design

Omni-directional antennae were used to make up for the loss in signal reception efficiency caused by the need to receive signals from many directions. The omnidirectional antenna used has capacity to scatter or gather electromagnetic waves equally well in all horizontal directions in a flat, two-dimensional (2D) geometric plane.

The signal is picked up by the omnidirectional receiving antenna from the RF transmission source and fed to the amplifier. The omni-directional transmitting antenna broadcasts the amplifying circuit's output to its immediate surroundings. Figures 3 and 4 show, respectively, the deployed antennae.

Figure 3: Receiving antenna

Figure 4: Transmitting antenna

- Amplifying Circuit

The LM386 power amplifier integrated circuit, which finds its application in low voltage consumer applications, serves as the foundation of this circuit. According to Semiconductor (2000), the IC is a component with eight (8) pins that is packed.

The capacitor and resistor choices for pins 1, 2, 3, and 8 affected the amplifier's gain. Between pins 2 and 3, is a 4.7 kΩ resistor and pins 1 and 8, a 10 µF capacitor were connected. Between pin 6 and ground is a 4700 uF, 25V capacitor. To drive the stage, a 12 V supply is provided to pin 6.

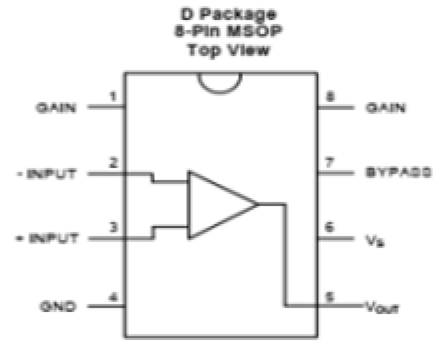

Figure 5: LM386 pin configuration

The overall system's schematic diagram is shown in Figure 6.

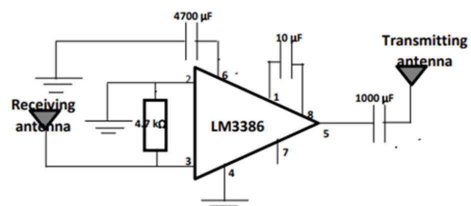

Figure 6: RF enhancing circuit

- Signal splitter

The amplifying circuit's output signal is splitted by this multichannel system (Splitter, 2005) into various channels or outputs. Figure 7 shows the splitter used.

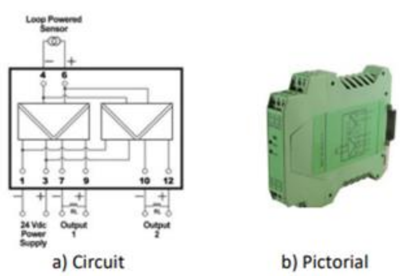

Figure 7: Signal Splitter

III. RESULTS AND DISCUSSION

The amplified circuit implementation is depicted in Plate 1, and the RF boosting system implementation is depicted in Plate 2.

Plate 1: Amplifying circuit

Plate 2: RF signal enhancing system

The installation of the transmitting antenna was on the tallest building in area under study, 35 feet tall. The receive antenna was placed on platform 16 feet above the surface. The Network Cell Info (NCI) Lite application software and the Radio Frequency Speed Detector (RFSD) were then used to ascertain the signal strength at the locations A through D as they were in the survey. The outcomes are shown in Figure 8.

Figure 8: RF enhancing system reading

Figure 9 compares the measurements made during the survey with those made after the deployment of the RF enhanced system in the environment being studied.

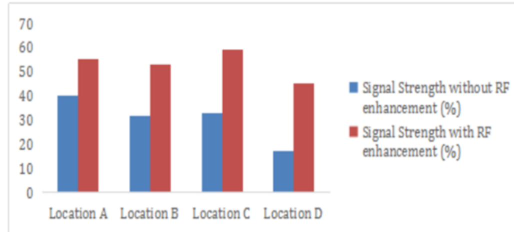

Figure 9: System performance chart

These improvements over the four locations, 37.5%, 65.6%, 78.78%, and 164.7%, were made using the RF improvement system.

CONCLUSION AND RECOMMENDATIONS

The RF signal reception was increased by the RF boosting system developed and put into use. This signal is important for study because it will make internet browsing faster. Additionally, it will encourage users to access information on the web for a variety of purposes. The discomfort brought on by a weak RF signal reception will be delayed. It is advised that this system be widely installed in all structures with poor or weak RF signals, especially in classrooms, banks, and libraries where RF signal is necessary to complete one work or another. This is necessary to offer dead zone-free, smooth, uninterrupted, and reliable data connection across extended distances.

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