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Development of Field Strength Meter for FM signal with Atmospheric Parameter

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Abstract - In studying the FM signal strength quality and atmospheric effect on the signal, a standing alone FM signal strength meter with following parameter: temperature, relative humidity, pressure and rain volume was developed, alongside with logging facility. The system consists of SI4703 FM module, real time clock module, memory card shield, µcontroller and Liquid Crystal Display unit and 5 V, 60000mAH lithium battery. A C-programming with Arduino platform was wrote used to communicate with SI4703, BME260, memory card shield, LCD and µcontroller (Arduino mega 2560). A SI4703 library was used to extract the RSSI, also, library of BME280 was used to measured air temperature, relative humidity, pressure and altitude. The tipping bucket was used to measure rain volume and rain rate. The signal strength ranges from 0 dB to 70 dB when compared with FM signal strength meter and developed device, their correlation was 0.89. The atmospheric parameter has been standardized from manufacturer. Also, the tipping bucket measured 0.11inch per tipping.

Key Words: *Signal Strength, µcontroller, radio wave propagation, atmospheric parameter*

1.INTRODUCTION

Wireless communication companies depend on the generated radio wave propagation models to conclude the most proficient point in placing their cellular towers. Ditto is true for commercial broadcast radio. Broadcasters wishes to place their transmitters in most proficient point to cover a wide range of broadcast. The rate of new FM (Frequency Modulation) broadcasting stations coming on air increases annually. Since the airwaves are becoming increasingly congested (1), the importance of knowing a transmitter's ability to reach a listening audience is heightened. Radio waves propagation plays a crucial role in the wireless communication technology. On the basis of physical sciences, the radio waves signal grows rapidly in the atmosphere. Due to the mediums' nature, the radiated radio frequency suffers loss in signal (attenuation) when passing through a medium (2). The signal strength pertains to the transmitter power output as being received from the source antenna at a distance interval from the transmitting antenna (3) (4).

Furthermore, the variations in the atmospheric condition contribute to the radio wave propagation as they travel through the atmosphere (5). This is ascertained due to the non-uniformity in the atmosphere since the condition changes with variations in the geographical location, height and changes with time. Information on the composition and state of the earth's atmosphere assists in understanding the radio wave propagation and the development of the communication system (receiving and transmission of radio waves signal) (6). The prima state and composition of the atmosphere within its layer (troposphere) is the meteorological concern are the atmospheric temperature, pressure, relative humidity and wind (5).

As a result of the aforementioned, the signal gets reflected, refracted, diffracted and scattered. When such occurred, the signal gets absorbed, signal travels along the multiple paths, or due to relative motion the signal frequency gets shifted between the transmitter and receiver. This shows clearly that radio wave propagation is a space-time-frequency phenomenon. It's crucial to understand that the propagation effects cannot be quantified in any accurate sense, but can only be explained on the basis of their statistic (7).

Radio signals consist of the electric and magnetic field components. The electric field component is measured in terms of the change of potential over a given distance, which may be in volts per meter, and this is known as the electric field strength [8]. This measure is often used in measuring the strength or intensity of radio signals (electromagnetic wave) at given points to determine the signal coverage area. In accurate examine the contribution effect of atmospheric parameter on the FM radio signal there is need to developed a field strength meter alongside with atmospheric parameters such temperature, relative humidity and pressure for computation of surface refractivity index. Since majority of research are spot measurement but this will be continuing logging for proper examination of effect on each other.

2. METHODOLOGY

2.1 Block Diagram of the FM Signal Strength with Atmospheric Parameter

The Figure 1 shows the block diagram of FM signal strength meter with atmospherics parameters consists of: BME280 for the measurement of air temperature, relative humidity and pressure; rain gauge; radio module; microSD shield; µController and display.

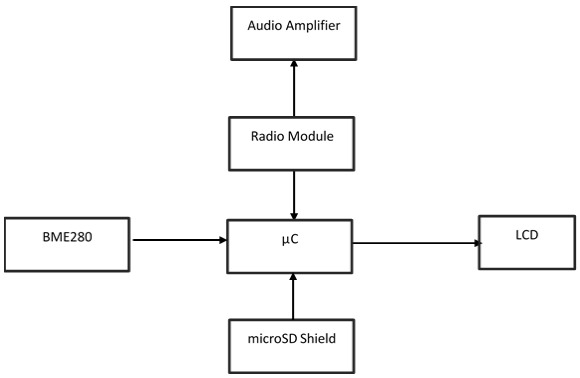

Figure 1. Block Diagram of the FM Signal Strength with Atmospheric Parameter

2.2 Radio Unit

The Silicon Laboratories produce SI4703 of a digital tuner radio has many features that make it excellent for FM radio receiver and for development of FM radio signal strength. The features were: worldwide FM band of 76 to 108 MHz; digital low; IF receiver; Frequency synthesizer with integrated VCO; seek tuning; automatic frequency control (AFC); automatic gain control (AGC); **e**xcellent overload immunity; signal strength measurement; programmable de-emphasis (50/75 µs); adaptive noise suppression; volume control; line-level analog; RDS/RBDS processor; 2-wire and 3-wire control interface; 2.7 to 5.5 V supply voltage and **i**ntegrated LDO regulator allows direct connection to battery. The Figure 2 is functional block internal diagram FM SI 4703 tuner.

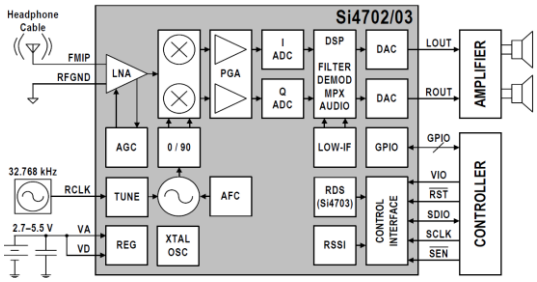

Figure 2. Internal Block Diagram of the FM SI4703 Tuner [9]

2.3 Atmospheric Parameter Unit

The BME280 sensor module reads barometric pressure, temperature, and humidity. Because pressure changes with altitude, altitude can also estimate. The BME280 sensor uses I²C or SPI communication protocol to exchange data with a microcontroller. The precision sensor measures the barometric pressure with ±1 hPa absolute accuracy, and temperature with ±1.0°C accuracy. Because pressure changes with altitude, and the pressure measurements are so good, and altimeter with ±1 meter accuracy. The range of measure of each parameter are given as: for Temperature **is** -40 to +85°C; Humidity is from 0% to 100%; and Pressure is from 300hPa to 1100hPa.[10]

Rain Gauge

The rain gauge used was obtained from shelf of spark fun. It was made of plastic with dimension of 14.8cm x 6cm x 8.1 cm, it shown in Figure 4a. The principle of operation is to trigger circuit microcontroller via reel switch when magnet pass over it. The trigger was to count the number of tips of the tipping lever and convert it to the volume of liquid at which the lever is adjusted to make a tip. In this tipping bucket the adjuster is permanently fixed. Therefore, the rain gauge bucket type has capacity of 0.011" (0.2794 mm) of rain that can hold before tipping which can cause a one momentary contact closure that can be recorded with a digital counter or microcontroller interrupt input [11]. The gauge's switch is connected to the resistor capacitor network in Figure 4b.

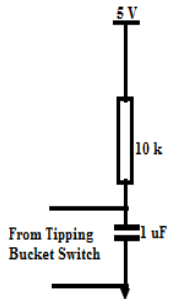

Figure 4. a The Rain Gauge Box [10] b. The Circuit of Connection

2.4 µController, Display and Logger Unit

The µcontroller is small size standalone computer on a single chip containing processor core, memory and programmable input-output peripheral. µcontrollers are use of embedded related applications program, but microprocessor is found used for personal computers and other general-purpose applications. Atmega2560 has a low power consumption, high performance; CMOS 8-bit µcontroller based on the AVR enhanced RISC architecture. Atmega2560 provides 256 Kbytes with 8 Kbyte RAM of in-system self-programmable memory with read while write capability and 2 Kbyte EPROM. The µcontroller oversee all the activities of the instrument from accepting data from BME280, rain gauge and radio module SI4703 for processing of data to the storing and displaying information [12,13,14].

MicroSD card shield module was interfaced with microcontroller using Serial Peripheral interface (SPI) protocol standard. The module is designed for dual voltage power supply. The interface module can be used with two logic level for instance, CMOS 3.3V or TTL 5V.

The Liquid Crystal Display **(**LCD) is used to display the temperature, relative humidity, pressure, rain volume, rain rate and FM signal strength for visual information. A Dig chip make 20 character × 4 lines JHD162A liquid crystal display was used in the instrument developed.

The display is a 16 pin which works with maximum power supply of 5.0 V and the data can be sent in either 4 bit, 2

operations or 8-bit, 1 operation so that it can be interfaced to 8-bit Microcontroller. Here we used 4 bits, 2 operation system [12,13,15,16].

3 COMPLETE CIRCUIT DESCRIPTION OF THE DEVELOPED FM SIGNAL STRENGTH WITH ATMOSPHERIC PARAMETER

The Figure 5 shows the complete schematic of developed FM signal strength with atmospheric parameter. The radio module, BME280 and the real time clock were using serial communication of I²C interface. Each one has own address so they can not interfere with one another. The output of rain gauge (tipping bucket) was connection external interrupt 0 of the Arduino mega 2560. The display was connected through digital pin on the Figure 5.

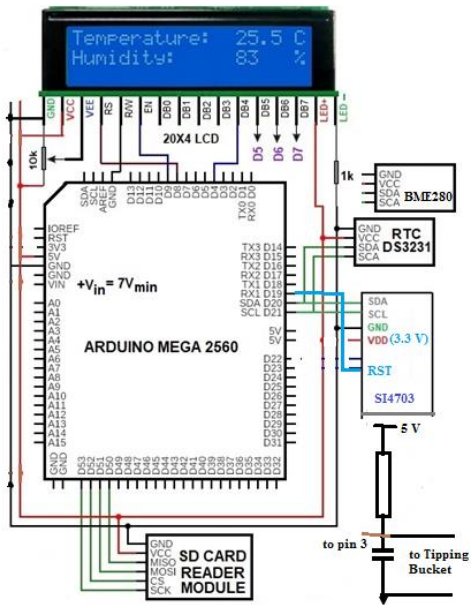

Figure 5. The Complete Schematic Diagram

4 TESTING AND VALIDATION OF MEASURING PARAMETER

A radio signal strength meter was compared with developed the obtained an agreement of 0.89 from data gather. And all the other parameter air temperature, RH and pressure has 0.9, 0.95, and 0.93 R-Square value respectively when compare with Vintage Pro weather station.

5. CONCLUSIONS

The developed FM signal strength device with atmospheric parameter has been achieved which can be installed to log signal strength alongside with atmospheric parameter. The device was compared with available FM signal strength meter and likewise air temperature, RH and pressure with Vintage pro has a very strong agreement. Therefore, device is a low-cost and can used to study effect of atmospheric parameter on FM signal.

REFERENCES

[1] Rusmandel, (2016) 2015 Year in Review: LPFM Made it Community Radio's Biggest Leap Forward. Radio Survivor.

[2] Zahera Naseem, Iram Nausheen and Zahwa Mirza, (2018) "PROPAGATION MODELS FOR WIRELESS COMMUNICATION SYSTEM", International Research Journal of Engineering and Technology (IRJET):05(01): 237-241

[3] Bolli, S., Mohammed, Z., and Ali, K.. (2014). "RMSE comparison of path loss models for UHF/VHF bands in India", IEEE REGION 10 SYMPOSIUM, 330 – 335

[4] Smita, S. A., and Rakhi, D. A. (2018). "Bluetooth Low Energy-Based Applications", IGI Global, 95 - 112.

[5] Ian, P. (Ed.) (2015). "Radio signal path loss In radio electronics". Retrieved April 3, 2015, from www.radio-electronics.com

[6] Dev K. R. (2012). Factors Affecting Radio Wave Propagation. Dev Kumar Rai's Blog. www.idc-online.com.

[7] David M. P., (2012) "Microwave Engineering", University of Massachusetts at Amherst, John Wiley and sons, inc,: 701-705.

[8] Morris, S. and William, O. (1973): "Essentials of Communication Electronics", McGraw- Hill, pp.2-4.

[9] Silicon Laboratories (2018). SI4703 Broadcast FM Radio Tuner for Portable Applications, www.sparkfun.com

[10] https://how2electronics.com/bme280-arduino-based-simple-weather-station/

[11] Argent Data Systems (2019) Weather Sensor Assembly p/n 80422. www.sparkfun.com/datasheets/sensor/weather meters

[12] Prarik, P, Rahul N., and Aunpsingh P. (2014): Design Solar Insolation Level Detector and Data Logger, international Journal of Current Engineering and Technology, 4(3), 2083- 2087.

[13] Ewetumo T., Egbedele I., Joseph-Ojo. I., and Fagbamiye-Akinwale O. M. (2019): Development of Low-cost Soil Tillage Profilelometer, Iconic Research and Engineering Journal (IRE). India 3(2): 365-371.

[14] Osinowo M. O., Willoughby A. A., Ewetumo T. and Kolawole L. B. (2019): Development of Low-cost Soil Heat Flux and Temperature Profile with Logger, International Journal of Advance in Scientific Research and Engineering (ijasre) India. 5(7): 51-57.

[15] Ewetumo T. (2019): Development of a Low-Cost Penetrometer with Depth Measurement, International Journal Scientific Research and Development (IJSRD), India. 7(4):483-486.

[16] Obagade T. A., and Ewetumo T. (2019): Development of Microcontroller Base Draught Force, Iconic Research and Engineering Journal (IRE). India 3(2): 476-480.