GSM Enabled Automated Radio Station

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Abstract: Automation is playing a vital role in the modern world. With the development of the embedded systems, the ability of electronics is crossing boundaries of limitations. A Radio station is one such phenomenal reach achieved by the modern engineering into the hearts of humankind. Community radio stations are operated, owned, and influenced by the communities they serve and they are generally nonprofit organizations. Due to the limited funds, the efficient working of the radio station, especially the human resource involved gets limited. By making the Radio broadcasting process an autonomous event, a major limitation of direct supervision by a human is eliminated and eventually more time, money and energy is also saved. The project uses a Real Time Clock for time synchronization and a GSM module along with a microcontroller for the automation of the radio station. The complete broadcasting process is monitored and controlled by a microcontroller and the live status is updated through text messages from a GSM module card. Thus enabling a completely automated, remotely controlled effective and efficient Radio Broadcast.

Keywords: Wireless communication; GSM network; Embedded System; Automation

I. INTRODUCTION

Radio broadcasting is a one-way wireless transmission over radio waves intended to reach a wide audience. Each radio broadcast is done from a ground station called the Radio broadcast station. There are basically three different types of radio broadcasting namely, the Commercial radio broadcast which is done by privately owned corporate media, as opposed to state sponsorship and it is mainly run for profit generated by the advertisements. Next is the Public Radio broadcast which is same as the commercial radio broadcast but it is run by a government on state or central sponsorship. Similar to the commercial and public radio broadcast services, the community radio service is done by a particular community in their own region.

Unlike the commercial radios, the community radios are generally non-profit organizations. The limited funds and human resources take a toll in the efficient working and utilization of these radio stations. The Radio broadcasting involves the broadcasting of pre-recorded or live programs through a transmitter and an antenna. The recorded audio files are played from a computer, whose audio output is fed to the transmitter through an audio console. The audio console takes care of amplification and conditioning of the audio signals. The transmitter, by the principle of frequency modulation broadcasts the sound waves in air with the help of a long range antenna, which converts the electric power into radio waves. Fig. 1 shows the overall radio broadcasting process.

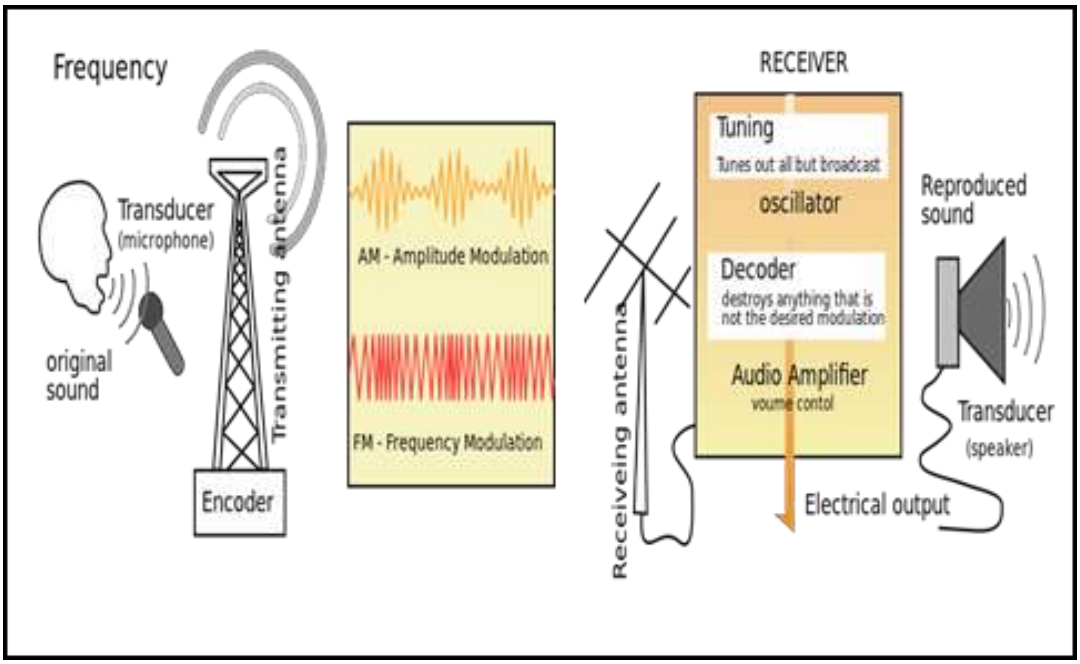

Figure 1. Radio broadcasting process

II. METHODOLOGY

The main idea of this method is to make the broadcasting process autonomous. The computer, audio console and the transmitter must be powered on simultaneously and the audio file must be played from the personal computer.

All these events must occur autonomously as per a programmed schedule and the status of these events must also be updated to the station engineer to facilitate a manual supervision. The process must also be remotely controllable so that in case of any change in schedule or malfunction, the process can be manually overtaken. To automate the broadcasting process, a closed loop logical control automation will be a best fit. In this type of automation, according to the programmed logic a direct feedback from the related devices are taken and accordingly the tasks are carried out. To implement such an automation for the radio broadcast, a basic set of devices/modules are essential as in Fig 2

- Controller or CPU
- A remote communication module
- A Real Time clock.(RTC)
- Electronically controlled switches

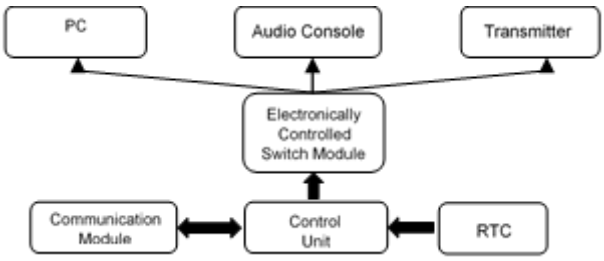

Figure: 2 Block diagram of the automation

An Arduino Uno board best fits the needs of this project. It is provided with an Atmel Atmega328P 8-bit microcontroller (µC). It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support a microcontroller.

The GSM module is a device which with the help of a SIM card, establishes GSM/GPRS communication with any device/machine over serial communication through its UART. SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. The DS3231 is a low-cost, extremely accurate I2C real-time clock (RTC) with an integrated temperature compensated crystal oscillator (TCXO) and crystal. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with an AM/PM indicator. Address and data are transferred serially through an I2C bidirectional bus.ULN2803 12V 8 channel electromechanical relay module is implemented to power on/off the devices connected. The ULN2803 is a Darlington array which helps the µC to drive the relays at 12 V.

The SIM900A module and the Arduino Uno are connected through their USART Tx and Rx pins. The RTC is connected through the SCL and SDA lines of the microcontroller. And the Relay module is connected to the I/O ports of the microcontroller. The automation is implemented with the above mentioned devices as shown in Fig.3

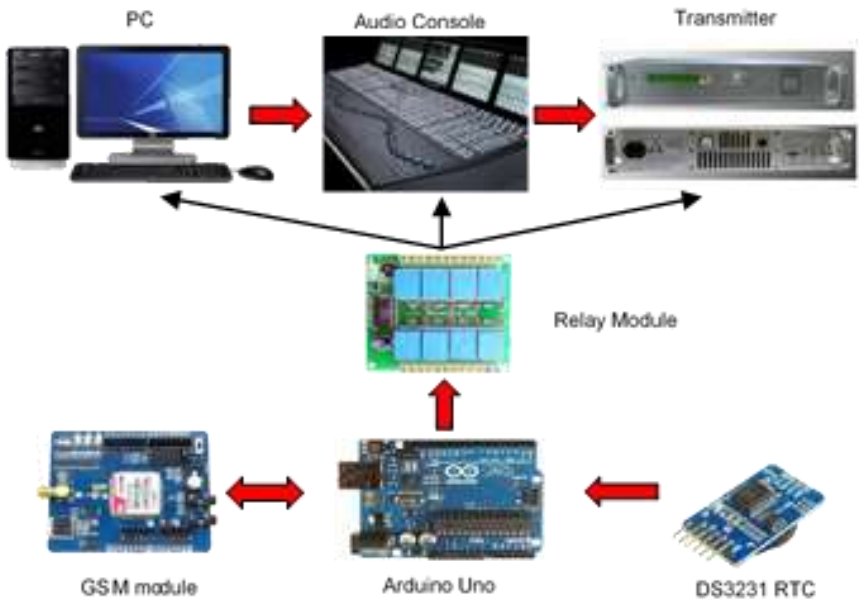

Figure: 3 Implementation of the automation

III. PC CONTROL

The PC is the main controlling device of the broadcast. All the audio files are played from the PC. To play the audio files, commonly used software are Winamp, Aimp Player, Itunes, Media Monkey, etc. In the broadcasting process, once the PC is powered on by the relay, the CPU of the PC has to be powered on again and after the Operating System (OS) loads, the music player must open and start playing the preloaded playlist of audio files. To make this sequence of tasks occur, the CPU power

button, which is a push button is connected to a opto-isolator and the opto-isolator is programmed to switch on and switch off for a short period of time.

A. Any operating system has a software feature called the Task Scheduler wherein one can create a schedule to open or close one or more programs as required at the required timings. By programming the scheduler, the audio playing software, say the Winamp is automatically opened and the audio files starts playing at the scheduled time. By programming the task scheduler, eventually the audio playing is also taken care by the automation system.

IV. PROGRAMMING AND CONFIGURATIONS

A. Programming Logic

The programming logic for the automation is broken down into simple steps and also made modular.

- The µC keeps track of time with the help of the RTC attached to it.
- The µC after reading time from the RTC, waits for any serial input from the GSM module.
- The module is configured in such a way that in case if the GSM module receives any new message, it is flushed to the µC immediately.
- The incoming serial data from the GSM module is first captured in a character array in the µC.
- The array is then searched for the sender's number. This is achieved by identifying the presence of "+91" and thus extracting the number from the array and storing it in a new character array.
- The number is checked with a set of pre-registered numbers and only if it matches, the program flow is continued, if it does not match, the buffer is cleared and the µC again waits for a new message.
- Next the array is searched for the presence of a delimiting character which helps in identifying the command present in the received message. The delimiting character used here is the hash tag "#".
- The command is fixed to a length of four characters. Hence the command after the delimiting character is extracted and stored in a separate character array.
- Now the extracted command is compared with a set of predefined commands and if a particular command matches, the respective task is executed and the appropriate response is sent to the GSM module.
- With the help of appropriate AT commands, the response is sent as a text message to a set of registered numbers.
- In case of any alarm, the µC is provided with interrupts from the RTC. Whenever the timer interrupts the µC, the scheduled task of the alarm is executed and similarly a response is sent as text message to the registered users.

B. Arduino programming

The objective of implementing a µC is to ultimately make the set of devices the required sequence of tasks by executing a set of instructions or codes fed into them as a program. Unlike other µCs which needs an external device to program, the Arduino board has its inbuilt programmer with the help of which programs can be uploaded to the µC just with a USB cable. The Arduino coding is done from the Arduino IDE, shown in Fig.5. It is a C/C++ based programming platform. The Arduino also facilitates easy integration of any external devices as it has a wide range of simplified libraries. One of the highlighting feature of the Arduino programming is that, it saves enormous amount of time spent on programming unlike programming a conventional µC.

C. GSM Module configurations

The SIM900A GSM module is provided with a powerful single-chip processor integrating ARM926EJ-S core. This enables the communication between machine and machine or man and machine with the help of a set of commands called AT (Attention) commands. The AT commands are a set of commands which are specifically used to control modems and exchange data with them. To use the GSM module, a valid SIM card must be inserted to establish communication with a 2G network. There two categories of AT commands namely:

The Basic commands which takes care of basic actions like initiating a call, attending a call, returning the online data status and few more actions. They include commands like AT, ATD, ATH, ATZ, etc. The Extended commands which are helpful in performing other tasks like sending a message, checking the network signal strength, etc .and include commands like AT+COPS, AT+CMGS, AT+CPIN, etc.

The module can be communicated from a PC over the RS232 terminal or a USB to Serial conversion bridge from any serial communication software like putty, HyperTerminal, Realterm, etc. Care must be taken that the baud rate set in the module must match the baud rate set in the device to be communicated. In order to provide a stable interface between the GSM module and the µC, certain configurations or initializations have to be done on the GSM module using the AT commands.

V. CONCLUSION AND FUTURE WORK

The radio broadcasting process might be a simple process to automate but practically nearly two hundred community radio stations are not fully functional due to the shortage of human resources. This project is a simple cost effective solution for almost all of the community radio stations.

Some of the salient features of this project are that it is fool proof and is accessible only by a group of registered users which ensures the safety of the broadcast. The project also has an accurate clock with the help of which up to ten alarms can be set and required devices can be controlled as per the alarms. Due to the usage of 2G network, the communication becomes more reliable. A highlighting feature of this project is that, a live feedback from the connected devices are sensed and accordingly the status reports are generated. In case of any fault in the broadcast and if at all any of the devices unexpectedly turns off, the automation system tries to restart it after regular time intervals and if the device remains faulty, an emergency alert message is sent to all the users along with the error message. The project is developed in such a way that, if required the system will provide periodic status updates of the broadcast and provision to add more devices to control and monitor remotely. This project is a maiden attempt and has been developed mainly for PSG Community Radio (107.8 MHz) where it was under testing for a span of three weeks and after minor customizations, the project has been incorporated by the organization. This project has made the PSG FM broadcast a completely autonomous one.

The project is relied mainly on 2G communication. All though this is reliable and the range is never an issue, the project may be implemented with a direct online control from the 3G or 4G networks. This can be implemented in a server-client architecture and a live monitoring can be enabled. An android app can be developed such that all the commands are available in the app as individual buttons and just a click on the screen can control the entire broadcast. In case of controlling any high power devices, the relays can be replaced with contactors. A separate backup power supply can be designed so that the system remains intact even when there is no power supply.

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Ethical Statement: The authors declare that they have followed ethical responsibilities.

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