A Wireless Quiz System using Low Power Microcontrollers

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Abstract --- **One of the many important parts of any multi-participant quiz game show is the Player Selection System. All participating groups are equipped with a selection button placed in front of them which can be used by them to give a response. The Player Selection System determines the group that gives the first response. Many of these systems used today are wired systems that consume a considerable amount of power. This paper describes a robust wireless quiz system using a low battery-powered microcontroller interfaced with a RF wireless transmitter.**

Keywords: Microcontroller, RF wireless transmitter, 802.15.4, MSP430, MSP430F2274, CC2500

I. Introduction

In a multi-group quiz competition, a question is put forth to the players and the one who responds first is the one who gets the opportunity to answer the question. This is done by visual, acoustical or electrical means. The problem with visual and acoustical means is that they often are not accurate methods for determining the first response. The requirement to determine the first response accurately motivates the need to have an electrical system for accurately selecting the participant giving the quickest response. The quiz system described in this paper is an electrical system that fulfills all the requirements of any ordinary quiz system with the added incentive of being wireless, which provides for added benefits such as ease of installation, portability, and reduced power consumption. The proposed system eliminates the drawbacks of currently used hard wired quiz systems.

II. Motivation

The objective of selecting the fastest response in a quiz game can be successfully achieved by means of a wired electrical system. However there are a number of drawbacks when such systems are used. These need to be addressed before one can actually start using the system. They are as follows:

1. All wired systems need to be physically disconnected and reconnected for every use, as all components are coupled together by means of wires.
2. Wired systems cannot be used outdoors or in extreme environmental conditions, unless specifically designed for it. This specification can incur a huge cost in the design of the system.
3. Numbers of participants within the game are required to be limited and every additional participant adds a significant cost to the overall system by increasing the cost for wiring, input to the player selection box, as well as power consumption. Therefore for adding more players into the game would require permanent physical changes to be made to the system and internal circuitry which increases the complexity of the selection circuit.
4. Another drawback of any wired system is that one needs to properly install each component and if any problem exists, there is always the possibility of loose connections due to wires or improper wiring.
5. The final drawback of wired systems is that they utilize an appreciable amount of power thereby adding to the functional cost of the system.

We can eliminate all of the above mentioned drawbacks of the wired quiz system by replacing it with a wireless quiz system that is operated using low power, low cost microcontrollers that are portable, inexpensive and robust. The advantage of having a wireless system is that one need not worry about factors such as correctness of installation, power input, number of players etc. The only action that the user of this product needs to take is to just power up the system and start using it.

III. System Overview

The developed system provides a solution based on the system requirements. The components of the system are described below.

A. Access Device: Quiz Master module

The following steps describe the order of operation of the Quiz Master module.

1. The quiz master module acts as the Access Device for receiving responses from the End Devices.
2. On initialization of the system, it acknowledges each end point trying to connect to it.
3. Once all of the end devices are connected, the quiz master can start the quiz.
4. The first response received from any player is displayed on the LCD screen.
5. The quiz master must press the reset button before asking the next question.

B. End Device: Participant Modules

The following steps describe the order of operation of the Participant Modules.

1. Participants use the end device to indicate their interest to answer the current question.
2. On power and initialization, the End Device tries to

connect with the Access Device.

3. On successful connection it indicates that it is ready for use.
4. After the Quiz Master indicates that it is ready, participants can start give their responses using the push buttons.

IV. HARDWARE DESIGN

The hardware used for this system consists of an Access Point microcontroller available with the Game master interfaced with a LCD module, and multiple End Point modules available with the participant modules.

Figure 1. The Game Master and End Point devices.

A. *MSP430F2274 Low Power Micro-controller*

The MSP430F2274 provides an excellent low power solution for the system described in this system. The microcontroller provides for handshaking signals (interrupts) to be used along with the Serial Peripheral Interface present on board used to communicate with the CC2500, the digital RF transceiver module. All data to be transmitted through wireless mode of communication is generated by the microcontroller based upon the status of the On-Board push button and the current condition of transmission and is pushed on to the CC2500 transmission stack. Once placed in the transmission stack, the CC2500 starts transmitting the data over the selected wireless channel with a 2.4 GHz frequency with the set conditions of the channel. The SPI communication is initialized in the 3 wire mode as there are no other slave devices besides the CC2500 and transmission/reception is done at a 1MHz clock speed.

Two different set of codes are written in C programming language for the system, one for the Access Point which refers to the Transceiver that continuously monitors the status of the players within the game and a second one for End Points that refer to the modules given to the participants to give a response. The operation of these codes is described in the Software Design section of this paper.

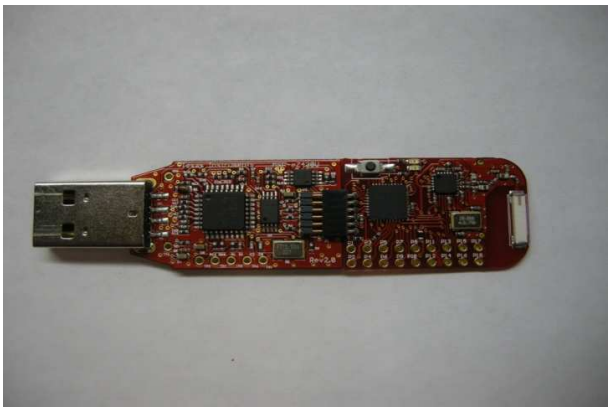

Figure 2. The Texas Instruments eZ430 RF Development kit.

B. *CC2500*

The CC2500, manufactured by ChipCon is a low cost RF transmitter and receiver used in many embedded wireless applications. It requires a minimum set of external components to be added to the pins in order to enable transmission and reception over a wireless channel. The chip has various special function registers (SFRs) that enable the user to modify the method of operation and communication. The baseband modem integrated into the CC2500 supports multiple modulation formats, data rates (up to a maximum of 500k Baud) and provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication and wake-on-radio.

The major operating parameters, including the special function registers (SFRs) and the 64-byte transmit/receive FIFOs of CC2500, can be controlled via an SPI interface. In a typical system, the CC2500 is interfaced with a microcontroller and a few additional passive components for successful communication. In the case of the wireless quiz system, the Microcontroller used is the MSP430F2274. A ready to use RF development tool available in the market is the eZ430RF2500 by TI is used for the quiz system.

Before initiating transmission/reception, the CC2500 needs to be initialized to the desired transmission/reception parameters using the available 54 configuration SFR s.

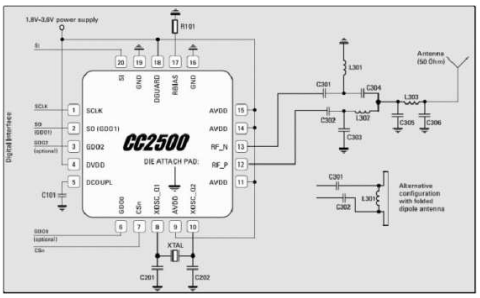

Figure 3. The Texas Instruments (ChipCon) CC2500 device.

C. JHD162A LCD Screen

The JHD162A is 16 x 2 LCD module used to display ASCII characters. The LCD can display a total of 16 characters in a row and has 2 such rows.

The LCD module includes an array of configuration registers and responds to incoming data as either a command or a data byte. Transmission of data to the module is done via the 4 bit data bus by passing the higher nibble followed by lower nibble of the data byte. All ASCII character data transmitted to registers 80H to 8FH and C0H to CFH, with handshaking signals, are displayed on the screen. Available hand-shaking signals are RS, R/W and E, out of which R/W is continuously grounded in order to keep the LCD in continuous write mode.

The objective of having an LCD module within the system is to precisely determine the player id of the first responding participant, the instant after which any further transmission is restricted till the Access Point is reset manually. Hence it acts as a front-end for the quiz master.

V. Software Design

The software codes for the system were written with IAR Embedded Workbench for MSP430 microcontrollers.

All the running codes that were written include the standard definitions for the MSP430F2274. There are two different sets of codes that are required to run the system.

The first set of code is for the Access Point micro-controller (present with the Game Master) and the second one for the End Point microcontroller (present at the player end). The pseudo codes for the same are described below. Each step in itself is a function that performs a set of task through the Embedded C language:

A. Access Point

The following steps represent the pseudo code explaining the operation of the Access point:

1. Initialize Microcontroller by turning off Power Saving mode and setting desired port pin directions
2. Initialize Microcontroller Serial Peripheral Interface (SPI)communication module to desired speed
3. Initialize CC2500 configuration registers by sending it the required values for setting up RF transmission parameters
4. Read RX stack in CC2500 via SPI
5. Check if there are any End points around
6. Add new end point address of End point received as the first byte to the list of End points detected and send acknowledge
7. Wait for data to be transmitted by any End point by checking RX stack
8. If no new data has been received, jump to step 4, else proceed
9. Check the data received and see if valid address has been received.
10. If data byte received has a valid address (player number), stop reception of all end points, transmit the address to the LCD module to be displayed on the LCD screen and wait for the Push Button to be pressed else discard data and go to step 4.
11. If Push button has been pressed, go to next step, else repeat step
12. Start Reception of data and go to step 4

B. End Point

The following steps represent the pseudo code explaining the operation of the End point :

1. Initialize Microcontroller by turning off Power Saving mode and setting desired port pin directions
2. Initialize Microcontroller Serial Peripheral Interface (SPI)communication module to desired speed
3. Initialize CC2500 configuration registers by sending it the required values for setting up RF transmission parameters
4. Transmit unique address of end point after every 1 second and check to see if any acknowledgement is received
5. If acknowledgement is received, got to next step, else go to previous step
6. Indicate valid connection by glowing LED.
7. Wait for player/user to press push button
8. If push button is pressed, proceed, else go to previous step
9. Fill the transmit stack of CC2500 and Transmit address of the player to the Access point and indicate same by glowing second LED for a fixed period of time
10. Go to step 7

C. LCD Driver

The LCD driver code is available with the Access Point. It is a standard code for 16 x 2 LCDs modified to be used with the MSP430.

VI. Conclusion

This paper describes the successful development and implementation of a wireless quiz system using low power, low cost microcontrollers for usage in general purpose quiz applications. An inexpensive system was built by means of a low cost microcontroller development kit for RF applications. The proposed system was successfully tested under real-time conditions and observed to produce all the necessary results. The battery life of the system can be extended by enabling the power saving modes of the microcontroller.

VII. References

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