POTD-Problem Based Alarm Clock

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1. Introduction

1.1 Objective

Getting up on time has always been a problem for many people. The very basic alarm that only makes clangorous sound often fails to wake people up, and often lead to people turning it off half-awake and falling back to sleep, which may cause a delay to their days. Setting alarm clocks with cell phones also has certain drawbacks. Often, the cell phone battery dies in the middle of the night, and thus the alarm fails.

To address this issue, we propose a problem-based alarm clock that requires users to answer several multiple choice questions to turn it off. The alarm clock is connected with a mobile app via Bluetooth so that users can load their own questions and setup time to wake up. The questions can be of any subject and are typed manually. The flexibility of questions gives users opportunities to review certain things as they like. The app also records the time it takes for them to wake up each morning and the result of their quiz.

1.2 Background

The process of thinking can stimulate people's brains and help people fully wake up, not only physically, but also mentally, according to Peter Balyta, President of Education Technology at Texas Instruments[1].

While waking up in the morning can be hard for a lot of people, there are many applications that attend to address this issue with problem-based approach in the market, such as the Mathe Alarm. It has both Android and iOS app that is available for free. Using this app, users are able to choose the number of simple algebraic questions they want to answer in order to turn off the alarm. The users can also pick the level of the math problems. However, it does not support custom questions and only have algebraic ones.

Moreover, in the current market, there is no physical alarm that has the similar functionalities. While some people use phone apps as alarm, many people still prefer to use physical alarm. According to a survey from market research firm YouGov in 2011 [2], while 48 percent of respondents aged 16-34 said they used their phone as an alarm, another 38 percent said they use either a clock radio or an alarm clock.

1.3 High-level requirements

- PCB must be able to function as an actual alarm clock: display time and alarm at the preset time
- PCB must load correct number of questions, check and record correctness of user input (answers to the questions) when the alarm goes off
- PCB must communicate with the Android app via Bluetooth to set alarm time and load questions, as well as send recorded user data back to the app for later analysis

2. Design

The project requires six sections of hardware and one section of software. The hardware contains power supply, microcontroller, external memory, Bluetooth module, user interface and an alarm. The main power supply is an approximate 12V battery power, which will be adjusted by variance voltage regulators for different components. The microcontroller can receive data from the external memory, the buttons and the software app, as well as send data to the alarm and software app. The external memory contains up to 256KB of storage for questions, time to alarm, ring-tone and other data. The software is an Android phone app which connects with the hardware via Bluetooth to send or receive data to / from microcontroller.

2.1 Block diagram

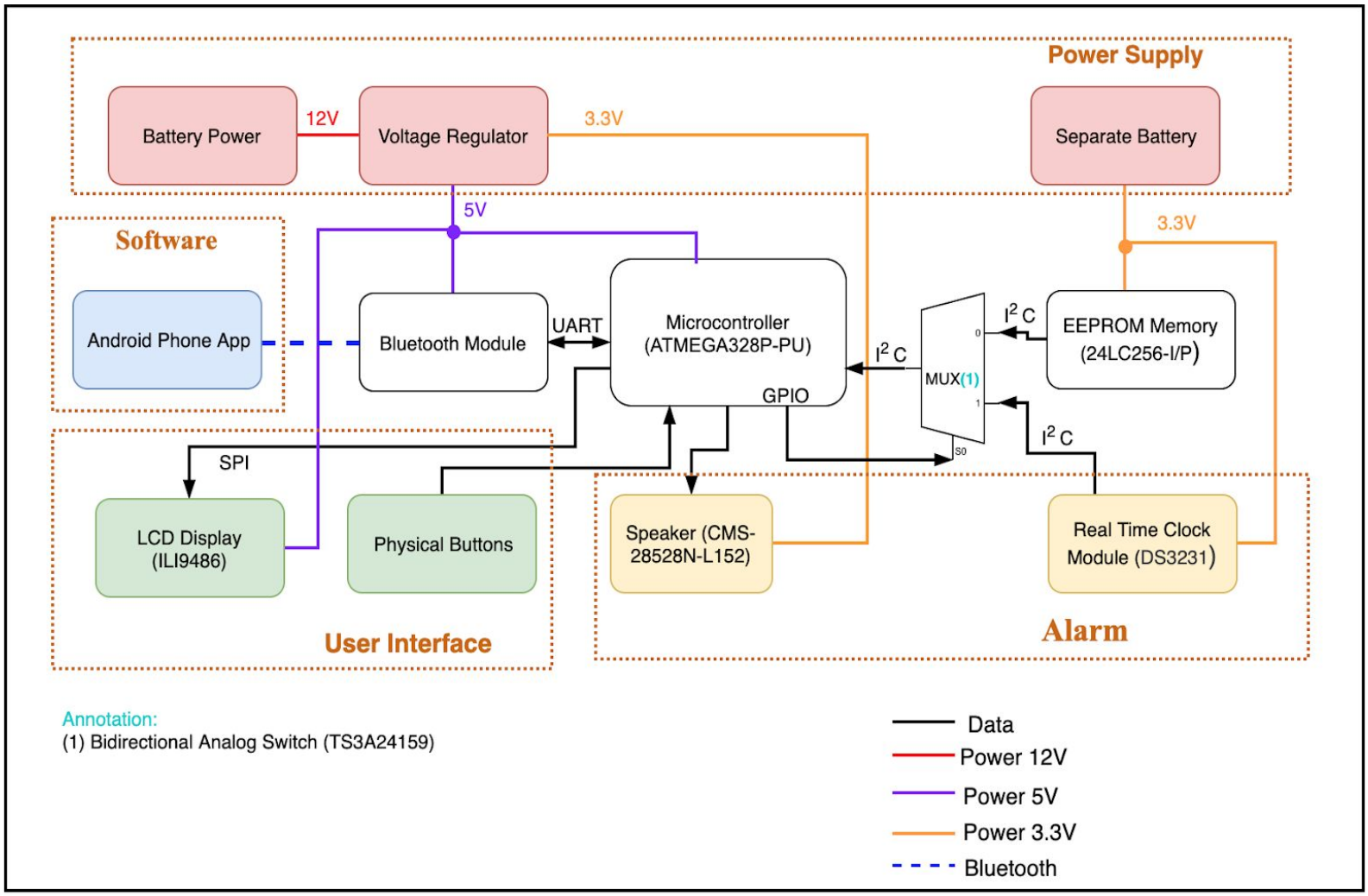

Figure 1. Block Diagram

2.2 Functional overview

2.2.1 Microcontroller

1. The microcontroller (atmega328p flash) receives and processes input from the external memory for questions and real time clock for time and loads data to LCD module for display as well as to the alarm, triggering it to go off at a certain time.
2. For the bidirectional 2-1 mux (TS3A24159), the control signal of the mux is from the GPIO of microcontroller. So the microcontroller can choose when and which input to

take in from the I2C (RTC or external EEPROM), and when to output data into the external EEPROM.

2.2.2 EEPROM memory

External memory (I2C Serial EEPROM (24LC256-I/P) 256k) is needed to store questions and user answer data, since microcontroller only contains very limited memory space. A separate battery is used to power the memory so data will not be erased when alarm is powered off.

Requirement: *Maximum number of questions stored: 30*
Question length constraint: 200 char
Answer length constraints: 25 char
*Integer for time: 10 digit (4 bytes*10)*
Memory estimated:
30(200 + 4*25) byte + (10*4)byte +*
some space to store user answer data + several ring-tone music < 256kB

2.2.3 Bluetooth module

Bluetooth module HC-05 is used to communicate between phone app and the microcontroller, so the users can load their questions into the alarm, and also can choose different ring-tone of the alarm. It is also used to send user answer data to the phone app when user's phone is connected to the alarm via bluetooth.

2.2.4 Power supply

The 12 volts battery is used to keep circuit powered, which works with variance voltage regulator to divide voltage for different components as needed.

A separate battery power is used for external memory, so the memory will not lose if the alarm is powered off, then user does not need to reload data into the memory.

2.2.5 User Interface

1. HiLetgo TFT LCD Display (ILI9486), used to display current time during the day and questions when the alarm goes off.

2. Four buttons that can be pressed for answering multiple choice questions (A, B, C, D) and one for signal to adjust time, the four buttons can also be used to select digits for time.

2.2.6 Alarm

1. DS3231 Real Time Clock Module to keep track of current time.
    a. DS3231 has its own battery-backup input for continuous timekeeping
2. CMS-28528N-L152 speaker to produce audio output to wake people up
3. Sound filter chip (LM386 Low Voltage Audio Power Amplifier) to filter out some noises

2.2.7 Software

An auxiliary Android app that communicates with the circuit via Bluetooth for users to type in their customed questions as well as setting alarm time. When connected to the circuit, the Bluetooth module will send back user answer, which the app will process and give a user daily wake up time report and performance report on the problems.

2.3 Risk Analysis

The communication between the microcontroller and external memory is a significant risk to the successful completion of this project. Because the memory of the microcontroller is very limited, using an external memory becomes necessary. The external memory is needed to store questions and data. If the microcontroller is not able to communicate with the external memory, then this project will fail completely. And because the questions need to be extracted from the external memory and be displayed to the screen in a matter of couple microseconds. Therefore it is key to figure out an efficient way to communicate with microcontroller and external memory.

The communication between the Bluetooth module and the Android phone app is another significant risk to this project. The Android phone app is used by users to load their own questions and set their alarm times. The information is sent to the Bluetooth module via Bluetooth. The Android phone app also display the daily time it takes a user to wake up and the statistics of the correctness of each questions. This function requires the Bluetooth module to send data determined by the microcontroller to the Android phone app via Bluetooth. So it is necessary to have a working Bluetooth communication between the Bluetooth module and the Android phone app. Otherwise, the Android phone app will not work at all.

3. Ethics and Safety

Lithium-ion batteries can explode if not handled properly (exposed to extreme temperature, overcharged etc). Also the voltage of the battery can be too high for sub components and can potentially cause damage to the circuit. Therefore, the voltage regulator must be properly connected to various components and adjusted to different voltages based on the requirement of that piece of component.

Privacy and security is a serious problem on the Internet. Information leaking is always the core issue of mobile applications. For instance, some apps track people's search history and send them advertisements based on that information. It is common to see some products searched yesterday pop up as a floating or static window.

Since we are collecting data from users on the mobile app, we must handle their information carefully. As the questions are manually created by users, they can potentially contain sensitive data, and thus the authentication of the application needs to be implemented properly. User information including account information and other relevant data will be stored in database in the server. Each user should have their own account with password and username and their information including question bank and the time it takes them to wake up each day are private data not be visible to other users.

Our application should align with the IEEE Code of Ethics, [3]"To accept responsibility.." there could be potential risks that result from having access to private user data.

References

[1] Hess, A. (2019). *10 highly successful people who wake up before 6 a.m.*. [online] CNBC. Available at: https://www.cnbc.com/2018/05/17/10-highly-successful-people-who-wake-up-before-6-a-m.html [Accessed 14 Sep. 2019].

[2] M. Floyd, “Almost 60% of 16-34 year olds use a phone as their primary timepiece,” *YouGov*, 05-May-2011. [Online]. Available: https://today.yougov.com/topics/lifestyle/articles-reports/2011/05/05/brother-do-you-have-time. [Accessed: 14 Sep. 2019].

[3] Ieee.org, "IEEE IEEE Code of Ethics", 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed 14 Sep. 2019]

Who encouraged African Americans to improve their economic and educational opportunities rather than fight discrimination directly?

A communist group in Russia, believed everyone should be equal. They overthrew the Russian Czar and sparked civil war. Vladimir Lenin was the leader of this group

A. Sri Ramachandra B.Augustus Caesar C.Bataan Death March

Basic:

1. 30 questions stored
2. Preset ringtone
3. Question length constraint: 200 char
4. Answer: 25 char
5. Total: 200 + 4*25 + 4 + some space + time display
6. Max: 350 bytes (display) + (
   30*300= 9000

Hardware:

Control Unit

- Microcontroller: atmega328p (flash)

Extend Memory: I2C Serial EEPROM (24LC256-I/P) 256k (not flash)

OLED display: Arduino Mega2560(ILI9486/ILI9488) via spi

Bluetooth module: bluetooth module HC-05 via serial communication

Power system:

- Variance voltage regulator
- Battery power
- Separate battery power for memory
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Alarm

- Sound filter chip: LM386 Low Voltage Audio Power Amplifier circuit
- Speaker: CMS-28528N-L152

Advance:

1. Customized music for ringtone