Voice Activated Scorekeeper

Team 31: Jason Hwang, Christopher Kalebich, Allan Zou

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TA: Enliang Li

1. Introduction

1.1. Objective

Pickup games are very casual and quickly organized games with either strangers or a group of friends. Due to its casual nature, there is no referee or scorekeeping system; rather, the players self-officiate and keep score themselves. Keeping track of the score can be especially difficult for games such as volleyball, where the games are played to twenty-five points. In addition, long rallies where players are focused on winning the current point result in players forgetting the score. As a result, players often ask what the score is after most points.

Our goal is to eliminate this problem by creating a visual scorekeeper that will allow players to know the score at a glance. In order to facilitate an easy user interface, the scorekeeper will be voice activated, where specific keywords are recognized in order to increment the score for each team. This allows for players to quickly update the score without affecting the flow of the game.

1.2. Background

A quick search through both the Google Play store and Apple App store reveals a multitude of scoreboard apps with many even tailored to volleyball specifically. These apps are often either very simple: keeping track of the score and time [1], or very complex: keeping track of timeouts, substitutions, rotations, and more, in addition to the score and time [2]. For a casual game of volleyball, the latter is much too complex. Instead, players are more likely to use the simpler application. While these simpler applications are almost perfect for casual games, they do not provide a quick and effective means of updating the score. Because they require touch-input, a separate

person, or a player must manage the device; neither option being ideal as there may not be more than 12 players.

1.3. High-level requirements list

- Score must be correctly changed through keywords spoken by a user.
- Battery should be rechargeable, and last at least 5 hours.
- Display should be visible from at least 30ft away.

2. Design

The block diagram shown in Figure 1 contains four subsystems: power, controller, user interface input, and user interface output. The power subsystem allows the battery to be recharged safely and in turn power the rest of the system for at least 5 hrs when supplying 3.3V. The seven-segment displays in the UI output subsystem must be large enough to be seen from the service line 30ft away. Since they will be larger than standard seven segment displays, the system utilizes a boost converter to increase the voltage from the voltage regulator in order to properly power the displays. Finally, the UI input subsystem contains a microphone which allows the system to capture the keywords spoken by a user and pass it to the microcontroller for processing and determining what action to perform.

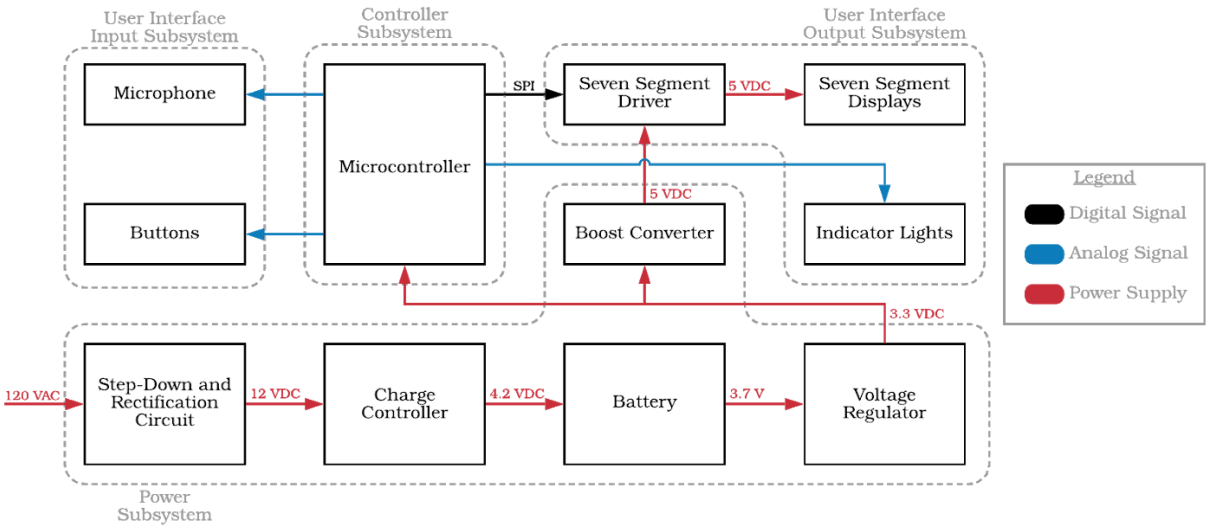

Figure 1: Block Diagram

2.1. Individual Block Overview

2.1.1. Step-Down and Rectification Circuit

The step-down and rectification circuit will utilize a transformer to reduce an input voltage of 120 VAC to 12 VDC. In order to change the voltage from AC to DC, a rectifying circuit will be used.

Requirements:

- Must step down the voltage from 120VAC to 12VDC.
- Must output 12 VDC ± 5%.

2.1.2. Charge Controller

The charge controller will supply the battery with a constant 4.2 V supply. More importantly, the controller will monitor the input charge current and stop charging once the current drops below 3% of the battery's rated current.

Requirements:

- Must provide the battery with a limited charging voltage of 4.2 V.
- Must stop charging the battery once the charging current drops below 3% of the battery's rated current.

2.1.3. Battery

A 3.7 V lithium-ion battery.

Requirements:

- Must provide a nominal output voltage of 3.7 V ± 3%

2.1.4. Voltage Regulator

The voltage regulator will output 3.3VDC while receiving variable voltage input from the battery.

Requirements:

- Must supply 3.3V ± 5% given input voltage may vary from < 3.5 V to > 3.7 V

2.1.5. Microcontroller

The microcontroller will receive input from the buttons or microphone, process the captured audio signal, and utilize the keyword spotting software to identify what action to perform. It will then output the proper signals to the indicator light and seven segment display driver.

Requirements:

- Must be able to receive more than five digital inputs for the buttons.
- Must be able to receive at least one analog signal.
- Must be able to convert a signal from analog to digital.
- Must have more than 100KB of flash memory.

2.1.6. Microphone

The microphone will pick up the keywords spoken by the user.

Requirements:

- Must pick up audio from a minimum of 10 ft away.

2.1.7. Indicator LEDs

The LEDs should light up when the microcontroller detects the keyword in order to give the user visual feedback that the device is listening.

Requirements:

- Must illuminate properly when biased with the specified voltage.

2.1.8. Seven-Segment Driver & Display

The seven-segment display will indicate the current scores of two teams, and the driver will be enable us to communicate with our seven-segment displays serially with an SPI interface.

Requirements:

- Must convert the digital serial input to the analog voltages needed for illuminating the display.
- Must be visible from 30 ft away.

2.1.9. Power/Increment/Decrement/Clear Buttons

Our device will have an increment & decrement button for both of the team scores to manually change the score value. The clear buttons will be used to reset the score to 0.

Requirements:

- Must provide pleasant tactile feedback.

2.1.10. Keyword Spotting Model

The software will receive as input a one second speech signal containing one word and should correctly identify the word.

Requirements:

- Must identify inputs with 90% accuracy.
- Must be no greater than 100KB.

2.2. Risk Analysis

The keyword spotting software is the most significant obstacle to this project. The decisions that the model makes determines what actions the microcontroller will take, so it is not wrong to say that it determines whether the entire project succeeds or fails.

A significant part of providing a good user experience is ensuring that our final keyword spotting model is accurate as possible. This poses significant challenges

however, since our microcontroller has a limited amount of memory. The final model should be no more than 100 KB. Another challenge will be supplying a sufficient amount of training data to train the model. It is likely that we will need to find an existing dataset, or multiple datasets that contain the keywords we choose.

3. Safety and Ethics

Our project does not infringe upon any of the IEEE and ACM Code of Ethics. The goal is simply to create a better scorekeeper for volleyball games. Our project is not a safety concern and complies with ethical design [3], [4]. It is also likely that our project will not be misused for harmful purposes, but rather useful cases such as other sports games like basketball or soccer. When considering safety and regulatory standards, we believe that this project has a very limited safety concern, with the main being the misuse of the lithium-ion battery used by the device. As the lithium-ion battery poses a security concern to our users, we plan to only expose the charging port and not allow them to remove it from the case. Voice recognition will not be a main issue, as voice recordings are not recorded by the device.

References

[1] D. Villegas, “Scoreboard - On The Go,” Version 3.1, *Apple App Store*, 2019. [Online]. Available: https://apps.apple.com/us/app/scoreboard-on-the-go/id1388012712. [Accessed: 19 Sep. 2019].

[2] D. Zrobok, “Volleyball Scoreboard:”, Version 2.8, Apple App Store, 2019. [Online]. Available: https://apps.apple.com/us/app/volleyball-scoreboard/id932240112. [Accessed: 19 Sep. 2019].

[3] D. Gotterbarn, “ACM Code of Ethics and Professional Conduct,” *Association for Computing Machinery*, 2018. [Online]. Available: https://www.acm.org/code-of-ethics. [Accessed: 19 Sep. 2019].

[4] “IEEE Code of Ethics.” *IEEE,* 2019. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 19 Sep. 2019].