Electronic Badge for Career Fairs

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ECE 445 Project Proposal - Spring 2020

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1. Introduction

1.1 Objective

Career fairs are an excellent place for students to connect with recruiters from a variety of companies and pursue roles that interest them in the most direct way possible. However, most students spend the majority of their time waiting in long lines for the more popular and well-known companies, which causes them to miss out on other promising companies [1]. This aspect hinders a student's ability to get as much benefit from a career fair as he or she should be able to. Additionally, as lion share of time goes away in standing in line for big companies, several promising but small companies get discouraged due to lower student volume at their stall. Another time consuming aspect of career fairs is the requirement of companies for the students to fill out electronic forms regarding necessary contact information for employment. This process is something that is repeated every time the student stands in line for a different company. Another issue many people overlook with regards to career fairs is the massive amount of paper that is printed for resumes [2]. Students can carry up to twenty resumes and so career fairs spawn tens of thousands of papers a lot of which get unused and wasted. In general, career fairs are plagued with a variety of problems which stem from inefficiencies in different facets.

Our main goal is to reduce a major portion of these inefficiencies by tackling the biggest problem which we consider to be the long lines and wasted time. Our solution involves building an electronic badge that students can carry around in career fairs that allows them to be placed in a virtual queue for a given company. This will grant students tremendous flexibility and allow them to be more productive with their time.

1.2 Background

As traditional career fairs struggle with inefficiencies, there has been a rise of virtual career fairs. They reduce paper wastage, have virtual queue systems and easy to apply interface for the candidates. This makes them a great alternative to traditional career fair. However, they suffer from lack of physical interaction, which is considered a key element in networking. Body language describes several qualities about a candidate and recruiters use it as a strong metric for selection [3]. Overall, in person interactions facilitate higher information richness and makes traditional career an essential aspect for recruiting. Hence, our solution to implement virtual queues aims to aid the traditional career and make it par with virtual career fairs.

Overall, virtual queues are becoming much more popular as more people are beginning to experiment with the concept. An example of this is amusement parks, which have adopted this idea by allowing visitors to queue up to different rides through a wearable [4]. This provides visitors flexibility to enjoy more rides and improves overall experience. Although easily available in other industries, the virtual queue technology isn’t widely adopted at career fairs which suffers from the same problem as amusement parks. If the virtual queue system is implemented in a traditional career fair, it could have several benefits for students and companies. Career fairs are sponsored by companies and if companies witness increased efficiencies, career fairs can charge higher prices and attract more companies. On the student side, it can increase the probability of getting through the company recruiting processes, which can result in higher employment/internship rate for university. Although seemingly simple, virtual queues can provide sustainable value to career fairs.

1.3 High-level Requirements

1. Electronic badge must be able to connect to the receiver with a tap (within 1 inch), and the student should be added on the virtual queue of the company.

2. Electronic badge must display current positions for a student for 3 virtual queues, alert them when the position is <10, and allow the student to remove himself/herself from the queue.

3. The receiver must maintain and process a virtual queue of upto 999 students, and send each badge the student’s position every 2 minutes.

2. Design

The virtual queue system will consist of 2 devices. The first is an electronic badge, which will have the student’s name, year and major printed on top of an underlying PCB. It requires 3 LED screens to display the student’s current position in the 3 queues, buttons to allow the students to remove themselves from the queue, and a buzzer to alert the student whenever their current position in any queue is < 10. It also requires an RFID tag to allow connection to the receiver with a tap, and a bluetooth module with long-range connection with the receiver, to receive position updates and send any commands to remove from queue. Lastly, it requires a microcontroller to contain the logic for all these moving and establish communication between them.

The second device would be an electronic receiver, unique for each company. The receiver will be mounted on a stand or a table. When the student taps the badge on a receiver, he/she will be added to that company’s queue. The receiver should also have a long-range bluetooth module which sends updated positions on queues to each badge every 2 minutes, and receives any commands to remove specific users from queue. When a student whose position is <10 on the queue taps on the receiver, the students must permanently be removed from the queue, as now he/she would be standing in the physical queue.

2.1 Electronic Badge

2.1.1 Block Diagram

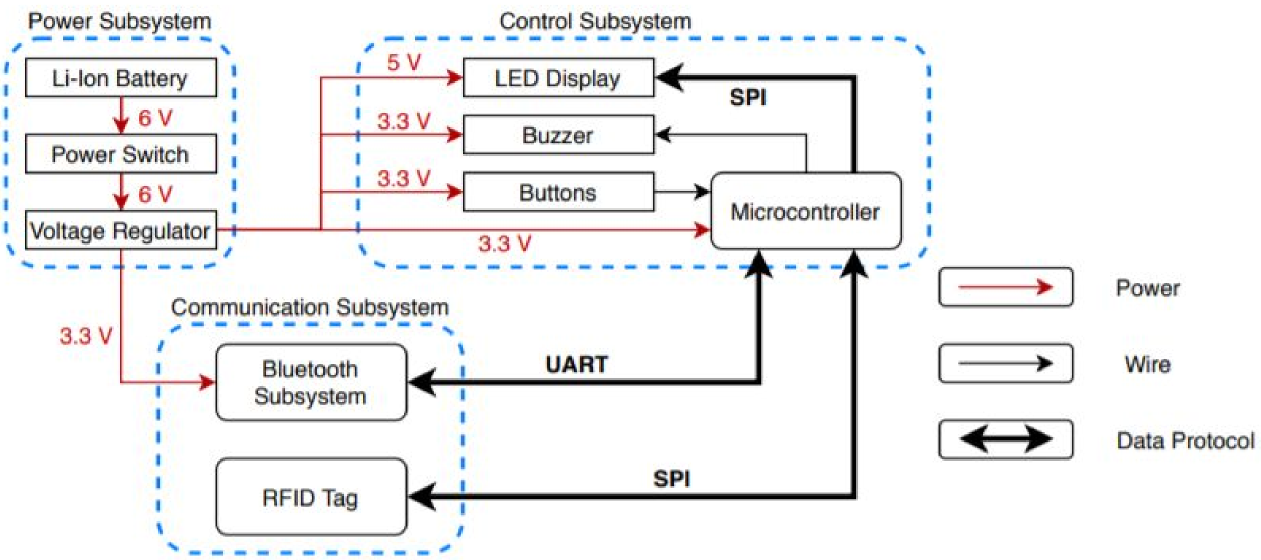

Figure 2.1: Block diagram

2.1.2 Physical Diagram

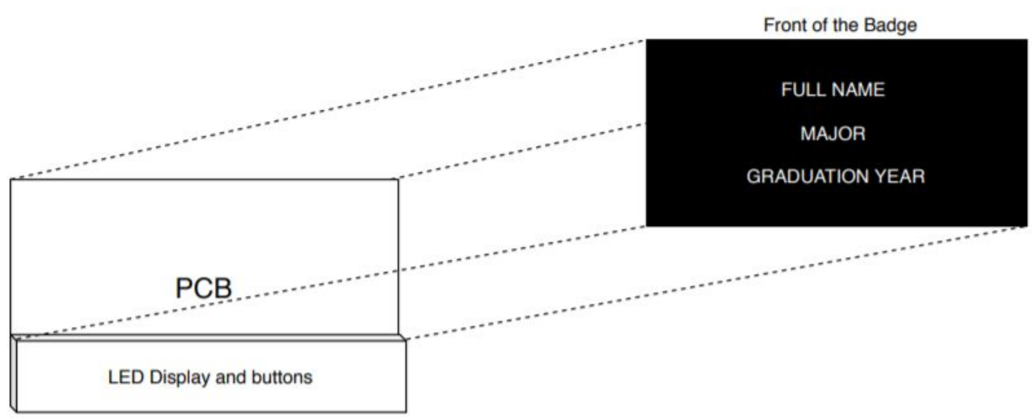

Figure 2.2: Block diagram

The black part will be hooked on the PCB and will cover the PCB board. It will be placed above the LED display and buttons.

2.1.3 Power supply

Li-ion battery

The lithium-ion battery must be able to keep the circuit continuously powered when switched on, and should be lightweight and small to fit on the electronic badge and not make it heavy. Additionally, it will need to last throughout the day in the career fair as we don't want students to go change the battery in the middle or keep it for charging.

Requirement 1**:** Battery should be able to output 5V to 9.5V and be able to provide it for 5-6 hrs (1500-2000 mAh)
Requirement 2: Should be safe and easy to handle.

Power switch

We don't want the device to run indefinitely, and would like to switch it off after use.

Requirement: A switch which disconnects the voltage regulator from battery when off and provides very less voltage (under 0.2 Volts) drop when switched on.

Voltage regulator

Different components in subsystems would require different voltages. Additionally, battery voltage drops over time, whereas various subsystems would need constant stable voltage. Hence, a voltage regulator would be needed to ensure stable and correct voltage is provided throughout the badge.

Requirement 1: Can provide 1-2 different voltage levels, particularly 3.3V and 5V as they are industry standard.
Requirement 2: Provides stable voltage level during its operation and ensures the subsystems don't get surge or under charged.

2.1.4 Control Unit Subsystem

Micro-controller

The microcontroller should be compatible with bluetooth module, RFID tag, LED display, and the vibrating buzzer. It must communicate with the Bluetooth module via UART and the RFID tag via SPI (Serial Peripheral Interface). Whenever it receives an updated position for the queues via bluetooth, it must update the LED display via SPI. It must trigger the vibration of the buzzer when any of the current positions are < 10. Lastly, if the button is pressed, it must send a request to the receiver via bluetooth to remove the user from the queue.

Requirement: The microcontroller must be able to communicate over both UART and SPI simultaneously and interact with different subsystems.

LED Display

The LED would display to the student his/her current position on the 3 virtual queues.

Requirement: The LED must clearly display the 3 current positions of maximum 3 digits each.

Buzzer

The vibrating buzzer soldered on the underlying PCB should be able to alert the student when his/her current position on any of the 3 queues is < 10.

Requirement: The vibrations should be strong enough to be recognized by the user, but not too strong. The vibrating mini motor disk should work with 2V-5V input voltage, which would be adjusted based on the required strength of vibration.

Buttons

There should be 3 buttons (one for each virtual queue), which when pressed, should allow the student to remove himself/herself from the corresponding queue.

Requirement: Buttons should be easily-pressible but should not be too sensitive to touch.

2.1.5 Communication Subsystem

Bluetooth module

The bluetooth module must be BLE (Bluetooth low energy eg. RN4871). This means it would have low power consumption, few milliseconds of connection time and high data rate. This module must be able to establish a connection with the receiver every 2 minutes to:

1. receive the updated position of the user on the queues and send them to the microcontroller.
2. send a signal to remove the user from the queue when commanded by the microcontroller.

Requirement 1: The module must be BLE with an input voltage requirement of 3.3V.
Requirement 2: Must establish a connection with the receiver's bluetooth module every 2 minutes, and thus must be long-range bluetooth (50-100 m).
Requirement 3: Must communicate with the microcontroller using UART to send the updated positions, and receive commands for removal from queue.

RFID Tag

The RFID tag should be able to activate when close enough to the receiver and send relevant information (UIN) to it, to allow students to be put on the virtual queue. It should be fast enough and should only work within a very close range as we don't have the system to work without a tap.

Requirement 1: RFID tag activates when within 1 inch of receiver and sends the corresponding UIN.
Requirement 2: Should be cheap to mass produce such badges.

2.2 Electronic Receiver

2.2.1 Block Diagram

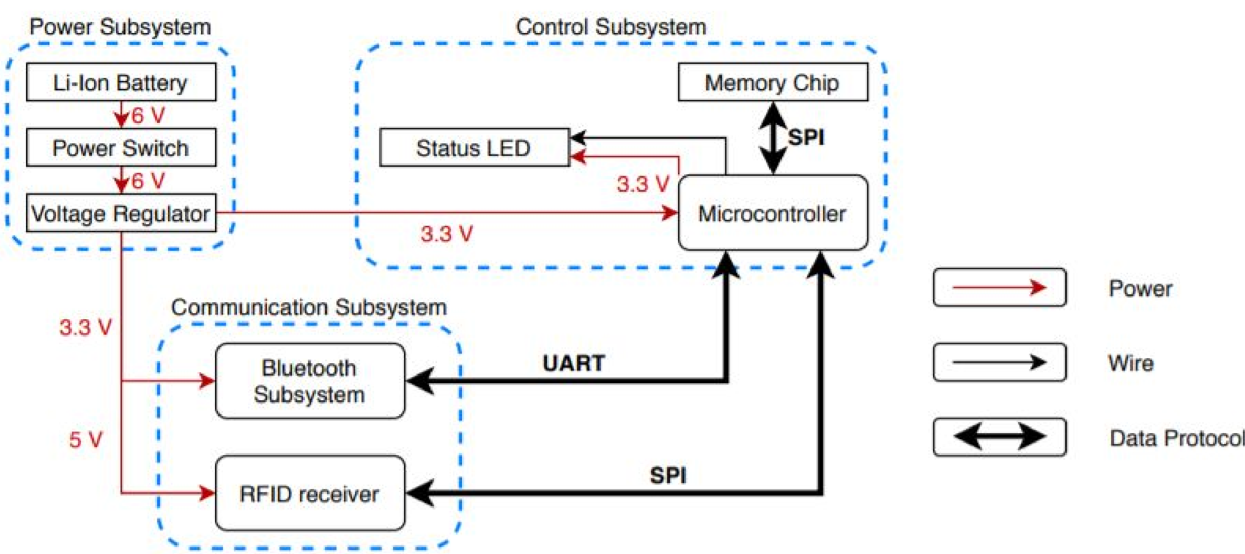

Figure 2.2: Block diagram for Electronic Receiver

2.2.2 Power Supply

Li-ion battery

The lithium-ion battery must be able to keep the circuit continuously powered over a long period of time.

Requirement: A 5V battery which is able to provide power for 5-6 hours (1500-2000 mAh)

Voltage regulator

Different components in subsystems would require different voltages. Additionally, battery voltage drops over time, whereas various subsystems would need constant stable voltage. Hence, a voltage regulator would be needed to ensure stable and correct voltage is provided throughout the badge.

Requirement 1: Can provide 1-2 different voltage levels, particularly 3.3V and 5V as they are industry standard
Requirement 2: Provides stable voltage level during its operation and ensures the subsystems don't get surge or under charged

Power switch

We don't want the device to run indefinitely, and would like to switch it off after use.
Requirement: A switch which disconnects the voltage regulator from battery when off and provides very less voltage (under 0.2 Volts) drop when switched on.

2.2.3 Control Unit Subsystem

Memory chip

It should be able to store the virtual queue for the receiver, which would be a maximum of 1000 entries, and must communicate with the microcontroller via SPI.

Requirement: Storage capacity of around 5-6 kB with at least read/write speed 0.1 kbps. (Industrial standard is way ahead, so might get over-qualified chip)

Micro-controller

The microcontroller should be compatible with bluetooth module, RFID reader and status LED. It must communicate with the Bluetooth module via UART and the RFID reader via SPI (Serial Peripheral Interface). Whenever it receives information regarding a new tap from RFID reader, it must add the student to the stored queue, and inform the student that he/she has been added via the status LED. Additionally, it must send the updated positions of each badge through bluetooth, and must remove any student from the queue if it receives the command through bluetooth. Lastly, when a student whose position on the queue is < 10 taps again, the student must permanently be removed from the queue.

Requirement 1**:** The microcontroller must be able to communicate over both UART and SPI simultaneously.
Requirement 2**:** Must have memory chip storage of at least 10kB for accommodating a virtual queue of a 1000 students and logic for maintaining it. Must also have read and write speeds of ~ 4.5Mbps.

2.2.4 Communication Subsystem

Bluetooth Module

The bluetooth module must be BLE (Bluetooth low energy eg. RN4871). This means it would have low power consumption, few milliseconds of connection time and high data rate. This module must be able to establish a connection with each electronic bade every 2 minutes to:

1. Send the updated position of each user on the queue to each badge.
2. Receive a signal to remove any user from the queue and forward the command to the microcontroller.

Requirement 1: The module must be BLE with an input voltage requirement of 3.3V and fast connection time.
Requirement 2: Must establish a connection with each badge's bluetooth module every 2 minutes, and thus must be long-range bluetooth (50-100 m).
Requirement 3: Must communicate with the microcontroller using UART to receive the updated positions, and send commands for removal from queue.

RFID Receiver

We need the receiver to activate RFID tags and receive UIN information. It should also be able to send this information to the microcontroller so that the system can maintain the virtual queue.

Requirement 1: RFID receiver activates RFID tag within 1 inch range and receives corresponding UIN.
Requirement 2: Connects to microcontroller and can successfully send it the received UIN.

2.3 Risk Analysis

The biggest obstacle and a fundamental piece of our project is the communication subsystem which involves the bluetooth module. One of the main risks is the ability of our bluetooth module to be able to handle a range of upto 100m with regards to the communication between the electronic badge and receiver. Although there are several options available for bluetooth of this range, our requirement for low energy will make this more challenging to make sure that all the other modules can also function smoothly. Along with this, bluetooth range can be impacted by a variety of factors like physical obstacles or interference from other bluetooth or WIFI devices (since they share the same frequency), factors which will definitely be significant in any type of career fair.

It is vital that the badge retains its connection with the receiver through all of these potential issues as this is how the student will be aware of his/her position on the queue as well as be alerted when he is tenth in the queue. As there is no method to alert the receiver that the updated position was successfully received by each badge, testing and preparing for failure may be hard. The bluetooth connection also dictates whether the student will be able to remove himself from a given queue through clicking a button. All of this functionality corresponds to the second and third of our high level requirements. Regarding the acceptable tolerances for the component, it is clear that as mentioned above, all students need to periodically be made aware of their current position on the queues. Although our aim is to ideally send this position on each badge every 2 minutes, it may be tolerable to have a few failures in the cases of some students regarding this information transfer, as they would be receiving another update within the next 2 minutes. We would have to make sure that the failures are rare, and does not lead to missing any vital information by any of the devices (eg. alerting the student when he/she is 10th in queue).

3. Safety and Ethics

When considering the ethics of our project we made sure to consult the IEEE code of ethics which consist of 10 different guidelines. Based on these guidelines, our project doesn't have any significant issues to breach the outlined ethical code, but there are some things that are worth talking about.

Some of these ethical issues relate to the eighth listed guideline of the IEEE code of ethics which says "to treat fairly all persons.." [5]. In certain cases, some of the parts which are used in our project, like the LED display or bulb could stop working due to overuse or other unknown reasons. This could result in some students not being able to use an electronic badge of their own to take advantage of the virtual queue system. We will therefore have to make sure we are aware of this as we build our badge and focus on using good quality parts. Another ethical issue which could unfairly impact some people is if they are talking to a certain recruiter and their position comes up for another virtual queue causing them to miss their place in the other queue. To counter this issue, we decided to have the badge alert them when they are tenth in the queue so that they have enough lag time to make their position. Another ethical issue could arise if the cost of the badge is placed on the students which could result in some students missing out on the product. Ideally this issue would not be present given the badges are handed free of cost from ECS itself.

The first and ninth listed guidelines of the IEEE code of ethics are also very important which say "to hold paramount the safety, health, and welfare of the public..." and "to avoid injuring others..." respectively [5]. These guidelines connect well with safety problems that could arise for our project which will be further elaborated upon. The two biggest safety issues for our project involve the Li-ion battery and the badge design. When it comes to the Li-ion battery, these can overheat with a lot of usage and when this goes to extreme levels, it has the potential to catch fire [6]. Although this is very rare, it is an important safety hazard and definitely something we have to be mindful with regards to the usage for both the electronic badge and receiver. Another safety issue is if a student drops the badge by accident, which could cause damage to the badge for future use and result in the parts being scattered across the floor. It is therefore very important that the badge is made to be as sturdy and durable as possible to avoid such a safety hazard.

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