UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

Team 38
# Good2Go Automated Token Exchanger (GATEr)
ECE 445

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Table of Contents

- **Good2Go** (G2G) is a service used by U of I dining halls

- Old container -> redeemable token -> new container

- Current problems
  - Lacks unification
  - Relies solely on human supervision

Objectives

- Automate service with 2 key functions

  - Exchange token for a clean container

  - Exchange old container for either token or new container

- Complete exchange process within 15 seconds

- Dispense exactly 1 new container at a time without jamming

- Correctly detect invalid G2G containers via 2 verification processes:

  - Overweight containers (>10g)

  - Invalid G2G QR codes

- Physical tokens -> digital tokens

  - Added convenience and security

Project Overview
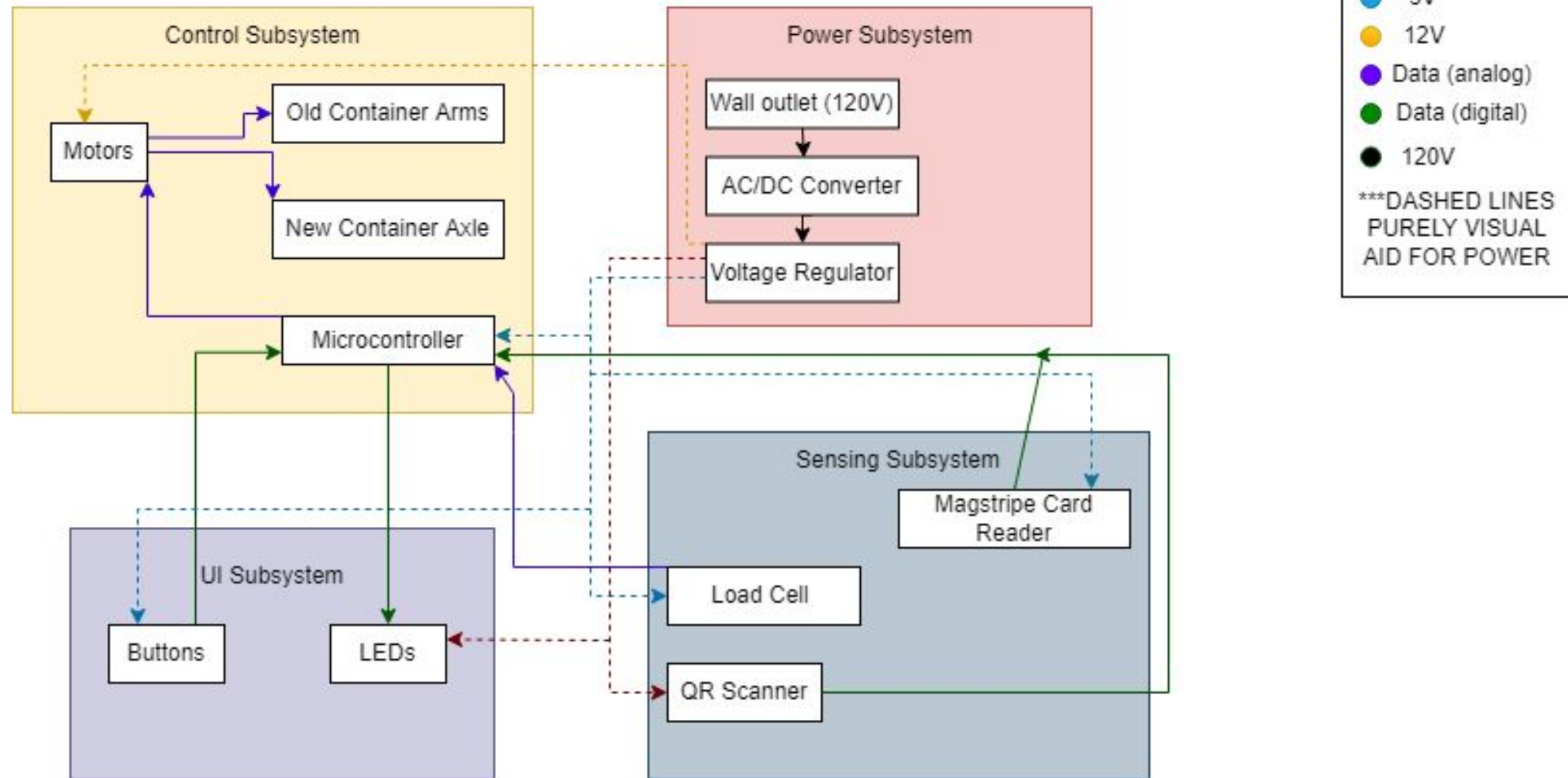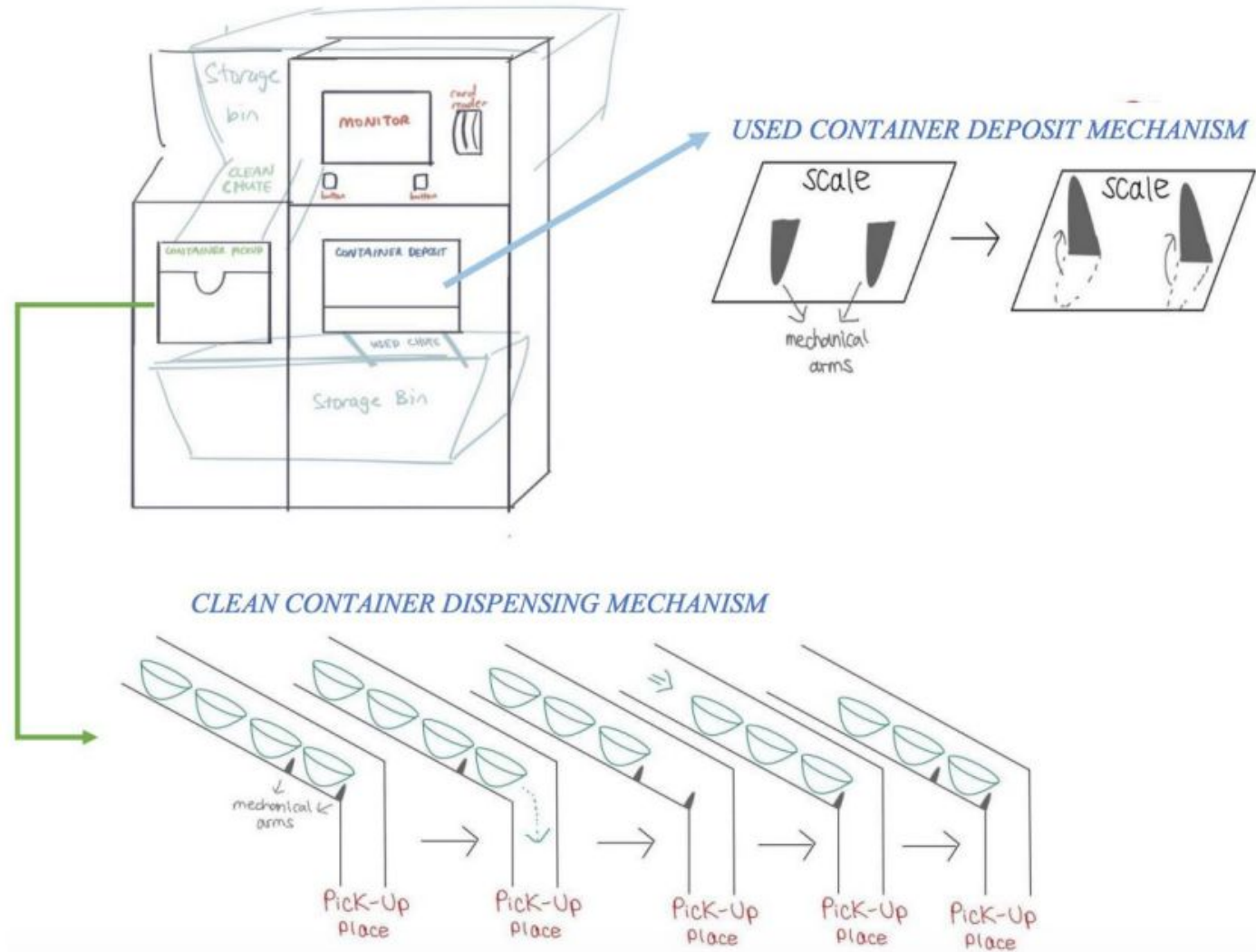
Changes from Original Design

- Downsize overall size of contraption

- Utilize a conveyor belt style of dispensing rather than have 2 mechanical arms retract

- Use of LEDs for status of machine rather than an LCD display

Requirements

1. Power all components in accordance with their rated

   voltage within 5% variance

Verification

1. Probe voltage running through each component,

   ensuring that measured voltage is within 5% of rated

   voltage

- Left side of PCB supplies expected voltage to each component
- Able to convert 12V from power supply into voltage value within 5% of 5V for AtMega328P

- Right side of PCB initially had a voltage drop

- 12V delivered from power supply does not convert

  into a value within 5% of 5V for ATTiny85

- Cause of drop was a corroded voltage regulator and

  a missing capacitor

Requirements

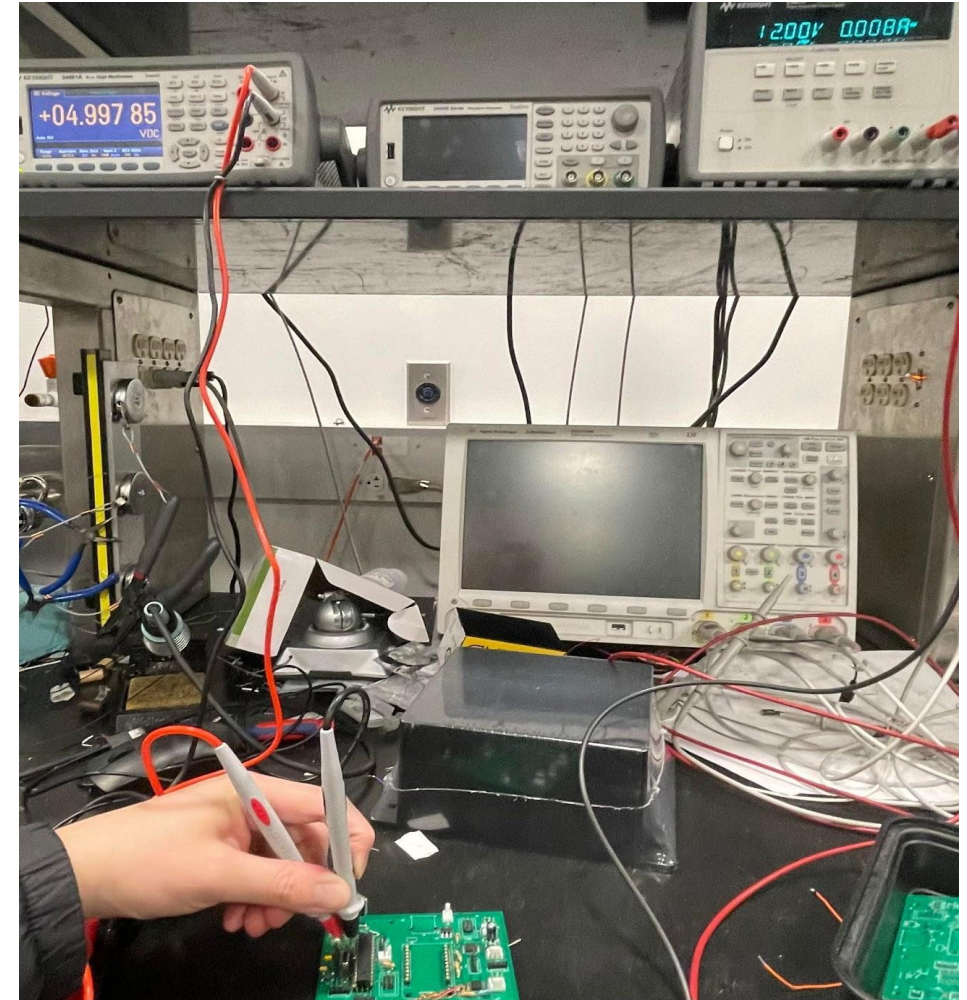1. Power all components in accordance with their rated voltage within 5% variance

Verification

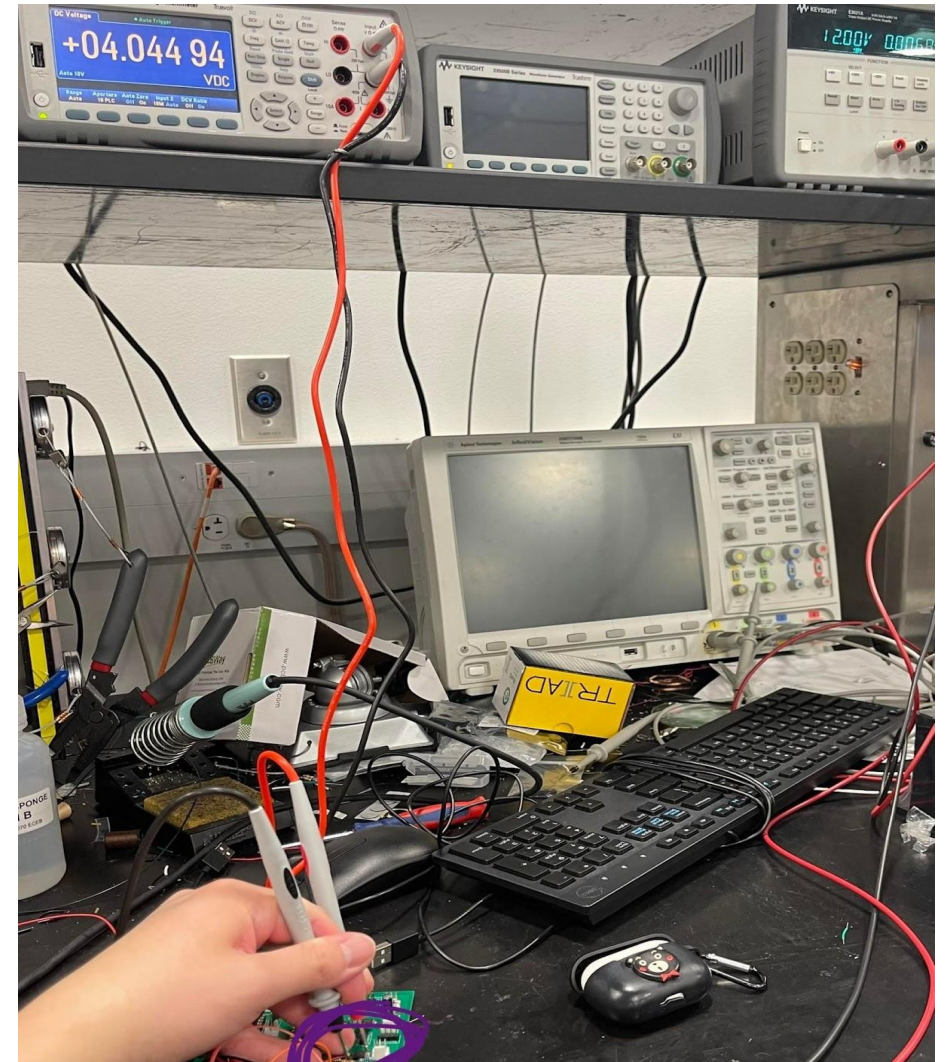1. Probe voltage running through each component, ensuring that measured voltage is within 5% of rated voltage

Validity

1. Yes!

- Able to power all components on PCB properly after fixing the issues

Requirements

1. Keep track of user's token count

2. Correctly keep track of user input

Verification

1. Check invalid tokens, storing tokens, using tokens

2. Execute specific action based on user selection

Validity

1. Yes!
2. Yes!

- Tokens are stored and updated successfully
- User cannot dispense a new container if they have no tokens
- Buttons execute correct action based on user input

```
RETRIEVING
SELECT dispense option
your updated token num: 1

CARDHOLDER/UNIVERSITY
UIN: 667474
card successfully read


your current token num: 1
Select Deposit option
Chose token
your updated token num: 0
DISPENSING
```

```
Start
CARDHOLDER/UNIVERSITY
UIN: 667474
card successfully read


your current token num: 0
Select Deposit option
Chose token
invalud num of tokens
```

Requirements

1. Able to scan QR code and measure weight on G2G containers

2. Execute retrieval and dispensal for valid G2G containers

Verification

1. Check if QR code enables a correct scan and load cell measures mass properly

2. Reject containers that are overweight or have an invalid/no QR code, while executing retrieval or dispensal for valid containers.

Validity

1. Yes!

2. Yes!

- Valid QR codes pass and weight is able to be read

- Machine rejects invalid containers properly, continues in state machine for valid containers

```
CARDHOLDER/UNIVERSITY
UIN: 66747█
card successfully read


your current token num: 0
Select Deposit option
Chose container: put container and scan
reading QR
3213
QR successfully read       <- Success with
1                             verified QR code
weight: 3.23    <- Valid weight
RETRIEVING
SELECT dispense option
```

```
CARDHOLDER/UNIVERSITY
UIN: 66747█
card successfully read


your current token num: 0
Select Deposit option
Chose container: put container and scan
reading QR
3213
QR successfully read    <- Success with verified QR
1                          code
weight: 11.47   <- invalid weight
invalid container
```

Requirements

1. Machine should complete exchange within 15 seconds from start to finish

2. Dispense exactly one container upon a dispense request without any mechanical issues

Verification

1. Repetitively time how long it takes to complete the exchange from start to finish

2. Repetitive tests, check if only one container is dispensed

Validity

1. Will be validated in the video!

Project Build

G2G system at U of I dining halls is only a service, not a product

- Physical Design:
  - Downscale
  - Retrieval & Dispensing mechanism
  - QR scanner continuous mode & Field of View
  - Transparency of containers
  - Needed a retrieval system + accurate weighing scale
   - Load cell with two arms beneath

State Machine
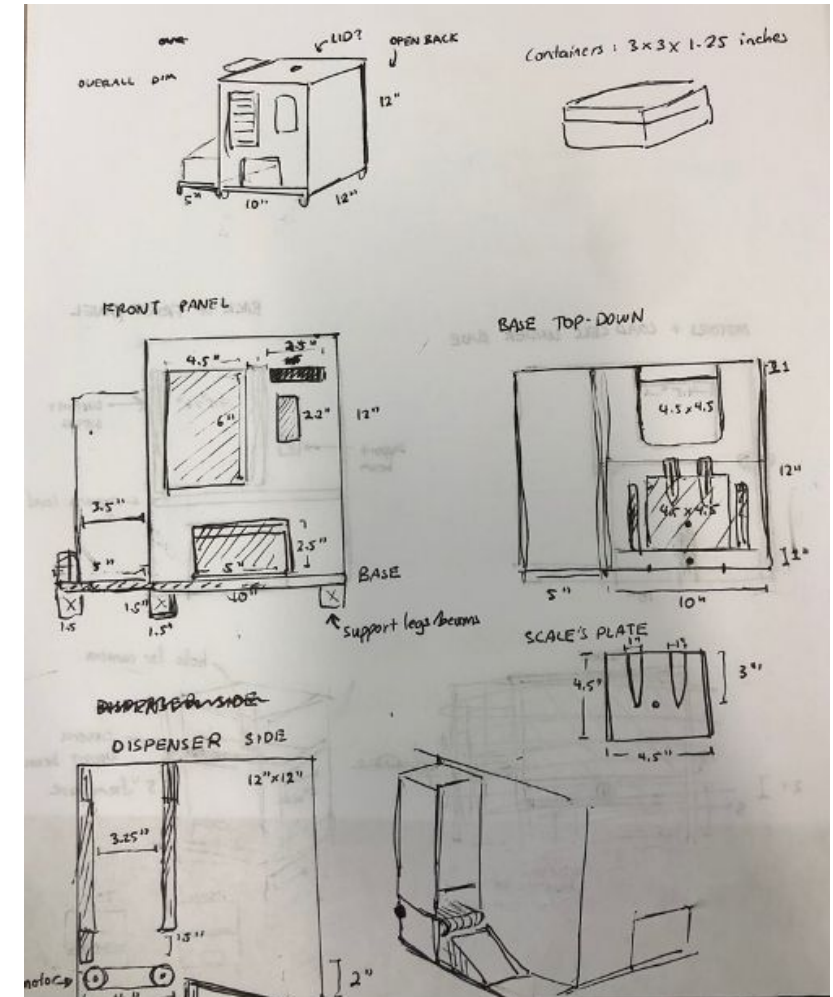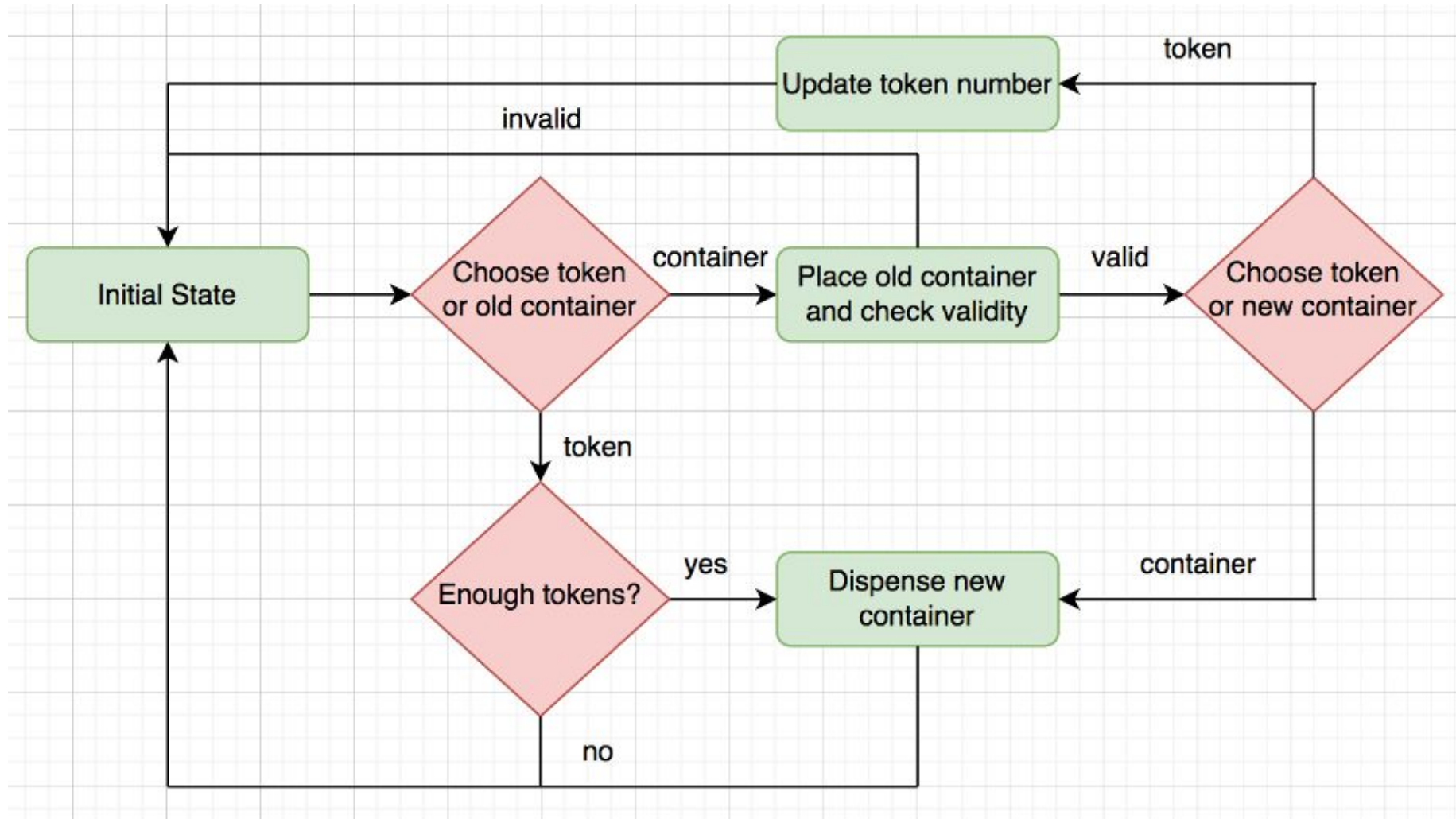
Servo Motors

- Non-continuous motor: RPM & angle tuning

- Continuous motor: RPM & duration tuning
  - Using PWM: pulse of ~1.5ms to stop motor
  - Calibration (adjustment screw & potentiometer)
  - 0 (CW full speed), 90 (stop), 180 (CCW full speed)

Issue: erratic behavior when powered

Solution: separate power supply, 470uF capacitor, software

Card Reader (iCard)
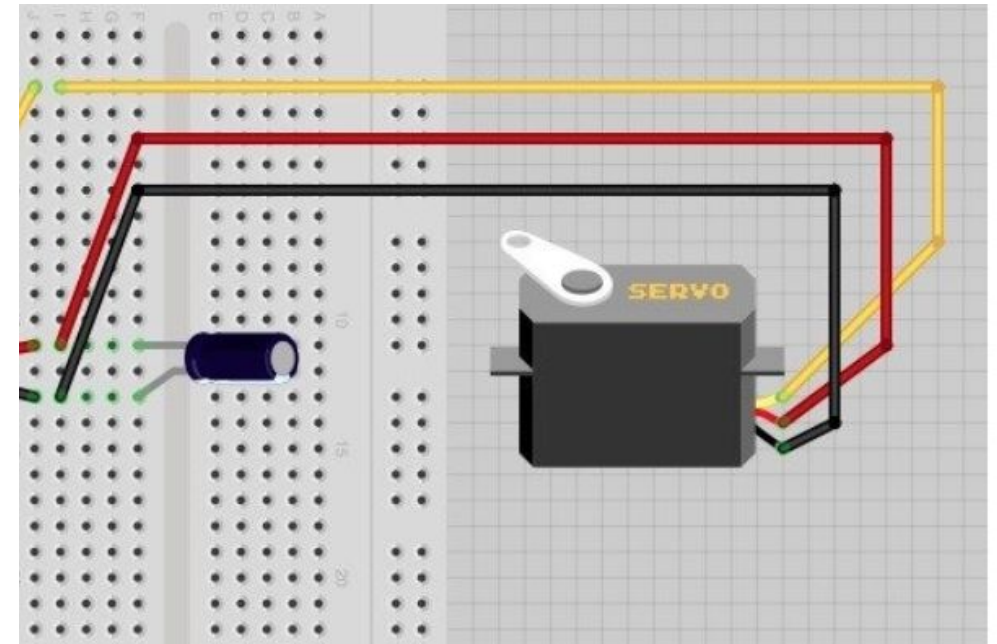
CARDHOLDER/UNIVERSITY
UIN: 667474████
card successfully read

- Interfacing with HID device, debugging driver code

- Failure with MSR 123
  - USB protocols (Product ID)
  - Device Descriptor

- MSR 90
  - Modify to handle only key-down interrupts
  - 3 tracks (header, data, unused)

RightShift changed
DN   >22< S
ASCII: %
RightShift changed
UP   >22< S
RightShift changed
DN   >05< S
ASCII: B

QR Scanner

- Reading/Writing to address of QR
  - Mode change to continuous
  - UART scan commands
  - timeout value

- Dynamic vs Static QR
  - Dynamic: encoded information changes
  - Static: fixed information (may become obsolete)

```
reading QR
3213
QR successfully read
```

Issue: UART serial port buffered upon failed

container return due to multiple scans

Solution: clear serial buffer if invalid

Load cell

- Strain gauge load cell & Amplifier
  - Convert load into electric signals
  - Degree of voltage change -> digital reading as weight

- Calibration process:
  - Software to set to 0 and place known weight
  - Adjust calibration factor (-7500)

weight: 3.23
RETRIEVING

weight: 11.47
invalid container

Issue: easy fluctuation in measurement when first inserted

Solution: delay measurement until QR scanner validation completes

Video

Link: https://www.youtube.com/watch?v=p8fdRb78moU&t=1s

Design Choices

- LED vs Display (LCD)
  - Imitate behavior of a vending machine
  - User information abstracted
  - At most 1 token needed

- Stepper vs Servo motor
  - High torque at high speed
  - Feedback (closed loop)

- QR vs Barcode
  - Barcode for small data
  - QR for human error
  - Orientation

- RFID vs Magnetic Card Swiper
  - iCard
  - Reduced layer of identification

- Success:

  - Physical solution to current G2G system ✔

  - Integration with iCard ✔

  - Full functionality achieved ✔

- Work in Place:

  - Power supply component

  - PCB modification

    - USB Shield

- Hardware

  - Separate power supply for motors

  - Wiring in downscaled container

- Software

  - Integration: USB task and UART communication

- Parts & Components

  - Machine shop

- Learning: soldering, abstraction details

- Database
  - Store more information (different containers, date)
  - Limited write cycles for on-chip memory
  - Scalable if using several G2G machines

- Display
  - Allow multiple choices and selection
  - Display non-sensitive account information (token)
  - Easy use with on screen instructions

Potential Ethical Issues

- Security
  - No layer of security
  - Data loss

- Safety
  - Mechanical jamming
  - Lack of warnings/alerts
  - Motors at high speed

Thank You For Listening!

Any Questions?

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