Bluetooth Enabled eWalker
Team 4

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Agenda

- ❑ **General Introduction**
- ❑ Design
  - ❑ Smartphone Subsystem
  - ❑ Control Subsystem
  - ❑ Power Subsystem
- ❑ Conclusions from the Project
- ❑ Future Ideas
- ❑ Questions

Motivation

Technological Advancement

- ❏ Smartphone interface is very common
- ❏ Walkers left behind

Problems with existing designs

- ❏ Lighting and charging features
- ❏ Flashlights
- ❏ No IoT

Solution - High Level Requirements

Button Functionality

- ❏ Initiate calls/texts within 8 seconds

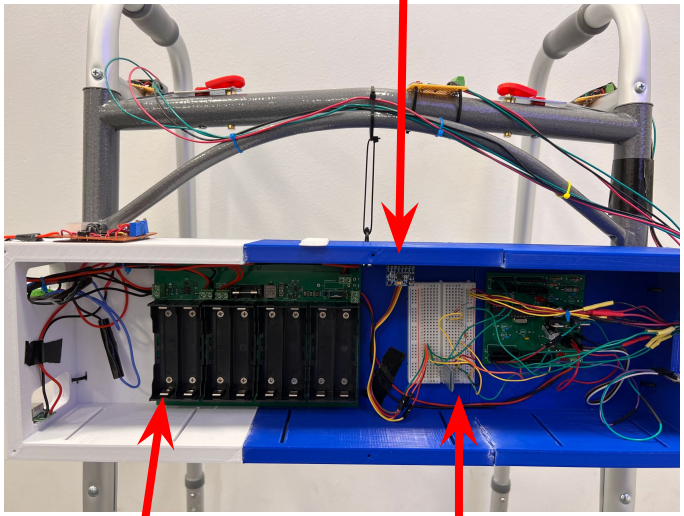
Messaging System

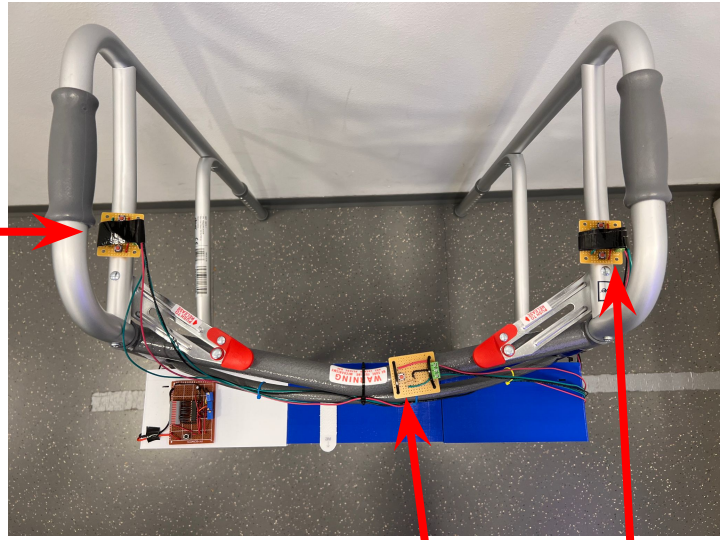
- ❏ Send different text messages based on the severity of the situation

Power Unit

- ❏ Rechargeable battery pack of 20800mAh capacity
- ❏ 5V 2A USB Type A charging ports
- ❏ Provide 9V 1A to the control unit.

Visual Aid


Gyroscope
Power Supply
Bluetooth Module


Text/Call Contact 2
Emergency Call
Text/Call Contact 1

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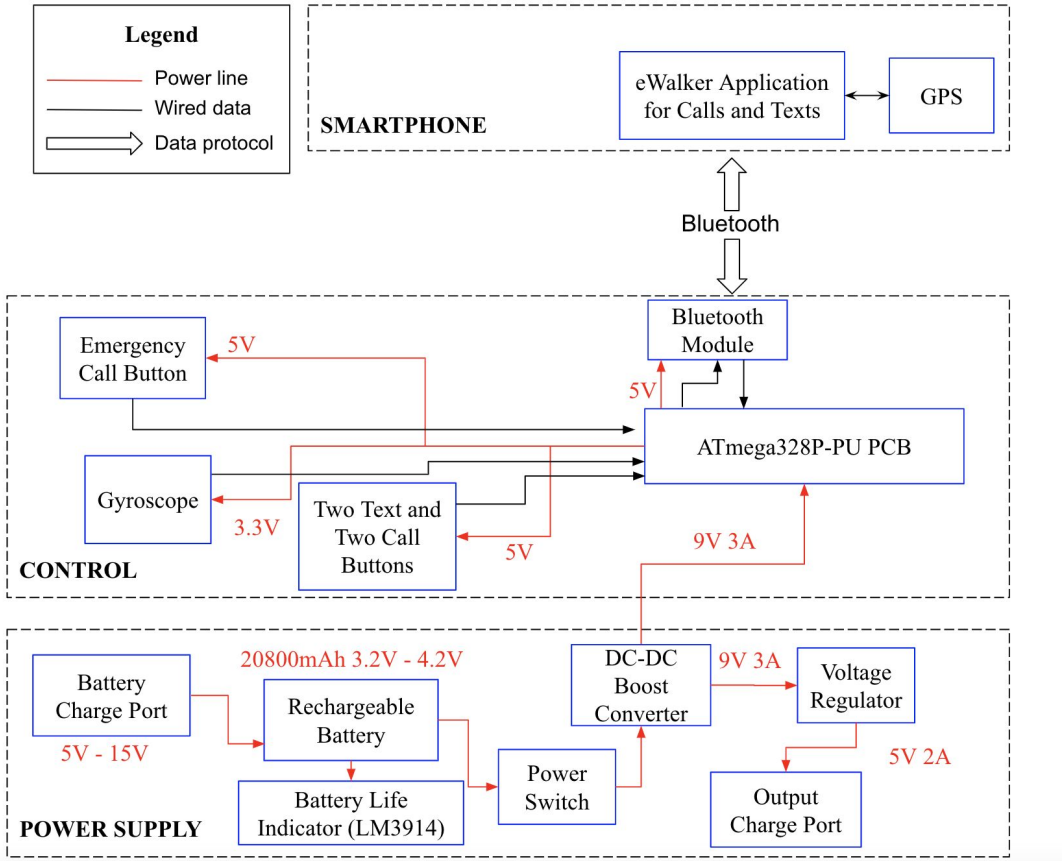
Block Diagram



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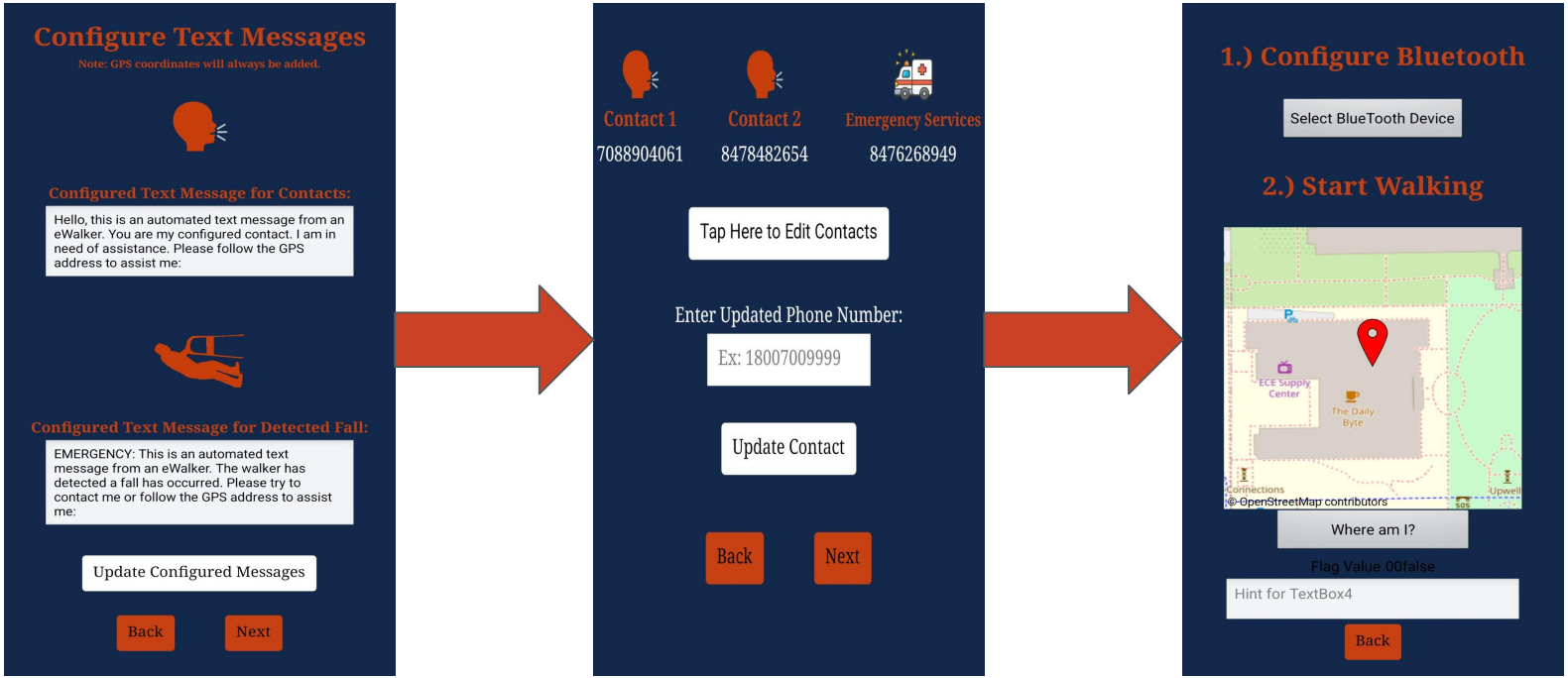
Smartphone Subsystem - eWalker Application

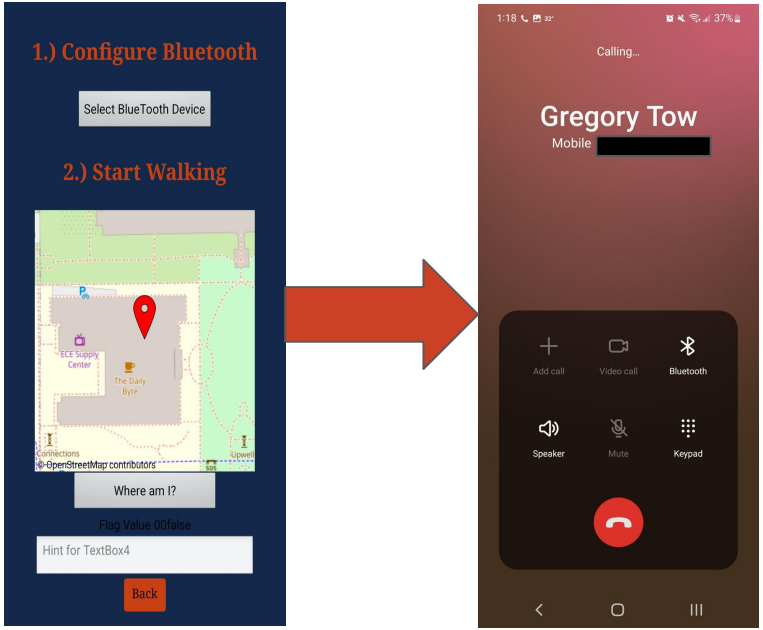


Smartphone Subsystem - eWalker Application Bluetooth

Flag Value:	Logical Response:
00	Do Nothing
A / B	Text Contact 1 / Contact 2 Configured Message
C / D / E	Call Contact 1 / Contact 2 / Emergency Services
Z	Text Contact 1 AND Contact 2 Configured Emergency Text Message

Smartphone Subsystem - Challenges

- ❑ Properly configuring API for text messages.
- ❑ Initializing Bluetooth pairing
- ❑ Permissions with direct calls



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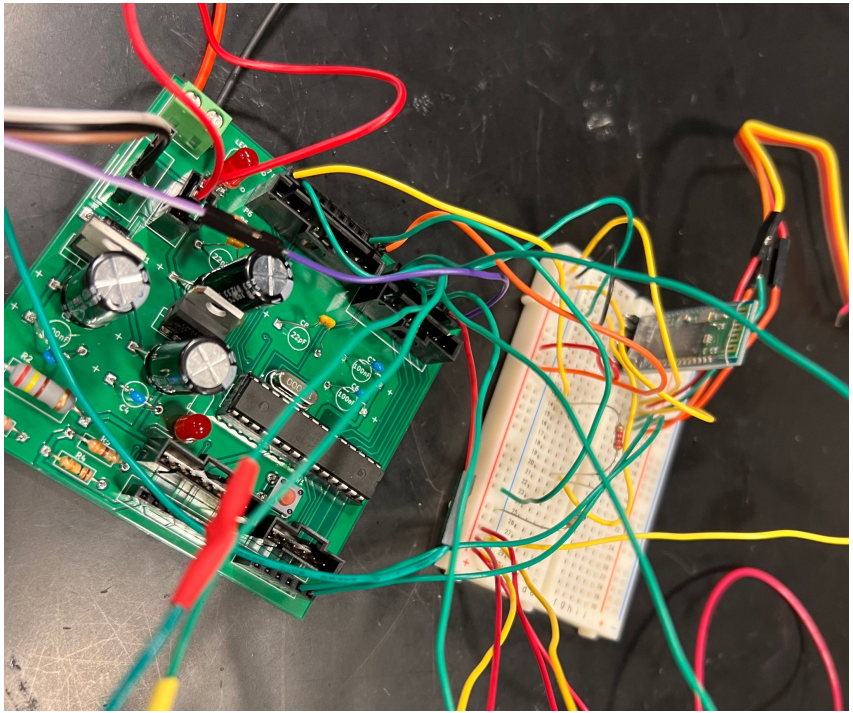
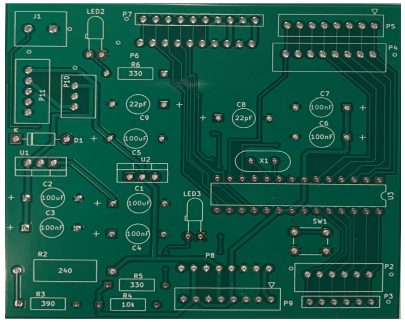


Control Subsystem - ATMega328P-PU PCB

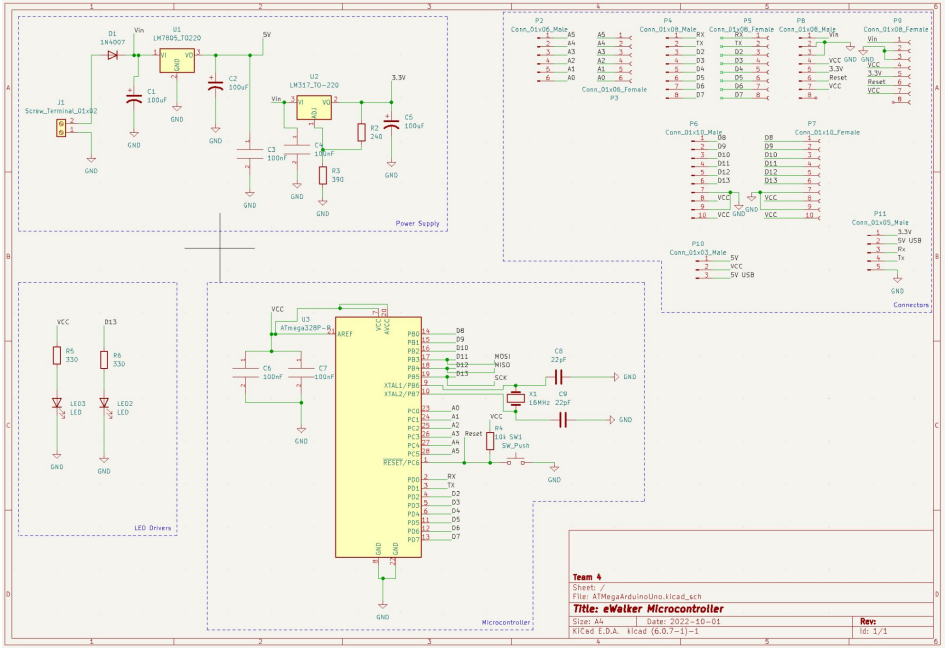
- Power supply, Connectors, LED Drivers, Microcontroller
- Replicates functions of an Arduino Uno
- Collect and process data from PCB, push buttons, and gyroscope

80.3mm



76.9mm

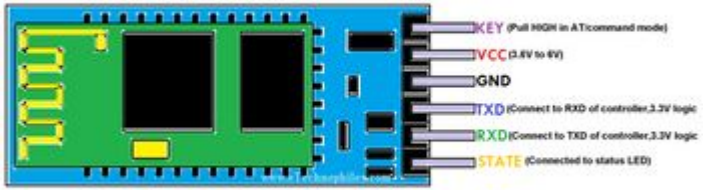
PCB Layout



PCB Schematic

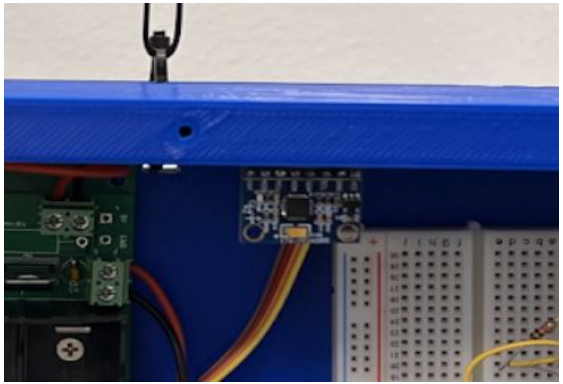
Control Subsystem - HC-05 Bluetooth Module

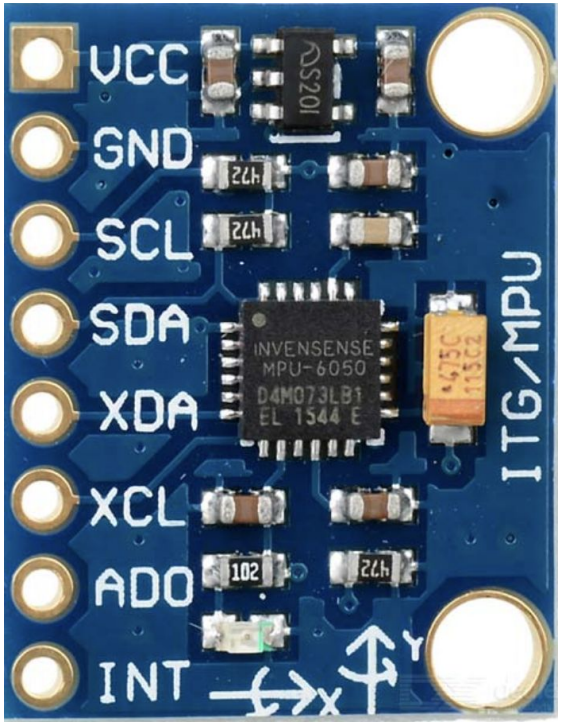
- SoftwareSerial package on Arduino IDE converts ASCII
- Only TXD is required to transmit data
- Receives power from microcontroller



Control Subsystem - Gyroscope

- GY-521 MPU6050 6-axis gyroscope sensor
- Interfaces with the ATMega chip to send signals to the bluetooth module





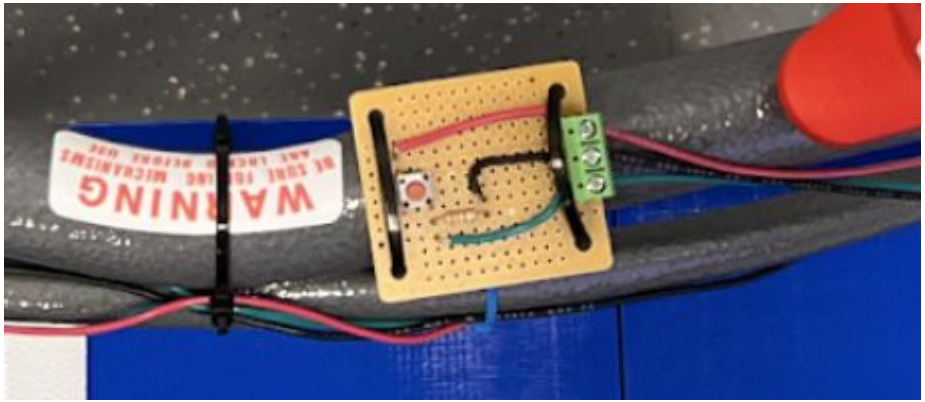
Control Subsystem - Gyroscope

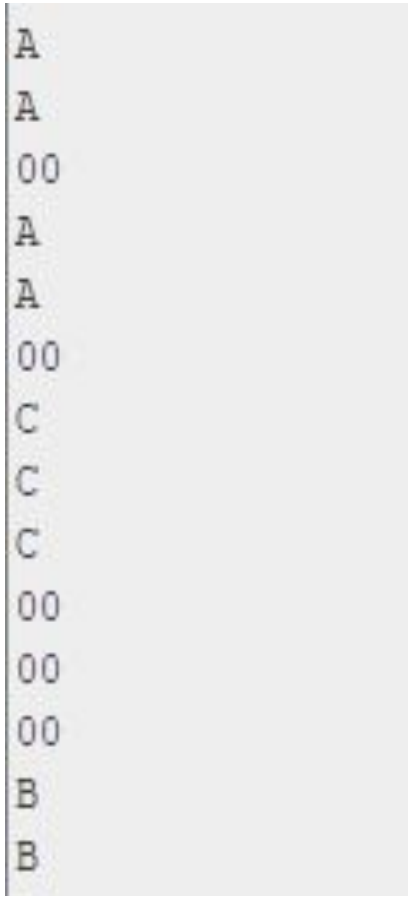
- Code adapted from provided source code
- aZ and aY variables are used for orientation tracking
- Values >15000 or less <-15000 for 8 seconds trigger an emergency text

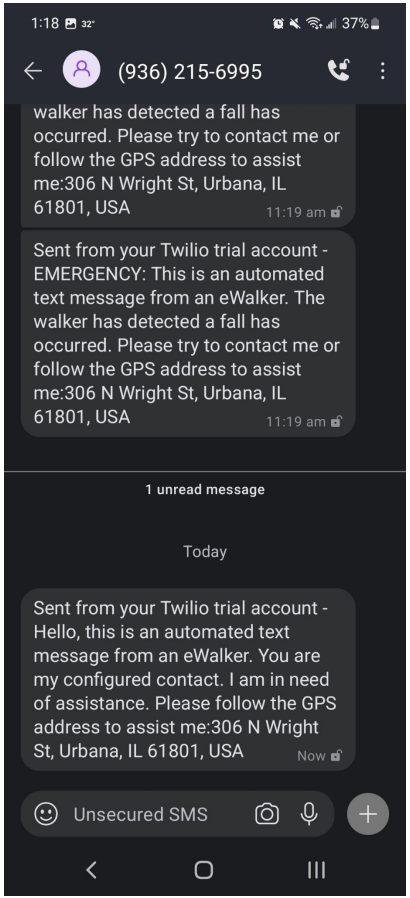
```
aX = -15932 | aY =    160 | aZ =   1068
aX = -15648 | aY =     48 | aZ =   1124
aX = -15880 | aY =    128 | aZ =   1256
aX = -15844 | aY =     20 | aZ =   1296
aX = -15772 | aY =      0 | aZ =   1260
aX = -15808 | aY =    160 | aZ =   1300
aX = -15748 | aY =     16 | aZ =   1132
aX = -15784 | aY =     68 | aZ =   1252
aX = -15848 | aY =   -564 | aZ =   1612
aX = -18572 | aY =   -816 | aZ =   1540
aX = -14776 | aY =    148 | aZ =   4680
aX = -12832 | aY =   -356 | aZ =  10776
aX =  -6872 | aY =   -300 | aZ =  14232
aX =  -7836 | aY =   -892 | aZ =  18008
signal high
signal low
aX =  -1764 | aY =   -428 | aZ =  17400
aX =  -1604 | aY =   -464 | aZ =  17340
```

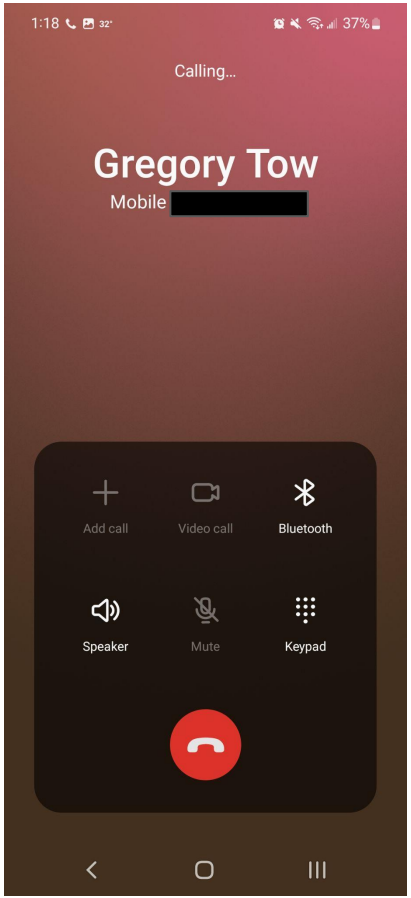
Control Subsystem - Text/Call Push Buttons

- Used E-Switch TL1105AF100Q model for our buttons
- Left and right side designated for contact 1 and 2 respectively
- Center designated for emergency call



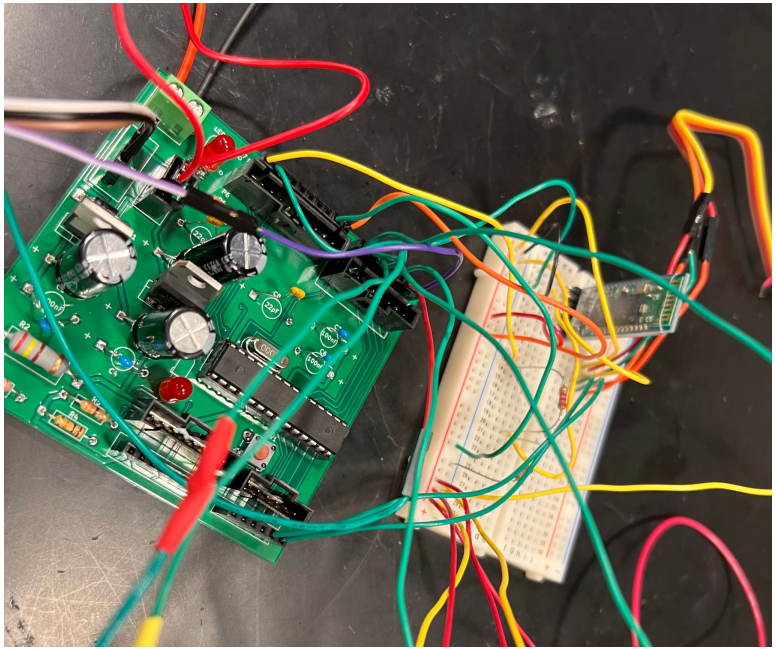

A
A
00
A
A
00
C
C
C
00
00
00
B
B


1:18
37%
(936) 215-6995
walker has detected a fall has occurred. Please try to contact me or follow the GPS address to assist me:306 N Wright St, Urbana, IL 61801, USA
11:19 am
Sent from your Twilio trial account - EMERGENCY: This is an automated text message from an eWalker. The walker has detected a fall has occurred. Please try to contact me or follow the GPS address to assist me:306 N Wright St, Urbana, IL 61801, USA
11:19 am
1 unread message
Today
Sent from your Twilio trial account - Hello, this is an automated text message from an eWalker. You are my configured contact. I am in need of assistance. Please follow the GPS address to assist me:306 N Wright St, Urbana, IL 61801, USA
Now
Unsecured SMS


1:18
37%
Calling...
Gregory Tow
Mobile
Add call
Video call
Bluetooth
Speaker
Mute
Keypad

Control System Challenges

- Stabilizing the signal communication between the ATMega and the eWalker application
- Code upload to the ATMega chip
- PCB layout and soldering



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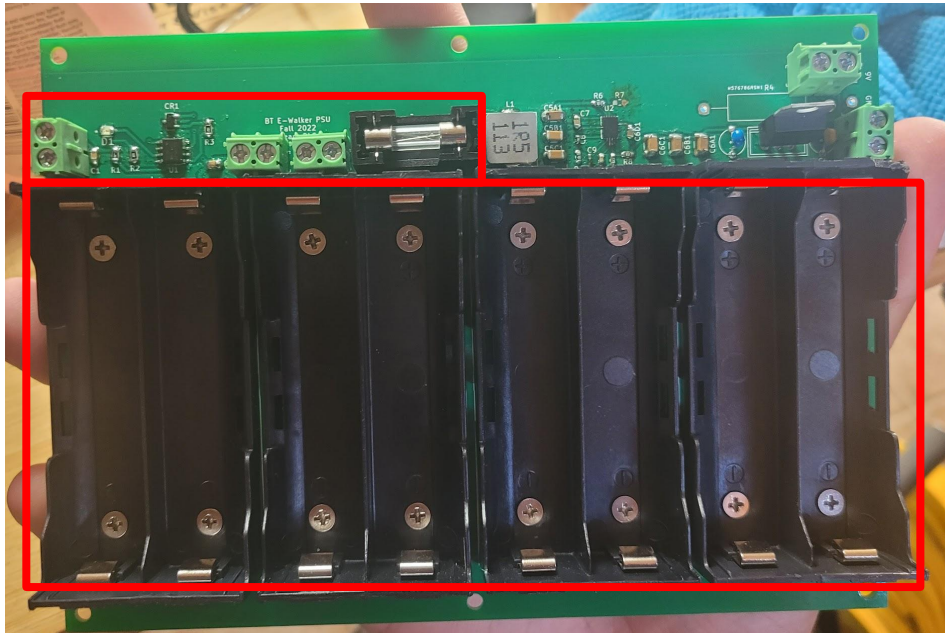
Power Subsystem - Rechargeable Battery Pack

Placement Left to Right

- ❑ USB Port Terminal
- ❑ BQ2057 Li-Ion Charger IC
- ❑ Battery Life Indicator Terminal
- ❑ Power Switch Terminal
- ❑ In-line 5A fuse



- ❑ 4x 18650 two cell battery Holders

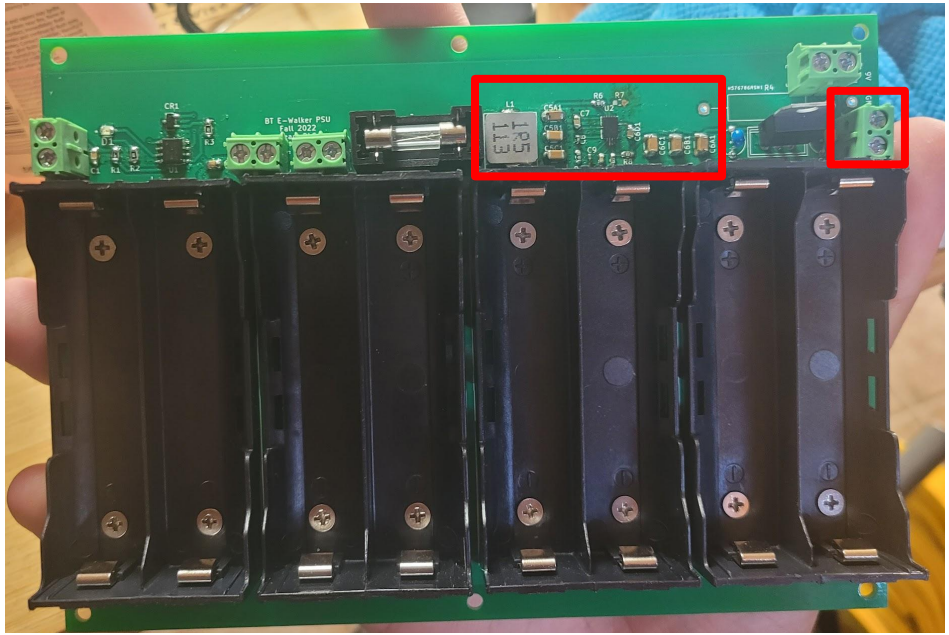
Rechargeable Battery Pack

- Consists of eight UltraLast 18650 Lithium Ion Batteries
  - Each cell rated for nominal 3.7V and 2600mAh
  - Parallel connection, 20800mAh total capacity
- The control system consumes about 400-500mA, allowing for almost two days of continuous operation.
- The batteries are manually balanced with the use of an external charger.

Rechargeable Battery Pack

- Battery Life Indicator Unit, LM3914
  - Minimum threshold at 3.2V is set to prevent discharging the lithium batteries further below the typical suggested minimum, which is below 3.0V.
  - Each LED represents a 10% voltage change, with 1 LED being baseline at 3.2V and 10 LEDs being 4.2V.
- The pack is isolated from the control system with the use of an illuminated rocker switch in addition to a 5A inline fuse.

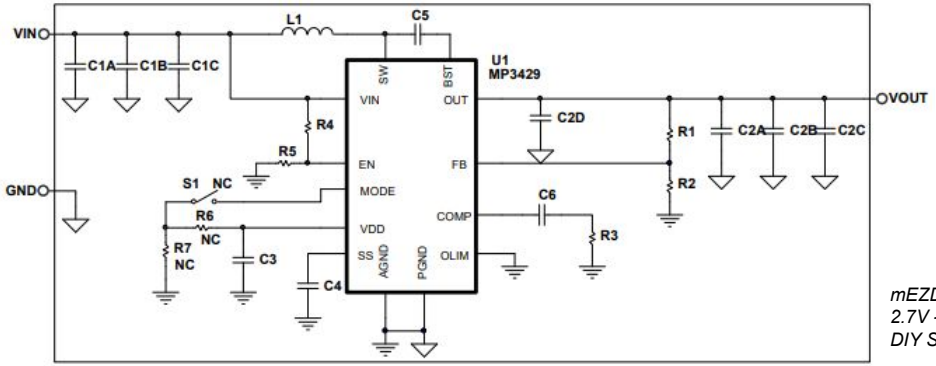
Power Subsystem - DC-DC Boost Converter



- ❑ 1.5µH Inductor
- ❑ Input/Output Decoupling Capacitors
- ❑ MP3429
- ❑ 9V Output Terminal

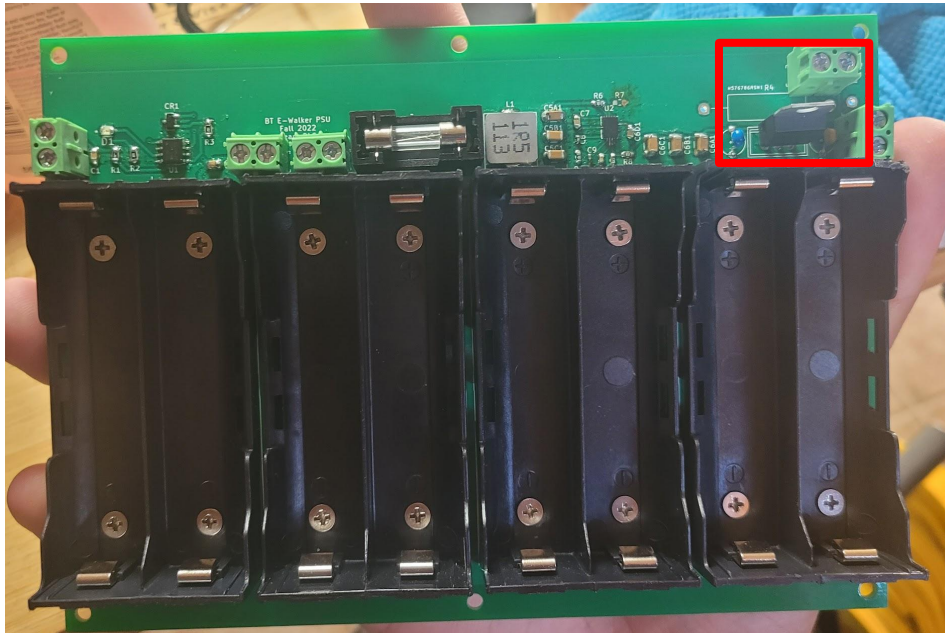
DC-DC Boost Converter

- MP3429 High Efficiency, Fully Integrated, Synchronous Boost Converter
  - Powers the control unit PCB and output charging ports
  - Manufacturer provides a reference DIY schematic
  - Configured for 2.7V - 4.2V input to output 9V 3A (27W) average power



mEZD41503A-X
2.7V - 10V Input, 3A, Step-Up Power Supply
DIY Schematic

Power Subsystem - Output Charge Ports

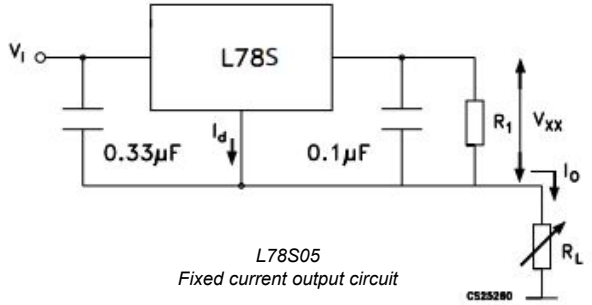


- Input/Output Decoupling Capacitors
- L78S05
- Optional Fixed Current Resistor
- Output Charge Port Terminals

Output Charge Ports

- L78S05 Voltage Regulator
  - 9V input from boost converter output to 5V 2A output
  - USB Charging
    - 5V required, smartphone circuit adjusts input current
  - Load Resistor limits max 2A output current

$I_O = V_{XX}/R_1 + I_d$



L78S05
Fixed current output circuit

Power System Challenges

- On-board Input Charging Circuit
  - BQ2057 Li-Ion Charging IC replaced with external battery charger
- Soldering
  - Boost Converter Circuit SMT soldering
- USB Output Charging
  - USB devices are able to be charged, but not at the desired rate

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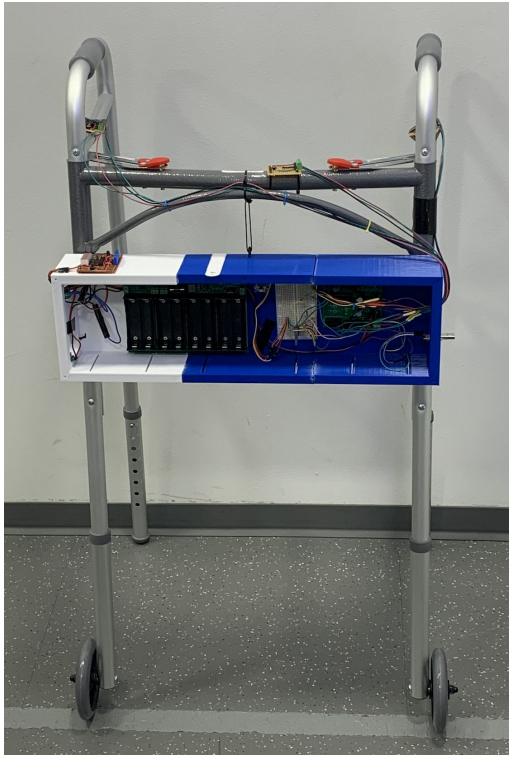
Conclusions

Accomplishments

- Fully functional product meeting high level requirements
- Kept the general walker's functions unchanged
- Built our own Arduino
- Charging capabilities
- GPS positioning

Takeaways

- Plan ahead
  - Lower costs
  - Time to fix errors
- Find team members strengths
- Importance of following IEEE and ACM Code of Ethics
- Be specific in stating product expectations and liability



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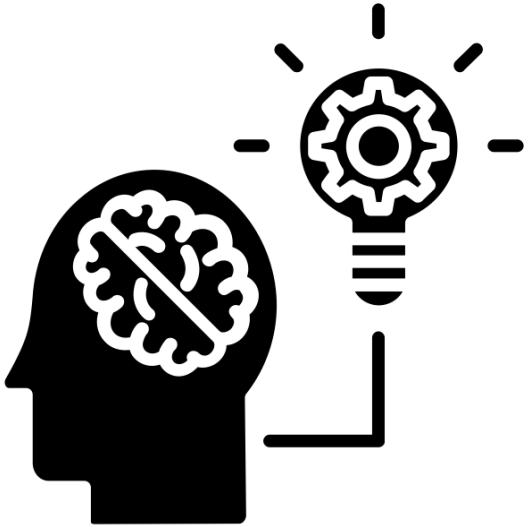

Future Ideas

- ❑ Phone mount
- ❑ Phone camera live stream
- ❑ IR proximity sensor
- ❑ Hidden wires and built in buttons
- ❑ Smaller microcontroller and enclosure
- ❑ On-board quick charger

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