MAE 189 Capstone Design
Team 3: Gonk Walker

Team Members:
Tom Nguyen
Jonathan Chavez
Connor Linklater
Qiyuan Lu
Overview and Requirements

Problem Definition: A steerable mechanical walker consisting of one drive motor each side.

Design Attributes/Requirements/Objectives

- Speed > 1.5 fps
- Turning radius < 3 ft
- Weight < 7 lbs
- Remote control of speed, forward, reverse, left and right
- DIY manufacture
- Arduino Uno
- Tank Steering
- Minimal Vertical oscillation < 1"
- Option for autonomous navigation

Reference design for a steerable walker developed by Chenhao of Sustech University.
Design Decision 1: Theme

Jonathan Chavez
Design Decision 2: Drive Motors

**Gear Motor**
- High Torque at low RPM
- Easy to control
- Able to control:
  - Speed
  - Direction

**Stepper Motor**
- High Torque at low RPM
- Easy to control
- Able to control:
  - Speed
  - Direction
  - Acceleration
  - Distance

Jonathan Chavez
Old Leg design

- Layering of leg links with spacers required for clearance
- Layers and spaces extends the width of the leg
- Support forces create cantilever bending on chassis connection

New Leg design

- Double shear connection place loads at center of the links
- Reduces the number of spacers and the width of the leg
- Keeps support forces near chassis connection.
Design Decision 4: Driveline Packaging

Stepper Motor Driveline
Prototype A

14 Tooth Gear: Added to create space for stepper Motors which are larger than the gear motors

Stepper Motor Driveline
Prototype B

48 Tooth Gear connected to the rotating leg mechanism creating a 1:1.33 gear ratio

Connor Linklater
Design Decision 5: Wiring

Prototype A

Prototype B

Connor Linklater
Arduino Code

Qiyuan Lu
Bluetooth Controller

Controller Interface and Logic

RX: 4 9
TX: __________________________

Select  Start

Setting

Setup the joystick buttons with your own commands to send

Left: L
Up: F
Right: R
Down: T
Select: C
Start: S
A: A
B: B
Y: Y
X: X

Qiyuan Lu
Digital Prototype: Motion Analysis

Walking Forward

Turning Left

Turning Right

Reversing

Tom Nguyen
Digital Prototype A

Mass of ~5.5 lbs

Overall Dimensions: 10 ½” x 7 ⅓” x 9”

Jonathan Chavez
Mass of ~4.83 lbs

Overall Dimensions:
10 ½” x 7 ¼” x 9”
Final Design

Mass of 4.463 lbs

Overall Dimensions:
$10\frac{3}{8}" \times 7\frac{5}{16}" \times 9\frac{1}{4}"$
### Verification of Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed &gt; 1.5 fps</td>
<td>✓</td>
</tr>
<tr>
<td>Turning radius &lt; 3ft</td>
<td>✓</td>
</tr>
<tr>
<td>Weight &lt; 7 lbs</td>
<td>✓</td>
</tr>
<tr>
<td>Tank Steering</td>
<td>✓</td>
</tr>
<tr>
<td>Minimal Vertical Oscillation &lt; 1”</td>
<td>✓</td>
</tr>
<tr>
<td>Remote control controlling speed and direction of walker</td>
<td>✓</td>
</tr>
<tr>
<td>Uses Arduino Uno</td>
<td>✓</td>
</tr>
<tr>
<td>DIY Manufacturing</td>
<td>✓</td>
</tr>
</tbody>
</table>

#### Motion Analysis
- **Steady-State Speed of ~1.5 ft/s**
- **1/10” Vertical Oscillation**

Connor Linklater
Validations of Requirements

- Weight of assembly recorded as 4 lbs 7.2 oz
- Top speed recorded at 1.1 fps
  - Time to walk 5 feet was 4.64 sec
- Smallest diameter it can turn at top speed approximately 1.5 ft

Risk Assessment

- Assessment to find highest RPM without tipping
  - Found to be 250 rpm due to insufficient torque from motor at that speed
Questions and concerns:
- What could be done to make the walker faster?
- Would more durable materials make it too heavy?
- What is the actual difference between using gear motors vs stepper motors?
- What is the physical size limit of this walker with available technology?

Recommendations for the Future:
- Different stepper motor drivers that outputs more current
- Metallic/acrylic leg mechanism for more durability and reliability
- Check and verify dimensions carefully before manufacturing, prevent redundancy
- Implementation of sensors that would allow for autonomous control

Tom Nguyen
Demonstration of the Hardware
Thank You
Any questions?