MiceUp: A Novel Mouse for People with Parkinson's

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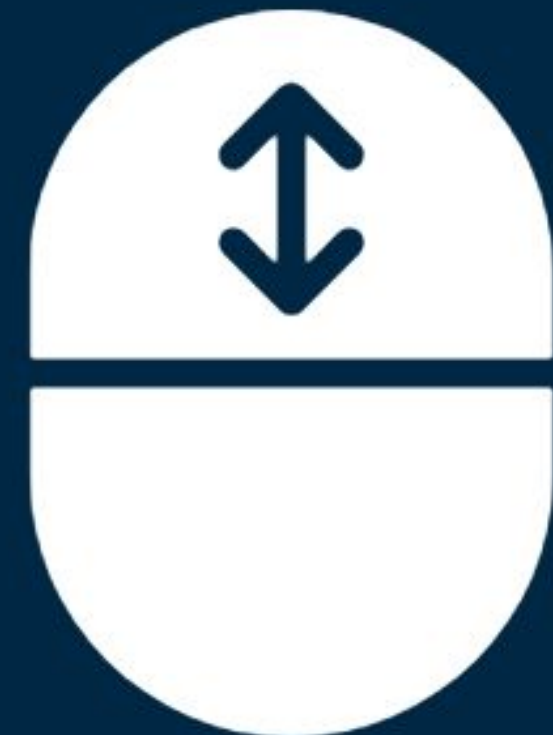Massachusetts Academy of Math & Science at WPI
MICEUP 20 21

Problem Statement

People with Parkinson's Disease face physical difficulties in using computers mice due to tremors, muscle stiffness, and fatigue.

MiceUp: A Novel Mouse for Persons with Parkinson's

Objective
- develop a novel computer mouse
- functionality
- adaptability
- ease of use

Audience
- individuals who have challenges in computer usage due to symptoms of PD

79% of PWPs reported the importance of computer usage in daily life

77% of PWPs reported difficulty in operating computers

Parkinson's Disease in the United States

- a chronic disorder of the nervous system
- caused by the degeneration of neurons in the brain

~ 930 000 adults currently diagnosed with PD (2020)

generally affects men more than women

severity of PD increases with age

~ 60 000 additional adults diagnosed with PD every year (2020)

~ 1 200 000 expected population with PD in 2030

Common Symptoms
- tremors and fatigue in the hands and fingers
- muscle stiffness
- motor impairments
- cognitive impairments

Computer Usage
- many individuals with PD have difficulties operating a computer

Level 1 Requirements

#	Criteria:	Priority:	Type:	Emu (P1)	Greenfinch
1	The device shall be safe to use and not worsen the symptoms of Parkinson's Disease.	Level 1	Physical	TBD	TBD
2	The device shall be novel.	Level 1	Functional	YES	YES
3	The device shall be specific to people with Parkinson's.	Level 1	Functional	TBD	TBD
4	The device shall be able to accommodate basic motions such as precise clicking, scrolling, and dragging.	Level 1	Functional	NO	YES

Build Process

3D Print all the necessary parts → Assemble Arduino and Mouse Chip → Install Tungsten Weights
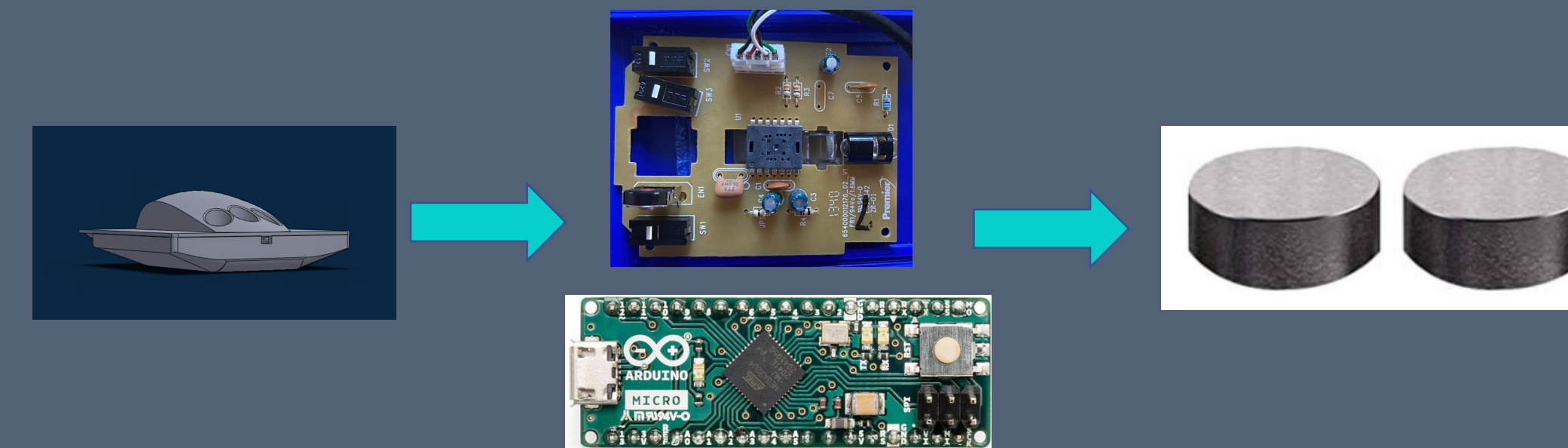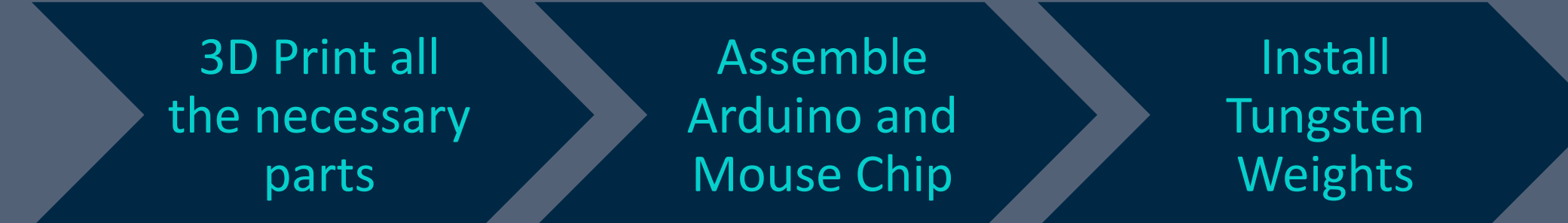
Version Desert Owl (v4)

- Added walls to hold tungsten weights
- Eliminated the use of prongs to secure the mouse chip (uses deep inset instead)
- Able to move cursor using original mouse chip
- Angle of curved base decreased to increase comfort
- Added curve to back side of mouse for future scrolling feature.
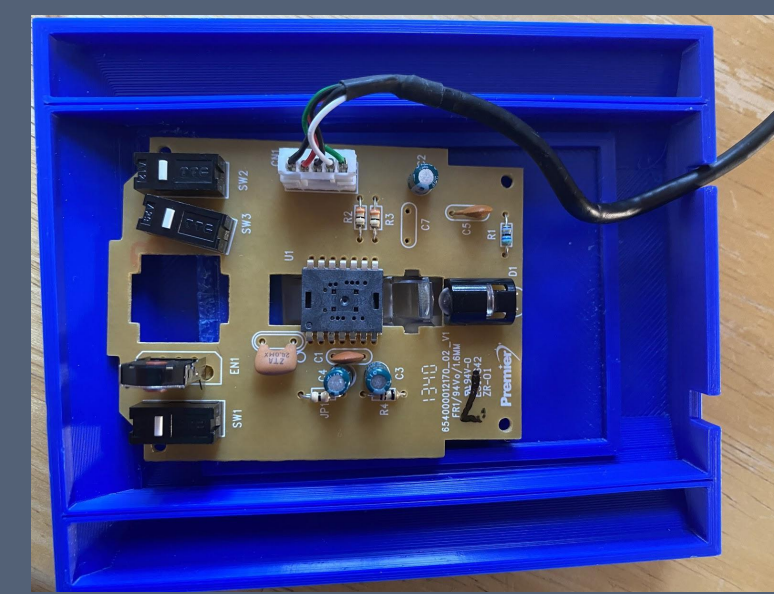
```
//function to convert accelerometer values into pitch and roll
void getAngle(int Ax,int Ay,int Az)

double x = Ax;
double y = Ay;
double z = Az;

pitch = atan(x/sqrt((y*y) + (z*z))); //pitch calculation
roll = atan(y/sqrt((x*x) + (z*z))); //roll calculation

//converting radians into degrees
pitch = pitch * (180.0/3.14);
roll = roll * (180.0/3.14) ;
```

Version Emu (Prototype 1)

- First fully functional prototype
- Integrates Mouse Chip and Arduino
- Rounded base towards corners
- Uses adhesive strips for temporary fixture
- Added weight slots to the base's edges
- No access to scroll wheel
- Accidental clicks still occur
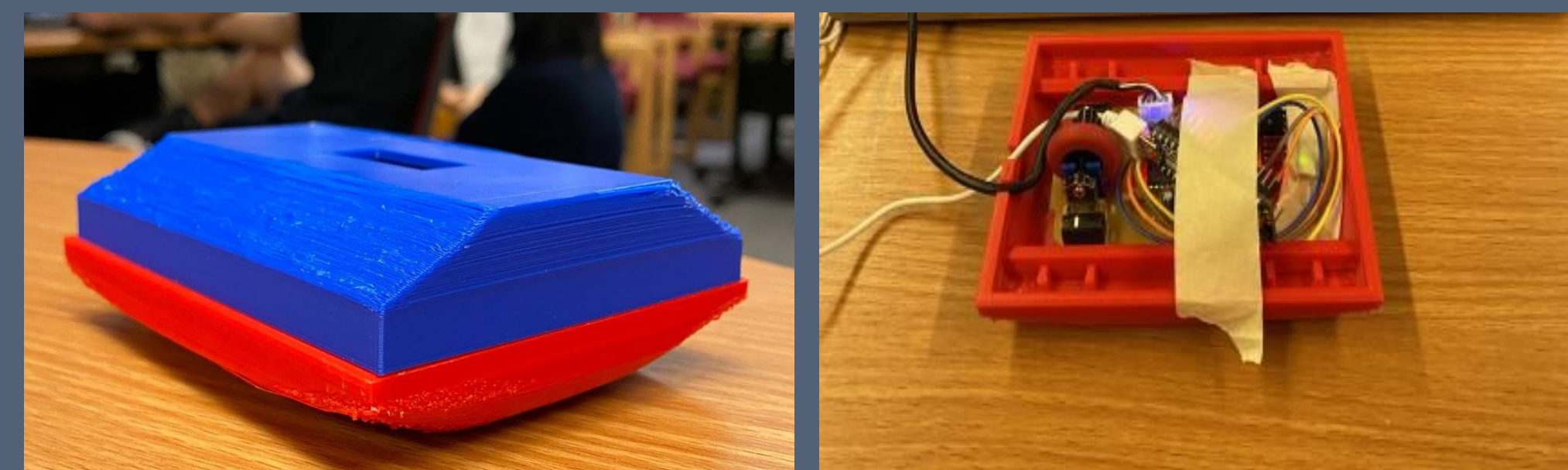
Version Falconet (Prototype 2)

- Prototype with an ergonomic mouse top
- Retains base (with electronics) from Version Emu
- Implemented scrolling and dragging
  - Posture of the hand during these movements raised concern
- Fixed accidental clicks
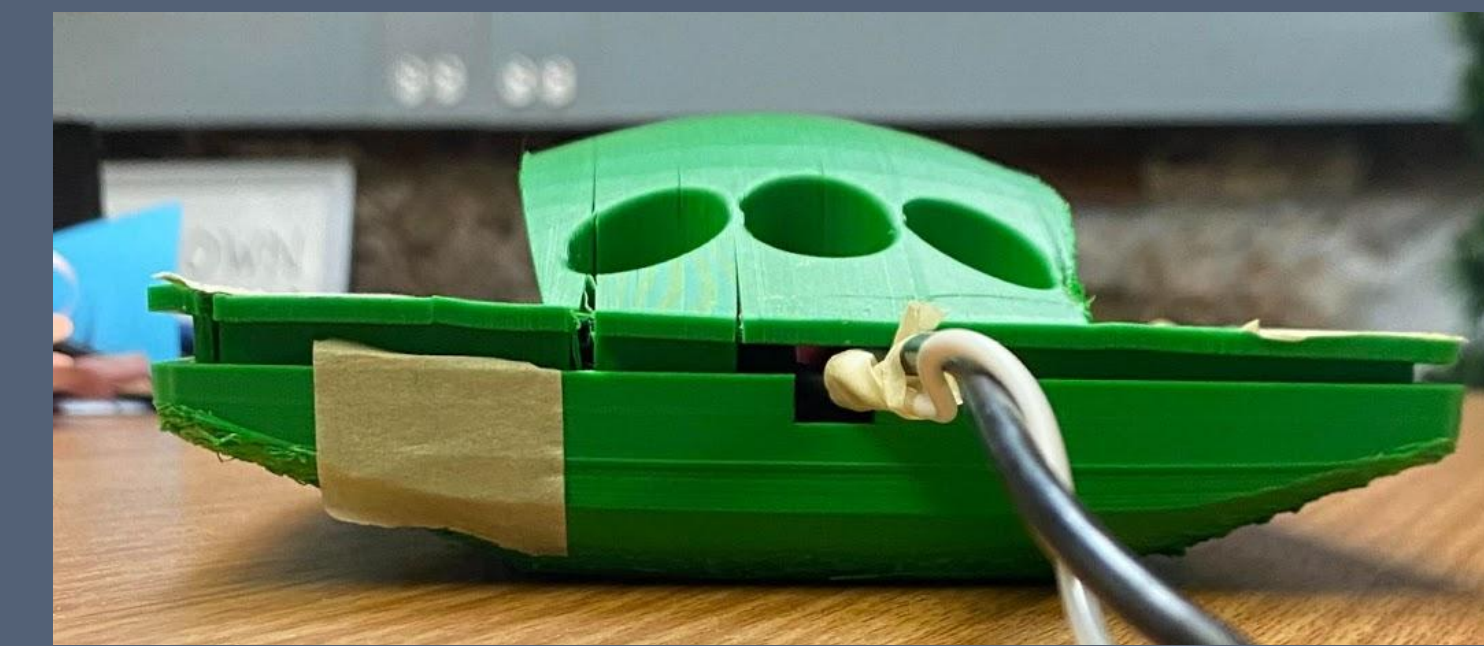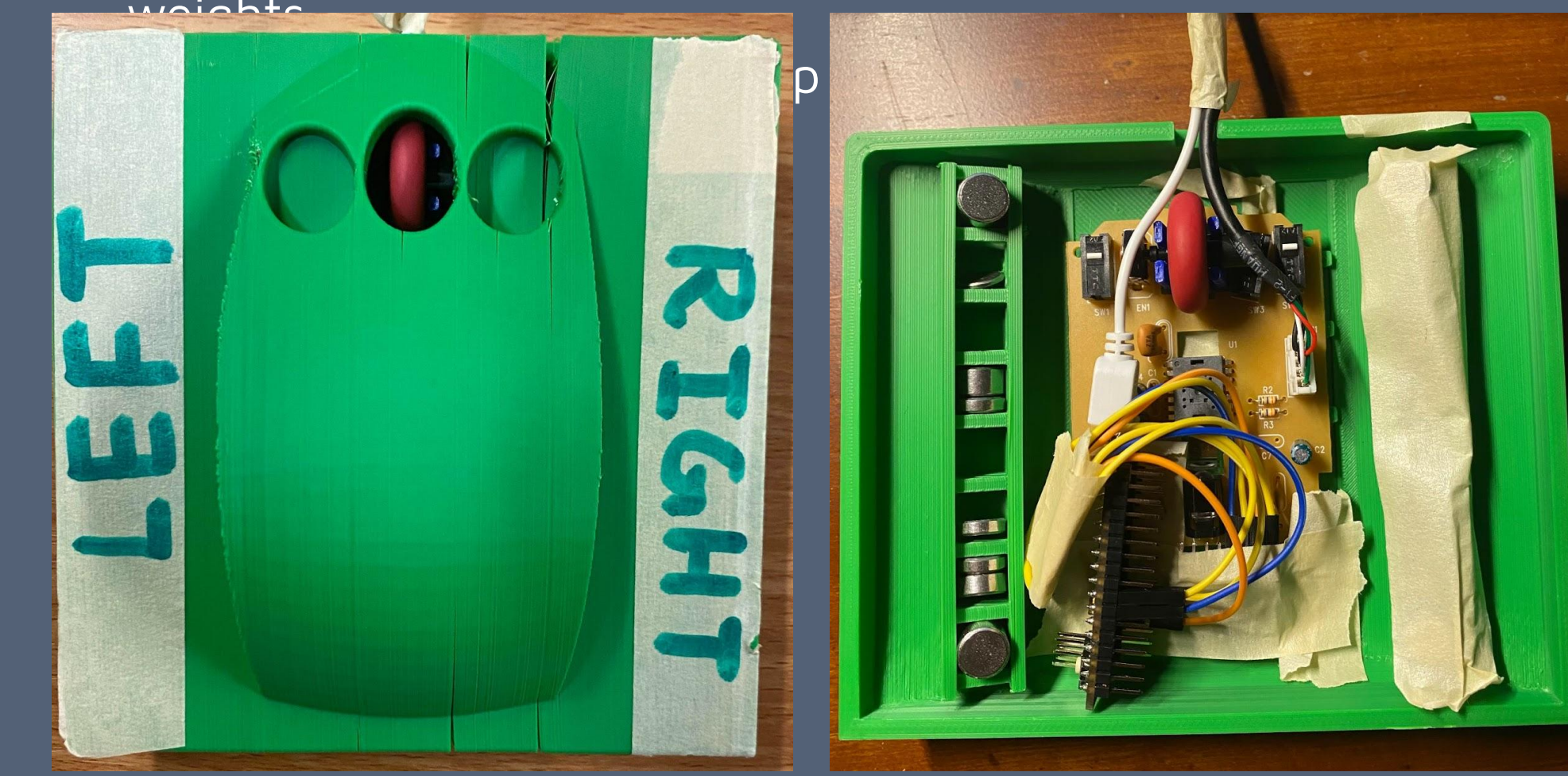- Displayed space issues with the location of the Arduino

```
//if mouse is tilted to the back-left, perform left down press
if(roll > 35 && pitch < -13){
  //Dragging Feature
  Serial.println("Diagonal Click");
    if (!Mouse.isPressed(MOUSE_LEFT)) {
      Mouse.press(MOUSE_LEFT);
      Serial.println(MOUSE_LEFT);
      delay(750);
    }else{
      Mouse.release(MOUSE_LEFT);
      Serial.println("Diagonal Release");
      delay(750);
    }

//if the mouse rotate 30 degrees up, scroll up
else if(pitch < 6 > 20) {
  Mouse.move(0, 0, 1);
  Serial.println("Scrolling Up");
  delay(100);
}
//if the mouse rotate 30 degrees down, scroll down
else if(pitch > 6 <-30) {
  Mouse.move(0, 0, -1);
  Serial.println("Scrolling Down");
  delay(100);
}
```
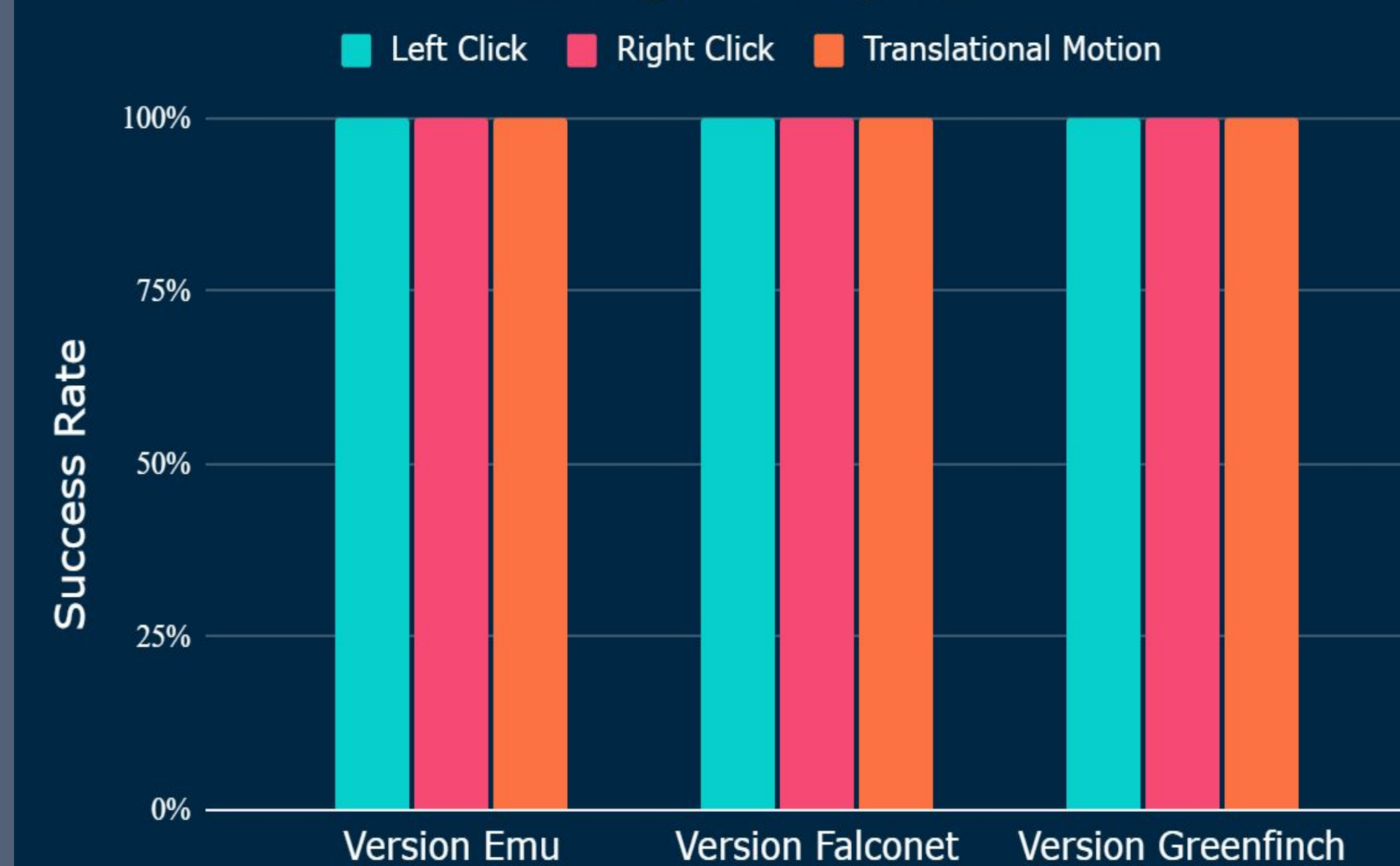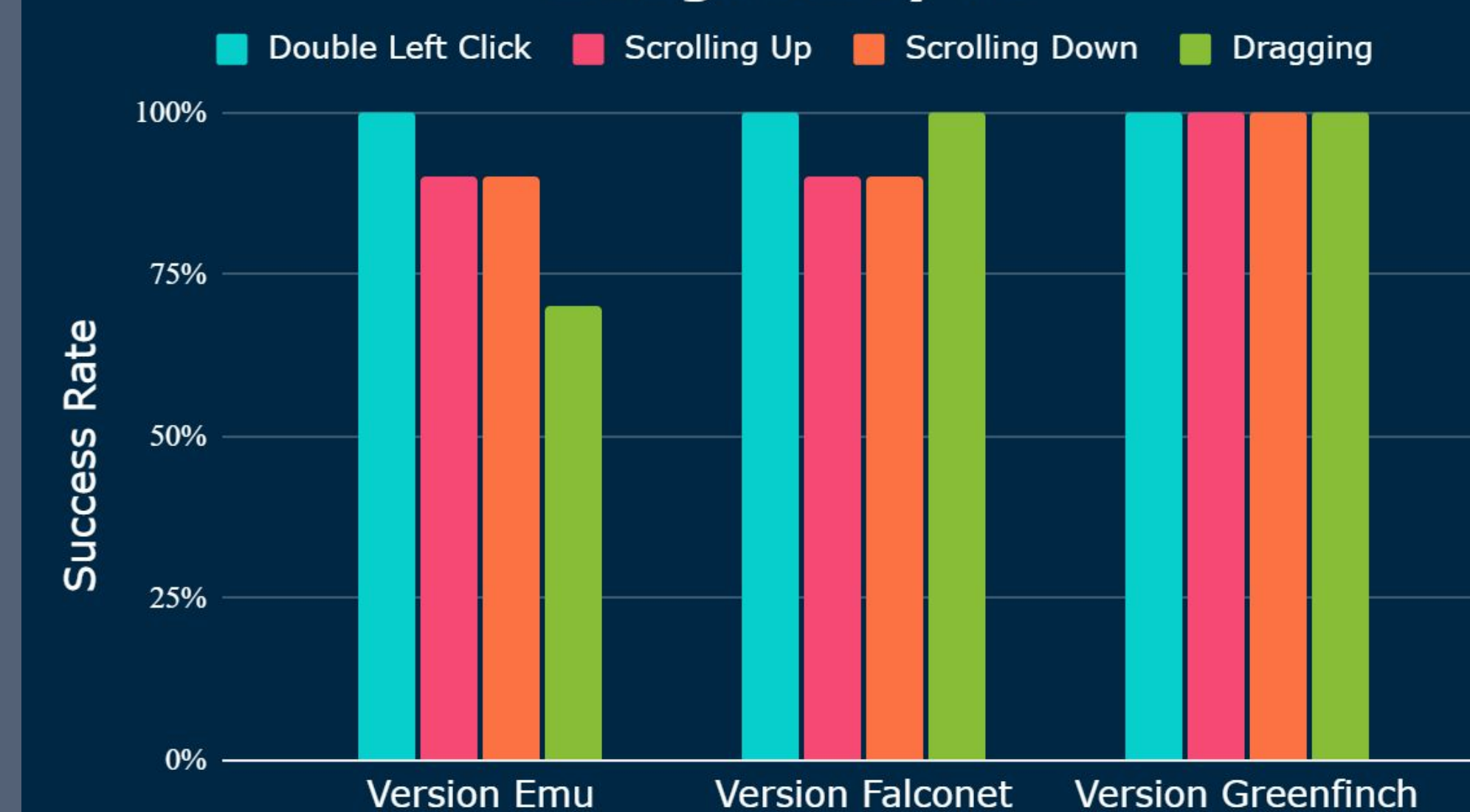
Version Greenfinch (Prototype 3)

- Base was approximately 40% wider to improve tilt feature
- Added column-like finger grooves to improve grip and ergonomics
- Extra space assigned for integration of Arduino and mouse chip
- Added weight dividers to provide a more fit and secure system for weights
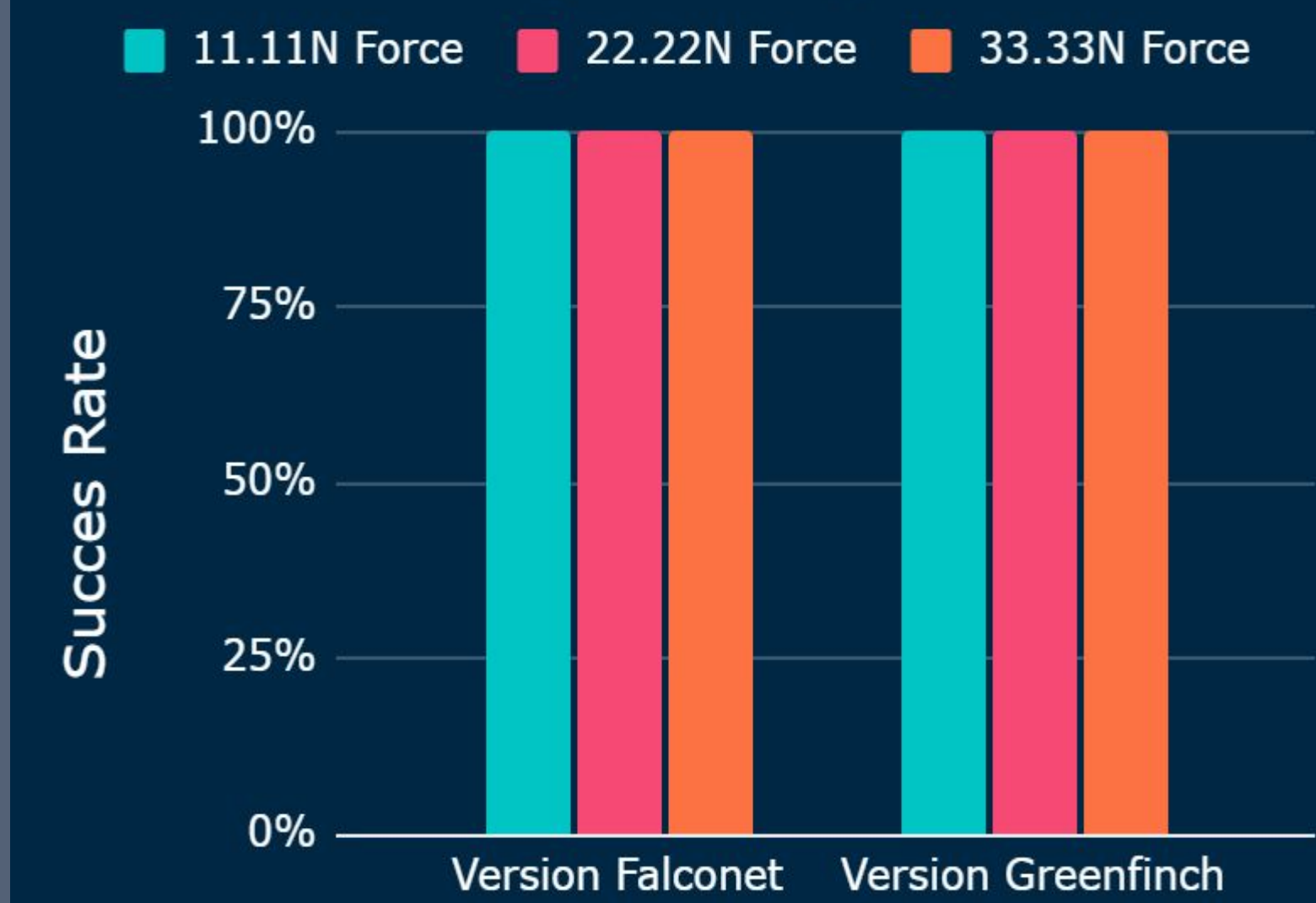

Design Study #1

Legend: Left Click, Right Click, Translational Motion
X-axis: Version Emu, Version Falconet, Version Greenfinch
Y-axis: Success Rate (0%–100%)

Design Study #2

Legend: Double Left Click, Scrolling Up, Scrolling Down, Dragging
X-axis: Version Emu, Version Falconet, Version Greenfinch
Y-axis: Success Rate (0%–100%)

- Version Greenfinch performed the best out of the three prototypes tested (100% successful in all four categories).
- Version Emu had issues with dragging and scrolling; however, this was fixed through changing Arduino code.
- Version Falconet improved on dragging but still did not perfectly succeed in scrolling.

Design Study #3

Legend: 11.11N Force, 22.22N Force, 33.33N Force
X-axis: Version Falconet, Version Greenfinch
Y-axis: Succes Rate (0%–100%)

Future Work and Extensions

Client Testing
- direct feedback from PWPs regarding the mouse's functionality and physical convenience

Structural Improvements
- automated activation of Arduino Micro
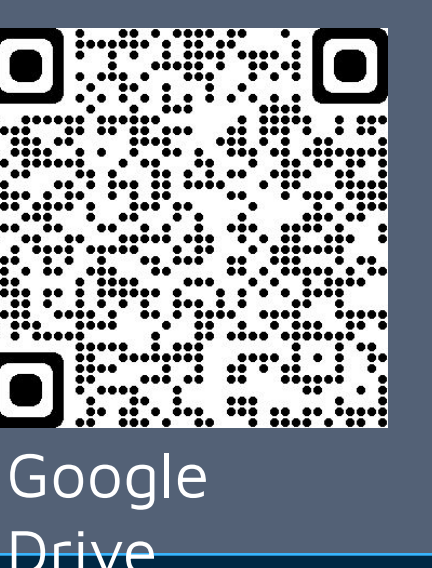- pro-ergonomic adaptations
- improve comfort of use

Functional Expansions
- addition of visual or auditory indicators
- more simple, intuitive gestures based on client testing

Resources

Github   MICEUP   Google Drive

References

"Demographics." *Parkinson's Foundation*, https://www.parkinson.org/research/Parkinsons-Outcomes-Project/Demographics. Accessed 25 May 2021.

Nes Begnum, M. E. (2010). Challenges for Norwegian PC-Users with Parkinson's Disease – A Survey. *Lecture Notes in Computer Science*, 292–299. https://doi.org/10.1007/978-3-642-14097-6_47

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