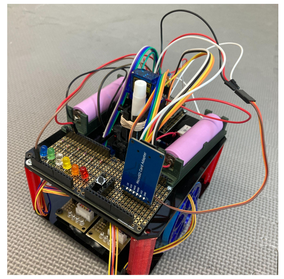
E2.06 - Penbot

Thomas Denning (PM), Chris Le, Diego Garcia-Mendez
Mr. Lee Hinkle, Mr. Mark Welker

TEXAS STATE
INGRAM SCHOOL OF ENGINEERING

Penbot is an autonomous robot that produces line art.



Project Overview

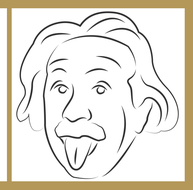
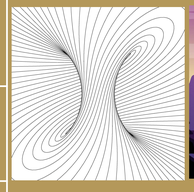
- Small autonomous vehicle
- Driven by stepper motors
- Moves along a path to leave behind line art drawn by a center-mounted pen

Requirements

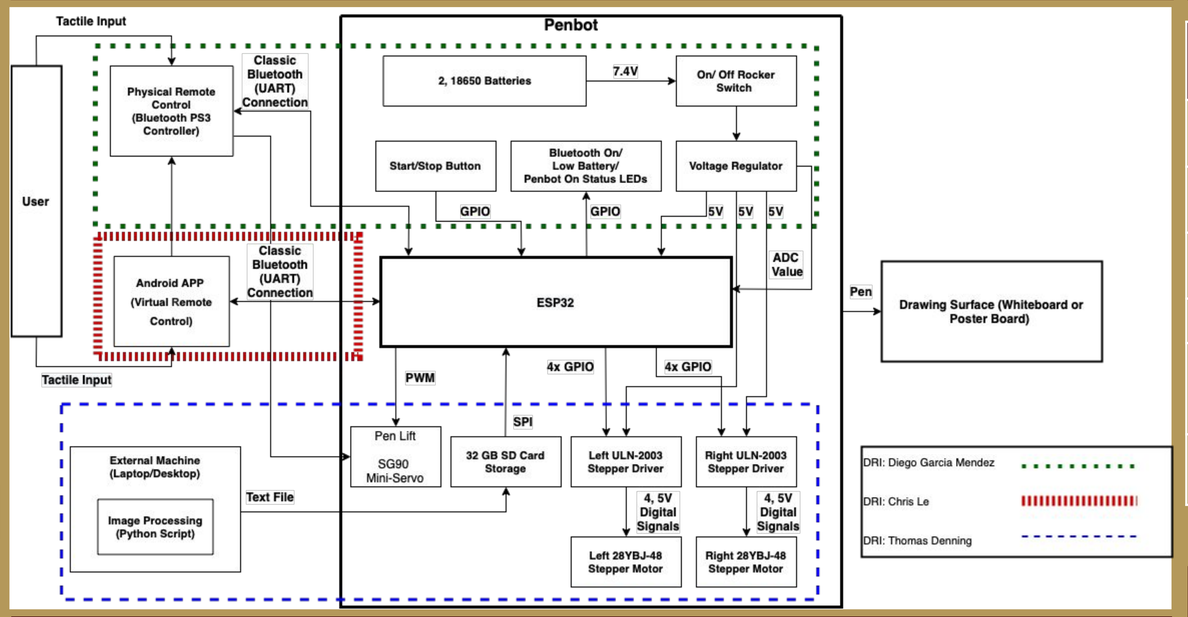
- Small size, low-cost, mix of 3D printed, cut sheet, and off-the shelf components
- Autonomous - must complete drawings without interaction
- Five Drawings: simple/fast, portrait, geometric, landscape, supersize
- Team must include an interactive control mode

Drawings

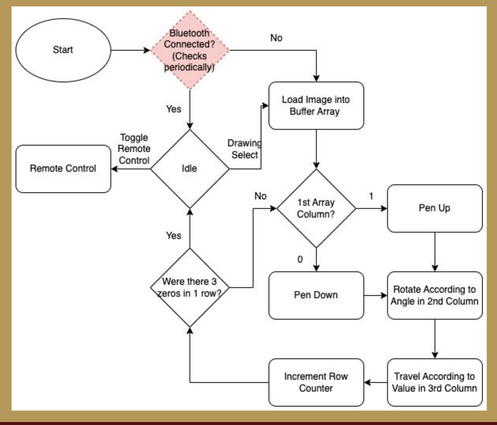
Drawing (max draw time)
Simple Abstract (90 seconds)
Portrait (5 minutes)
Geometric (30 minutes)
Landscape (1 hour)
Supersize (2 hours)

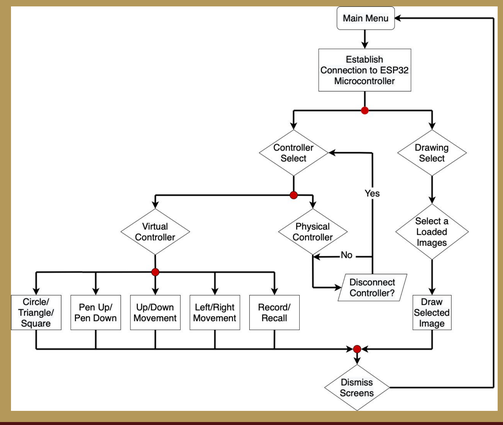
Functional Block Diagram



Stepper Motor Control



Android App Flowchart

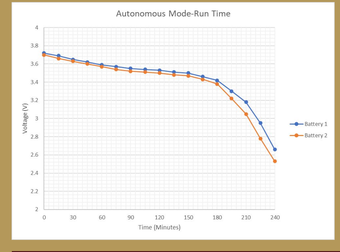


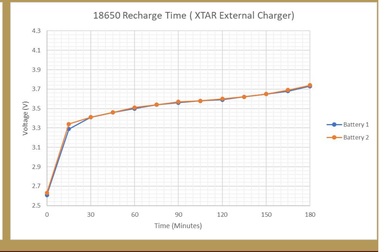
Test Cases

Description	Criteria
Test for image processing recreation accuracy	Pass: The average SSIM (structural similarity index measure) for the 3 images tested was 0.91
Test for stepper motor accuracy	Pass: The measured distance was within .5mm and the measured angle was within 0.985%
Test for stepper motor speed	Pass: The top linear speed is 4.75cm/s ± 0.05 cm/s and rotates at 48.6°/sec
Test for Bluetooth range	Pass: No noticeable delays between button presses
Test for impact of Bluetooth devices in an area	Pass: A disconnection occurred once on the first floor of LBJ, but reconnection to the controller was immediately possible
2 hour battery life	Pass: Ran continuously for 3.5 hours without a noticeable performance loss

Power Dissipation

Source	Voltage (V)	Power (W)
18650 Lithium-Phosphate Battery (2)	**7.4**	**16.28**
Source	**Voltage (V)**	**Power (W)**
ESP 32	5	0.73
28byj-48 Stepper Motors	5	1.77
SG-90 Servo Motor	5	0.72
SD Card Module	5	0.2
Indicator LEDs	3.3	0.39
	Total	**3.81**





Meet the Team

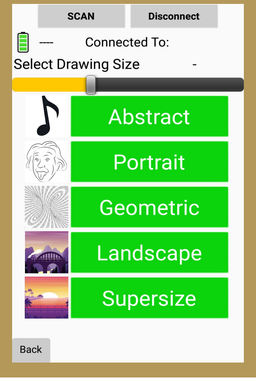
Diego Garcia-Mendez
Remote Control
Power

Thomas Denning
Image Processing
Stepper Motor Control

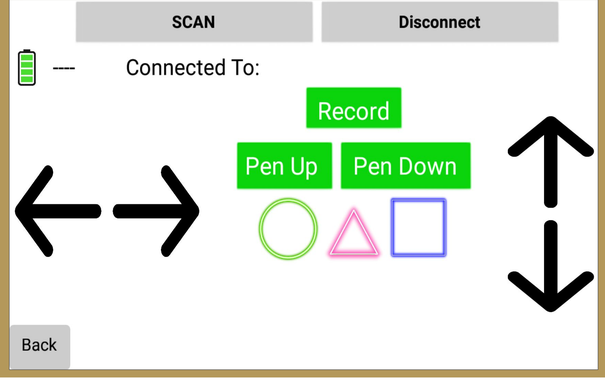
Chris Le
Mobile App UI

Mobile App UI

- Main menu features commands to draw preloaded images and the ability to enable two different controller options
- Drawing select menu shown on right



Virtual Remote Controller



Acknowledgements

- Faculty Advisor: Mark Welker
- Sponsor: Lee Hinkle