‘The Elders’ Dragon & the Young 王朋

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B. VIDEO/PHOTO DOCUMENTATION

C. CONCEPT AND DESIGN

- Project Concept - Our final project is an interactive animatronic dragon installation, combining storytelling, physical computing, and user-driven interactivity. It begins with a choose-your-own-adventure animation narrated by a mysterious old lady. After the story, the user is prompted to draw a copper-tape-covered sword from a stone, triggering the dragon to awaken. Once the sword is drawn, LED “fire” animations light up the battlefield, and the user can move the sword across space to control various animatronic dragon movements.
- Audience & Value
    - Target Audience: Children & young adults; fans of fantasy and mythology; general showcase attendees interested in interactive installations
    - Special Value:
        - Engages imagination through interactive storytelling & physical action
        - Combines narrative choice with mechanical response, which is pretty rare in interactive installations from what I’ve previously seen
        - Tangible feedback (movement, lights, sound potential) encourages hands-on exploration
- User Interaction and Design Choices
    - Sword-in-Stone Mechanism:
        - Copper tape + open/closed circuit made it intuitive for users to trigger events.
        - Visually and narratively symbolic; heightened engagement through physical action.
    - LED Fire Battlefield:
        - Activated only after sword is drawn → reinforces mythic awakening theme.
        - Moving LED strips simulate fire, providing visual feedback and excitement.
    - Motion Sensors for Dragon Movement:
        - Positioned *underneath* the dragon due to weight limitations on the dragon’s hanging body.
        - Wrapped in foliage to blend with the battlefield aesthetic, though some users were confused during testing.
    - Multiple Motors for complex movement:
        - Four foot servos, two jaw servos, and steppers for tail, body1, and body2
        - Each responded to different user-controlled inputs, which made the experience feel more alive

- User Testing Feedback - People loved the animation and sword interaction, but confusion emerged around where and how to move the sword. Luke also suggested that we have the sword inside a "stone" and draw it out like excalibur. Professor Weil and I were brainstorming, and then thought of using copper tape to open/close the circuit when the sword was in/out of the stone. Beyond the sword interactivity, the motion sensors weren't visible enough, and people kept assuming the sensors were ON the dragon, rather than BELOW it. During the showcase, several users repeatedly put the sword inside the dragon's mouth and expected something to happen. Some users also mentioned that they wished the dragon had sound effects and roared or hissed.
- Post-Testing Adaptations - Added visual cues around sensor regions to clarify interaction zones and improved LED animations to enhance feedback when sensors were triggered. Unfortunately, did not have time to add audio, though this remains a desired future addition. In future iterations, we would also redesign the sensor mountings so that motion detection could occur on the dragon's body itself.

D. FABRICATION AND PRODUCTION

Division of Labor: Noah built the dragon and made the animated story in processing. I wrote the movement code in Arduino and put together the mechanical elements for the dragon movements. I also designed & built the sword, including building the circuit for the LEDs & copper tape and writing the initial basic code for the lights in Arduino & Processing (turning them red). Noah took the lights a step further and made them light up like fire would, which was very cool! Noah designed the 3D printed teeth, and I troubleshooted the 3D printer issues and formatted the file to actually print. Noah also fixed the weight issue with Luke's pulley system idea. We worked together on building the "battlefield"; Noah added the greenery, I designed the "draw your sword - 中国龙" signs, and we both placed the distance sensors. We both collaboratively worked on adjusting the specific rotations of the steppers and servos. We also both took apart the project together after the showcase.

Major Components & Choices - Lots of changes were made between the initial prototype and final product. We ended up cutting down a lot on the number of steppers and motion sensors we used because we felt that they weren't necessary. In the end, we cut the stepper controlling the head because it was quite heavy, and we also felt like the head movement was already very cool when it was just the jaw snapping open and closed.

- Servos (6 total):
  - Jaw (2) & Legs (4): Chosen for their simplicity and ease of control using `Servo.h`.
  - This gave the dragon naturalistic jaw snapping and leg-twitching motion.
- Stepper Motors (3 total):
  - Used for Body 1, Body 2, and Tail movement.
  - Chosen for precise and reversible motion control via `AccelStepper` library.
- Ultrasonic Distance Sensors (3):
  - Mapped to each section of the dragon (tail, body1, body2).
  - Triggered based on proximity of the sword.
- Copper Tape Circuit (Sword Mechanism):
  - Sword and stone created a complete circuit when together.
  - Used digital input to detect when sword was removed → activated LEDs and dragon behavior.
- LED Strips (Fire Effect):

    - Added visual “battlefield awakening” tied to sword removal.

Selection Justification

- Servos: Servos are quiet-ish, controllable, and appropriate for indoor display. We also had easy access to the number we needed, and we knew how to use them. We did not want to use 180º servos because they were annoying to program correctly. I tried. It did not go well. I switched them out.
- Stepper Motors vs. DC Motors: Stepper motors allowed for *precise incremental movement*, vital for lifelike dragon motions. Again, easy access, existing knowledge of use, and they worked well for what we needed.
- Ultrasonic Sensors vs. IR Sensors: Ultrasonic sensors were more reliable for measuring proximity in open space, particularly across the battlefield area. However, after user testing, I noticed that some people wanted to hit the dragon like a pinyata. Perhaps motion sensors on the dragon’s body to detect it shaking in the air when hit would have been a smart addition.

Rejected Alternatives

- IR sensors: Too sensitive to ambient light and inconsistent in movement detection.
- Mounting sensors on dragon: Again, we had to reject this due to weight concerns; the steppers couldn’t handle the added load without significant performance issues.

Fabrication Highlights

- Hanging the dragon using wired ceiling mounts connected to steppers enabled dramatic vertical movement. Noah and Luke fixed the weight problem with a pulley system.
- Motion flow choreographed to simulate breathing, tail wagging, and head/neck motions.
- Modular design allowed testing individual parts before integrating.

Coding Process

- Initially tried to use ChatGPT to help write the code, despite warnings from professors; it generated overly complex structures that didn’t work well (of course). After hours of troubleshooting, I deleted the entire thing and started over using exactly what I had learned in class, and not using ChatGPT. This led to simpler, understandable logic, clear movement response mapping to sensor input, and coordinated servo and stepper motor timing. In the end, the only AI involved in the code is when I needed one of the steppers deleted from the program and didn’t want to do it all by hand. So I put my code into ChatGPT and instructed it to “delete Head1 from all areas of this program”. - Since it was referenced many times in many functions, it was a helpful resource to save time and prevent user error in case I overlooked something, while not taking away from my learning and understanding of how the code actually works.
- I had trouble getting everything to work in-sync at first, so I wrote separate programs for each type of movement. The steppers had their own Arduino sketch first, then the jaw, then the feet. Finally, I put them all together! I kept all versions of the code so I could revert back to what I needed when necessary. I had to revert back a couple times, so this was a good method of organization.

E. CONCLUSIONS

Restated Goals

- Create an immersive, story-driven, interactive installation featuring an animatronic dragon that responds to user movement and narrative events.
- Merge mechanical motion, lighting, and storytelling into a cohesive user experience.

Goal Achievement

- Yes, goals were largely achieved:
    - The project successfully delivered on storytelling, interaction, and mechanical motion.
    - The dragon came alive with multi-directional movement, synchronized with user proximity.

Audience Response

- Audience was engaged and curious, particularly captivated by the physical sword mechanism and story-driven approach.
- Some confusion around sensor zones, but most figured it out after brief observation.

Definition of Interaction

- Interaction, in our project, means *user agency triggering meaningful system change ~* in this case:
    - story path selection -> sword drawing triggering world awakening -> sword movement affecting dragon behavior

Improvements for the Future

- Add sound: Audio feedback (roars, breathing, voice) would dramatically enhance immersion.
- Better sensor integration: Find lightweight alternatives or redistribute weight so sensors can be mounted on the dragon.
- More fluid movement: Refine motion choreography for smoother, more dramatic animations.

Lessons Learned

- Simplicity in coding and wiring is often more effective than overengineering.
- User testing is invaluable. Even if your design feels intuitive to you, others may experience it differently. We noticed that a lot in the showcase when people kept asking us: “What do I do?” We kept thinking, “Isn’t it obvious?” but then we realized that while we’ve been working on this project for weeks and weeks, they’ve only just seen it for the first time and have maybe never interacted with something like this before.
- Balancing aesthetic, narrative, and mechanical functionality is challenging but deeply rewarding. I really LOVE combining creativity with technology!

Final Takeaways

- A greater appreciation for storytelling in interactive design.
  Practical experience troubleshooting physical computing systems and sensors.
- Confidence in independently building and coding complex electromechanical systems.
- One moment that really stuck with me was the day of our final showcase. Everything had been working great in our last test, but suddenly the puppet arms began twitching erratically right before we had to present. None of us could figure out what was wrong, especially since we literally had not changed a single thing. Kevin stepped in and calmly diagnosed a grounding issue. He added a second ground wire between the Arduino Mega and the breadboard, and just like that, we had stability. It reminded me how sensitive these systems are, how sometimes the tiniest overlooked connection can throw the whole thing off. And it made me realize how collaborative this kind of work really is. We were constantly leaning on each other and others around us, including mechanical insight from Luke, electrical troubleshooting from Kevin, copper tape advice from Flora, 5V power hacks from Andy, and collective trial-and-error to build something way beyond any one of us could have made alone.

- Beyond the technical side, this project became surprisingly emotional for me. There was something so satisfying about bringing the dragon to life, like in watching its mouth move, its joints shift rhythmically with the beat of our audio, and seeing people's faces light up when they triggered its movements with the sword. It felt like a synthesis of so many things I love: performance, storytelling, engineering, absurd humor, and theatricality. I found myself deeply invested in the dragon as it became a character to us, something with presence and personality. I also learned how important adaptability is in a creative tech project like this. So many of our original plans had to be reworked, both because of hardware limitations and creative changes. Each time something broke or didn't quite function, we found ourselves asking not just “How do we fix this?” but “What new idea might come from this obstacle?” That mindset shift, from frustration to curiosity, was huge for me. Through this project, I’ve learned how to be more adaptable in a positive, collaborative way. In the end, the dragon worked beautifully, and we were proud. But even more meaningful to me than the applause it got was the weird little world we built together to make it happen. From late-night debugging sessions to cutting out felt tongues and LED wiring, it was a messy, funny, sometimes stressful, always exciting experience. And those are the kinds of projects I want to keep doing, these ones where art and code and imagination collide in big, chaotic, and unexpectedly heartfelt ways. I’ve really had a blast this semester and this past year in IMA/IMB classes at NYUShanghai, and I’ve learned so much!

F. DISASSEMBLY:

F. APPENDIX

- LINK TO ALL CODE
- LINK TO ALL PHOTOS/VIDEOS