Magic Elevator Project Proposal

CSCI 4889: Machine Learning for Human Computer Interfaces

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Idea

Elevators are a curse and a savior. They enable heavy equipment to be transported across levels and they are often the only means to enable people with mobility impairments to move up and down in a building. However, waiting for them and riding them in an awkward silence is anything but exciting. The magic elevator will solve this problem: we will transform the ATLAS elevator into the most awesome elevator on campus. All that is needed is a little magic, more magic, and some engineering:

ATLAS Elevator | A Little Magic | More Magic | Some Engineering | Most Awesome Elevator on Campus

The elevator riders will summon the elevator with a wand, or with *their wands* through a group spell if there are multiple riders. Once inside the elevator, the riders will compete against each other: all riders execute a spell to select their requested level, and the magic elevator decides who performed the most accurate spell. As a reward, the magic elevator moves to this level first. Better start practicing those spells!

The elevator riders will benefit from an exciting elevator experience. We learned from feedback of previous elevator-related projects the most requested rider feature: a faster elevator. Unfortunately, we cannot speed up the elevator itself, but with the magic elevator, time will fly since the interaction will be so much fun!

A previous project on calling the elevator has already given insight on the feasibility of the magic elevator. Available hardware and software (solenoids, raspberry pi, OSC communication) makes remote control of the elevator possible. Machine Learning will provide the necessary personalization during the user experience.

Mission Statement

Our mission is to create a Harry Potter elevator experience. To summon and control the elevator, our magicians must cast spells with wands and sometimes work as a team (or as foe…).

Challenges to Overcome

Receive Permission

Before we can get started with this project, we want to receive facility management's permission to work on the elevator. This includes the non-destructive addition of a control terminal outside and inside the elevator. Also, limitations on the elevator during a 30 minute test phase will have to be taken into account.

Hardware Design

Building on the previous experiences with the magic elevator, this project will require more hardware. So far, the existing hardware has been limited to calling the elevator in the lobby. This part of the hardware will remain in place. In order to "steer" the elevator, an additional panel with a computer and solenoids will be installed inside the elevator. The corresponding solenoids have to be ordered, wired and installed in a custom-made case. This time, the solenoids have to be stronger too, in order to actually press the relevant buttons. At the same time, the power supply inside the elevator has to be ensured (there is no power outlet inside the elevator). All hardware will meet building safety and accessibility codes.

User Experience

For the first time in this class, multiple users will have the option to interact in one game. This brings the challenge of having multiple input devices which must be coordinated and transformed into the right outputs. A seamless user experience is indispensable for this application. Computation time and generalization are key. Additionally, the system must be end-user customizable. Users should be able to train the system to work well for them, i.e., accurately recognize their spells (when they cast them properly!).

Needed Technologies

It is anticipated that we need the following components for this project:

Item	Class	Amount	Purpose
Raspberry Pi 3	Hardware	2	Receive inputs and Icontrol solenoids
GiPo 4 Channel Relay Board	Hardware	2	Flicks solenoids
Solenoids	Hardware	8	2 for calling elevator up/down, 4 for selecting floors inside the elevator 2 backups
Micro:bit	Hardware	4	3 for sending OSC for each wand, 1 for receiving OSC linked to a computer

12 V Battery Pack	Hardware	2	Supply electric power to solenoids (one needed for each Relay Board)
Rockbirds AC Adapter	Hardware	2	Supply electric power to solenoids (one needed for each Relay Board)
3D Printer Filament 3mm	Hardware	1 roll	Materials to build Terminal Cases
Keyboard, Mouse and Monitor	Hardware	1	Interface Raspberry Pi
Acrylic Plexiglass Sheet (⅛ x 12 x 12 in)	Hardware	1	Cover on Terminal Cases
Wekinator	Software		Control machine learning models
WekiInputHelper	Software/Language Tools		For feature engineering
Processing and Python	Software		Custom programming logic
Processing.io	Software/Language Tools		For solenoid activation
oscP5 and netP5	Software/Language Tools		Communication between components

Proof-of-Concept in Week 10:

The proof-of-concept in week 10 has to show the feasibility of previous difficulties with the elevator interactions. On the hardware side, this includes the right setup for the solenoids that will press the elevator buttons (How are they mounted? Do they have enough force to press the button?). From a software side, the processing of 3 different wand inputs has to be proven. We will not show the full user interface at this point. The miniaturization of the wand is also a stretch goal.

Risk to Failure

The risk of failure in this project is a reflection of the challenges to overcome. If we cannot get permission to work on the elevator, this project will not happen. Building a mock-up elevator out of cardboard would not come close to the user experience in the real, moving elevator, so we will not go there. Hardware-wise, we are confident we can unite engineering and computer science knowledge to overcome the challenges of implementation. The greatest challenge besides getting permission for this project would be the thought-out user experience. The elevator riders have to be able to collaborate and challenge each other in the skill of spell casting. The seamless integration of both interactions are crucial for success. In addition, all devices need to be controlled and powered wirelessly, since there are no outlets available inside the elevator.

Ethical Questions:

The magic elevator comes along with a manageable amount of ethical questions. First of all, the elevator may not be damaged or physically hacked in any way. The designers also have to ensure that at any given time, the users are able to overrule the system by physically pressing the buttons inside and outside the elevator. Our additions to the elevator should not in any way reduce the usability or accessibility of the elevator.

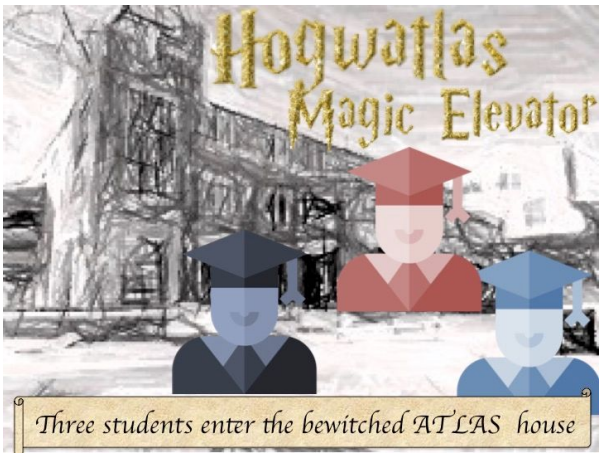
Ideally, all consoles that are added to the elevator can easily be removed by the users, returning the elevator to its original state.

Timeline:

Week	Phase	Goals	Deliverable
8	**Concept**	• Formulate user requirements (What is the best possible user experience / user story ?) • Brainstorm product concepts (How many "challenges" can be included?)	• Preliminary project proposal
9	**Planning**	• Revise proposal with feedback • Write user stories • Minimum Viable Product (MVP) building (feature extractors, ML, actuators, UI)	• Revised proposal • Living github repo • MVP: A system that can call an elevator with magic spells (after training the wand to work for the user).
10	**Design & Development**	• Extend MVP to full prototype • Learn new technologies (e.g. replace microbits by smaller sensors) • Iterate through ideas → code → data according to the lean startup methodology	• Changelog.md • Youtube Link
11		Spring Break	
12 **13** **14**	**Design & Development**	• Extend MVP to full prototype • Iterate through ideas → code → data according to the lean startup methodology • *Stretch goal*: Learn new technologies (e.g. replace microbits with smaller sensors)	• Changelog.md • Youtube Link
15	**Deadline**	• Final Report	• Final Youtube

	• Project Polishing	Video • Readme

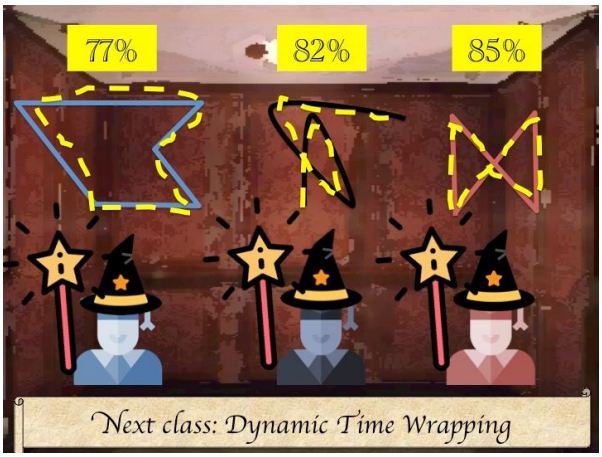
Story Line:


Hogwatlas
Magic Elevator
Three students enter the bewitched ATLAS house


If you guys want to go up, you have to unite magic forces!
The sorting hat leads them through their quest!


Great Job! Come on in!
Only a common spell cast will call the elevator!


Whoever performs the spell the best, gets first pick!
From teammates to competitors...


77%
82%
85%
Next class: Dynamic Time Wrapping


Look Player 3, the magic elevator has chosen your level first!
We have a winner!

Peer Feedback:

In this section, a selection of the peer feedback received for the first stage of this project proposal is summarized. The designers of the Magic Elevator comment on the received feedback and describe which approach they will take to address the feedback.

1. **Queue Ordering of Elevator Commands:** The main concern of our classmates regard the order in which the elevator will go to different floors after the users have casted their spells. It is proposed that a feedback loop is needed for the elevator to “know” its own position. In addition, external disturbances (e.g. a person on the third floor calling the elevator) influence the queue order of the magic elevator.

   →**Approach:** The designers are aware of the ordering problems and want to address them by minimizing destructive factors such as other persons to press buttons on different floors during the use of the magic elevator. Since it is not feasible to equip all levels of the ATLAS building with magic elevator terminals, help will be seeked from to facility management to close the elevator for third party users during the time of the 10-minute demo. Instead of determining the order of floors which the elevator has to go to, the elevator will only go to the user who casts the spell the best in the first prototype. However, it is planned to add a device that recognizes the current position of the elevator. This device will be needed to activate the button of the magic elevator in the reasonable order.

2. **Connectivity issues:** A very valuable, single input from a classmate was the challenge that might come along with connecting the terminal inside and outside the elevator to the wand inputs. It is suggested to transfer as much user interaction as possible to the ATLAS lobby.

   →**Approach:** The designers are highly thankful for this input. Related issues such as power supply, Wifi Connectivity and time management become easier with the lion share of the user interaction happening outside of the elevator. The designers aim to have only the physical activation of the solenoids placed inside the elevator. Summoning, training spells and competing for the best personal spell are now planned to take place in the ATLAS lobby.

Bibliography:

[1] Sung-Jung Cho et al., "Magic wand: a hand-drawn gesture input device in 3-D space with inertial sensors," *Ninth International Workshop on Frontiers in Handwriting Recognition*, Kokubunji, Tokyo, Japan, 2004, pp. 106-111.
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[3] Fiebrink, Rebecca. Cook, Perry., “The Wekinator: A System for Real-Time, Interactive Machine Learning in Music.” *Cumulative ISMIR Proceedings*, Princeton University, 2010.