# JargonJolt

Team 28
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# 1. Introduction

## 1.1 Problem

When learning a new language, amassing and retaining vocabulary is often one of the most challenging parts of the learning process and can be a choke point for advancing into conversational fluency. It is very easy for people to fall off track when learning a new language/new content, especially in the later stages which can prove detrimental to spaced repetition algorithms. According to an American 2021 study by preply.com, 71% of those surveyed who have given up on learning second languages regret letting their language skills slip. Furthermore, 43% of those people stopped studying due to either a lack of opportunity to practice, boredom, or a perceived high level of difficulty. Our project aims to assist those people to continue their endeavors to learn language.

Flashcard applications that already exist do so primarily as mobile or desktop applications. Desktop applications such as Anki have high functionality, but are not portable and could cause the user to miss days if they do not have access to their PC. Mobile applications require that the user has a smartphone, which is not ideal for certain audiences such as children or elderly. Battery life is also a concern for longer practice sessions and portability.

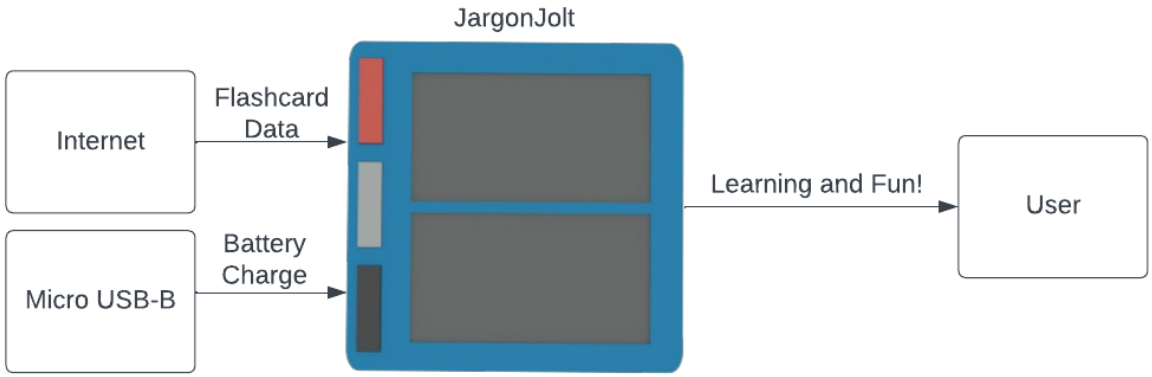
## 1.2 Solution

Our solution is the *JargonJolt*, a digital pet and portable flashcard device that makes consistently practicing your language skills convenient and fun! The *JargonJolt* will take advantage of the "tamagotchi effect". Named after the popular toy by Bandai, the tamagotchi effect is the phenomenon of humans becoming emotionally attached to machines, robots, or otherwise inanimate entities. We plan to harness this aspect of human psychology to encourage people to keep up with their daily language review and practice. Nurturing/playing with a digital pet who gets happier as you do better in your flashcard reviews will keep flashcard users more engaged during their reviews as well as more consistent.

Users of the *JargonJolt* will be able to download Anki flashcard sets, where we will make use of spaced repetition algorithms to show users flashcards in optimal order for memory and knowledge retention. The *JargonJolt* will feature a low power digital ink screen for displaying both flashcards and the digital pet as well as several buttons for selecting options for responding to flashcards. Applications of similar functionality may exist as smartphone apps, but the

*JargonJolt* has unique advantages that give it cause to exist as a product. The simplicity and toy-like nature of the *JargonJolt* makes it ideal for children who are not ready for a smartphone or tablet. A rechargeable battery will also allow users to take their *JargonJolt* on the go without worrying about the battery life of their mobile devices or the cell reception in any given area.

### 1.3 Visual Aid




### 1.4 High-level Requirements

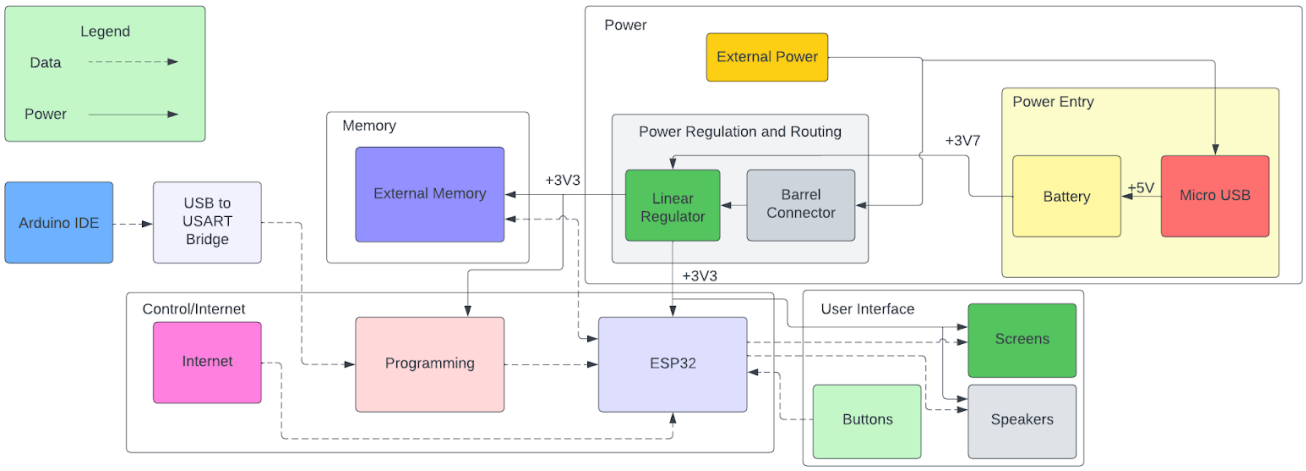
The device enables users to view flashcards, see answers, select their results, and monitor the status of a digital pet. Flipping and switching between flashcards must be completed within 1 second, and the digital pet should respond to any state changes within 1 second.

The device must have the capacity to store and recall ‘question and answer’ data for up to 500 flashcards, in addition to retaining user interaction history with the flashcard set. Furthermore, it should be capable of downloading flashcard sets from the internet in under 5 minutes.

The device should be portable, with dimensions not exceeding 160mm x 120mm, and designed for long-term use. It must feature a rechargeable battery with a lifespan of at least 2 hours on a single charge.

# 2 Design

## 2.1 Block Diagram




## 2.2 Subsystem Overview and Requirements

### Subsystem 1: Control/Internet

This module consists of the ESP32 module, a small amount of programming circuitry, and the internet module, which is physically built into the ESP32 module. The ESP32 will run code to determine which flashcard to show the user, process the user's button inputs, send audio to the speakers, and change the digital ink display to show both flashcards and the status of the pet. The ESP32 will also interface with the memory submodule to retrieve flashcard data. The control subsystem will also contain serial programming pins for flashing the microcontroller. The ESP32 also contains built-in wifi support, with which it will be able to connect to the internet to download flashcard data, which will be stored in the memory module.

**Requirement #1:** Must be able to download flashcard data and write to memory for use with the MCU program.

**Requirement #2:** Must be able to retrieve data from the memory subsystem and send both audio and video data to the user interface subsystem.

### Subsystem 2: Power

The JargonJolt will feature a rechargeable battery and a Micro USB-B charging port. The battery supplies a 3.7 V rail which will be regulated down to 3.3 V by a linear voltage regulator. All electronics down the line (MCU, E-INK, etc.) will run on 3.3 V. The power module will also contain a barrel jack for tabletop testing without needing a functioning battery

**Requirement #1:** Must be able to supply at least 500 mA continuously and 1 A for short periods of time to the rest of the system at 3.3 V +/- 0.1 V.

**Requirement #2:** Must allow recharging through the use of a USB charging cable with a battery life of at least 2 hours per charge.

### Subsystem 3: User Interface

The user interface subsystem consists of two video displays, a speaker, and three buttons. The video displays will be low power 4.37 in, 512 × 368 resolution digital-ink screens that display the flashcards and the digital pet. They will communicate with the MCU subsystem via SPI. The speaker will be used to play audio associated with the flashcards, such as the pronunciation of words and example sentences. The MCU subsystem will output an I2S signal which can be converted into audio signals via an off the shelf I2S amplifier. The buttons will be used to answer the flashcard questions and will be connected to GPIO ports of the MCU subsystem. All powered electronics in the User Interface subsystem will run on 3.3 V supplied by the linear regulator in the Power subsystem.

**Requirement #1:** Must be able to display flashcards and the digital pet on the screens as well as playback audio associated with flashcards.

**Requirement #2:** Must be able to send user inputs back to the control unit.

### Subsystem 4: Memory

The memory module contains external SRAM which will be used to store the flashcard data, allowing the JargonJolt to operate entirely offline once flashcards are downloaded. The microcontroller will interface with the SRAM through an SPI interface, both writing flashcard data from the internet and retrieving it for use during practice sessions.

**Requirement #1:** Must be able to store data for at least 100 flashcards

**Requirement #2:** Must be able to be written to and read by the control unit

### 2.3 Tolerance Analysis

One potential cause for concern in this project is the life of the battery. One of the biggest selling points of the JargonJolt is portability, the ability to work completely offline, and being unbound from a mobile device. The JargonJolt is planned to be equipped with a 3.7 V battery that holds 1000 mAh of charge. This means that the battery is capable of supplying 1 amp at 3.7 V for one hour. Using P = IV, this corresponds to a power output of 3.7 watts for 1 hour, or a total stored power of 13.3 kilojoules.

| Device | Worst case current draw (mA) | Worst case energy cost (mW) |
|---|---|---|
| Digital Ink Screen | 18.7 | 61.7 |
| Speaker | 333 | 1000 |
| ESP32 | 500 | 1650 |
| Memory | 8 | 26.4 |
| Total | 859.7 | 2837.01 |

In the worst case scenario, which would consist of the speakers firing, the screens performing a full refresh, and the memory unit being written to all consecutively, we would still get a battery life of around 1.3 hours. This is not too far off from the goal of a 2-hour long battery life, and this worst-case scenario would be impossible in real operation. Furthermore, the battery could be bumped up to a larger but similar battery that can supply 3.7 volts for 2000 mAh, doubling the total stored energy and pushing us well into spec for battery life. Furthermore, instantaneous current draw is not a concern, as the battery we selected can supply up to 1 A without seeing a dip in output voltage. Linear voltage regulators can approach 95% to 99% efficiency when regulating down from a voltage not far above the output voltage. This is the case in our design, so losing significant power there is not a large concern.

## 3 Ethics and Safety

When developing JargonJolt at the University of Illinois, the IEEE Code of Ethics and Safety will be upheld including improving capabilities of emerging technologies (I.2), seeking criticisms of our technological developments (I.5), and crediting those who have contributed to any of our own developments (I.5). In addition to the IEEE Code of Ethics, the ACM Code of Ethics will also be upheld. This project focuses on limiting the damages that electronics often have on the environment. By using a wide range of power-reducing techniques, JargonJolt will aim to limit the amount of energy needed in accordance with ACM's environmental sustainability principle (1.1). Should any issues arise, we will disclose any problems that our developments may cause in a transparent manner (1.3), all while respecting the privacy of our users' data.

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