Retrofitting an iMac G3 & Mouse for Use in the 21st Century

ECE 445 Design Document
Team 23
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Introduction

Problem:

Disposal of outdated technology contributes to approximately 50 million tons of e-waste annually, leading to environmental concerns. Our project aims to demonstrate a sustainable approach to repurposing technology from the past, diverting it from landfills and back into the consumers' hands.

Specifically, by modernizing old devices, like updating the original iMac G3 to modern computing standards, as well as its original peripherals, such as the mouse included with the device, we not only extend the lifespan of these devices but also preserve their original creative style and design intent. This initiative will align vintage technology with modern computing needs, ultimately fostering a more eco-friendly and innovative technological landscape.

Solution:

Our project aims to replace legacy hardware within the 1998 iMac G3 by utilizing the internal components of a newer Mac Mini computer. The new components will be mounted inside the original iMac shell to give new life to this outdated machine. The original CRT screen will be replaced with a newer LCD screen. The original speakers and disc drive of the iMac will be re-utilized as well, and the ports will be upgraded to the relevant modern port types.

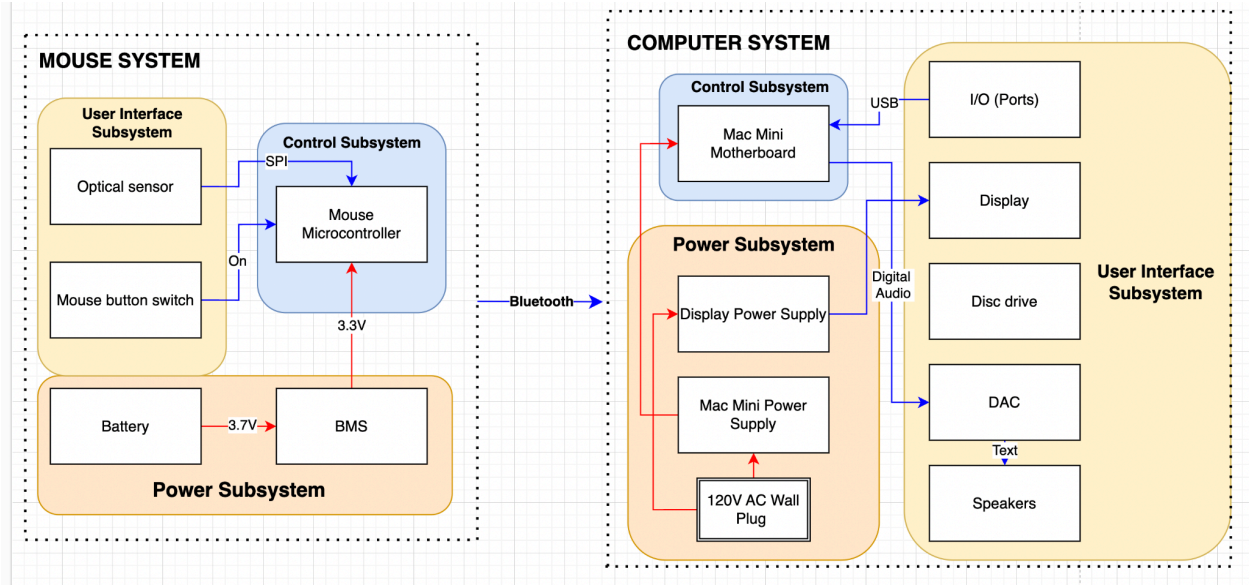
We also aim to update the original Apple USB mouse included with the device by using modern optical sensors and bluetooth to replace the legacy hardware. A modern switch of higher quality and durability will replace the original switch used for the mouse button and rather than physical rollers interacting with a rubberized ball on the bottom of the mouse, we will use an optical sensor to detect mouse movement. The user can customize the sensitivity of the mouse, a feature unavailable on the original hardware. The USB connection will be replaced with bluetooth to communicate with a computer. Due to its wireless nature, the mouse will be battery powered. The mouse can detect when it is not being used and automatically shut off as a battery saving measure, similar to modern bluetooth mice.

Visual Aid:

High Level Requirements:

1. The mouse must connect to modern computers using bluetooth and allow movement of the cursor as well as clicking.
2. The iMac must connect to WiFi, have bluetooth capability, and run at least two applications simultaneously, as well as perform actions within these applications.
3. The mouse must have a latency of no more than 20 milliseconds

Design



BLUE = DATA RED = Power

Mouse System - User Interface Subsystem:

The mouse button switch allows the user to click the mouse button. The switch must activate every time the mouse button is pressed and release only when the button is released (no bouncing).

The optical sensor will allow the mouse to function as a normal, modern Bluetooth mouse. This sensor will replace the ball originally within the mouse. The sensor will control the movement of the mouse and track it more efficiently.

Mouse System - Control Subsystem:

The microcontroller will connect to the computer using bluetooth. It will communicate to the computer to move the cursor and click with a latency of 20ms or less. The mouse control system will be the main hub for the functionality and is the most important part of the mouse.

Mouse System - Power Subsystem:

The battery will be connected to the BMS which will provide 3.3V(+/-.3V) DC to the microcontroller and sensors. The battery will last for at least 2 hours of use.

Computer System - Power Subsystem:

The power system of the computer will consist of a display power supply and the Mac mini power supply which will both be powered by a 120V AC plug.

Computer System - Control Subsystem

The control system of the computer will consist of the Mac mini motherboard which we will place into the iMac G3. The new motherboard will allow for the upgraded features of a new computer within the G3 outer shell and must be able to be powered by the Power subsystem, as well as support the requirements of allowing the iMac to connect to WiFi, have bluetooth capability, and run at least two applications simultaneously, as well as perform actions within these applications.

Computer System - User Interface Subsystem:

The user interface system of the computer will consist of the different I/O components, such as the computer's ports that will allow the connection of any wired devices. The UI subsystem also includes the display screen, and the speakers and disk drive original to the iMac G3, that will be reutilized within our new computer system. The ports will be fully functional for use with I/O devices. The display will be fully functional as well and will allow the user to clearly visualize their actions with the cursor/mouse on screen. The speakers will be able to be increased and decreased in volume, and the sound quality will be clear. The disk drive will also be able to be utilized.

Tolerance Analysis:

The subsystem that is the most critical success to our project is the power subsystem of the mouse. This subsystem will be responsible for powering the mouse and any components within it. The overall subsystem includes a rechargeable lithium ion battery and a BMS with an IC chip and voltage regulator. The battery will have a rating of 3.7/4.2 volts. The microcontroller we will be using is a ESP32 which will take 3.3 (+/- .3) volts. We will be using a 3.3 volt voltage regulator to ensure we stay in this range of voltages.

Requirements & Verification Table:

Subsystem	Requirement	Verification
Mouse System - User Interface Subsystem	The mouse button switch is clickable	The switch must activate every time the mouse button is pressed and release only when the button is released (no bouncing)
Mouse System - User Interface Subsystem	The optical sensor allows the cursor to move	While the mouse is initially at rest, move it along both x and y axes. Verify that the cursor moves only in the direction the mouse moves, and stops once movement ceases.
Mouse System - Control Subsystem	The microcontroller will connect to the computer using bluetooth	The microcontroller will communicate to the computer

		to move the cursor and click with a latency of 20ms or less
Mouse System - Power Subsystem	The battery will be connected to the BMS which will provide 3.3V(+/-.3V) DC	We can test with our microcontroller and check the voltage it is receiving.
Computer System - Power Subsystem	The power system of the computer will consist of a display power supply and the Mac mini power supply	Both the display and the Mac Mini will be powered by a 120V AC plug
Computer System - User Interface Subsystem	The screen should be able to display as well as have functioning I/O ports.	Boot up the computer. Verify that the display actively shows the computer's output.
Computer System - User Interface Subsystem	The computer ports will be accessible and able to connect various I/O components	I/O components will be accessible and successfully connect to the computer via the ports

Cost Analysis

Part Description	**Quantity**	**Price**
ESP32 MCU	1	1.85
D2LS-21 Switch	1	2.00
PMW-3389 Optical Sensor	1	15.00
Battery	1	~7.00
Voltage regulator	2	~3.00
Resistors	~10	~1.00
Capacitors	~5	~.50
Misc. SMD Components	~10-15	~5.00
DB15-HDMI adapter	1	~25.00
DAC	1	~20.00
iMac G3 Mouse	1	20.00

iMac G3	1	40.00
Mac Mini	1	80.00
Total parts cost:	$220.35	

Estimated labor costs:
$40/hr x 2.5 x 60 hours = $6,000 per partner
$6,000 x 3 = $18,000
Total cost:
$220.35 (parts) + $18,000 (labor) = **$18,220.35**

Schedule

Week	Tasks	Person
2/19	Complete Design Document	Everyone
2/26	Finalize parts list and order Create prototype PCB board Begin coding microcontroller	Everyone Saif Savannah/Sebastian
3/4	Make changes to design document Finalize PCB design for submission Continue coding microcontroller	Everyone Saif Savannah/Sebastian
3/11	Test subsystems of mouse Finalize coding of microcontroller Begin building mac to test mouse on	Everyone Savannah/Sebastian Saif
3/18	Construct prototype mouse with PCB Make changes if necessary to PCB design Continue to build Mac if not completed	Everyone Everyone Everyone
3/25	Rebuild prototype mouse with updated PCB	Everyone
4/1	Begin Final Paper	Everyone
4/8	Continue working on Final Paper	Everyone
4/15	Mock Demo	Everyone
4/22	Final Demo and Mock Presentation	Everyone
4/29	Final Presentation	Everyone

Ethics and Safety

Ethics:

The ethical issues that are relevant to our project that may arise during development of misuse of our project relate to violations of patents. According to the ACM Code of Ethics, section 1.5 details protection of a creator's work and ideas. Our project is upgrading an existing computer and mouse created by Apple, therefore we must credit the creator during our development process.

Safety:

We do not have many safety concerns for our project. Our only concerns would come during the lab portion when constructing our project. The disassembly and use of a battery are the biggest areas of concern but with proper lab safety we hope to have no issues. After assembly there would be no safety concerns for the end user.