LED20 PDS

Team 1

Version 1.2

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ECE 411

Industry Design Processes

Executive Summary

Our product is a 3D-printed, illuminated D20 die designed to enhance the tabletop gaming experience with both visual and audio effects. When rolled, the die lights up with a predetermined pattern corresponding to the number it lands on, adding an exciting visual element to gameplay. Additionally, when a 20 or a 1 is rolled, the die plays a tune to either congratulate the player's critical success or revel in their critical failure, making key moments even more memorable.

Specifically crafted for Dungeons & Dragons (D&D) enthusiasts, tabletop RPG players, and fans of electronics, this device blends traditional dice-rolling with modern interactive technology. It operates just like a standard D20: players roll it during gameplay, and the built-in electronics automatically detect the number rolled, triggering the corresponding light pattern.

By combining classic game mechanics with engaging visual and audio feedback, this product appeals to a wide audience of gaming and electronics enthusiasts, making every roll more gratifying and lively.

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1 Market Analysis

The primary target customers for this product are Dungeons & Dragons (D&D) players, tabletop RPG enthusiasts, and fans of electronics or novelty gaming accessories. This audience is generally comprised of tech-savvy individuals who enjoy enhancing their gaming experience with unique and interactive tools.

In terms of competition, there are existing illuminated dice and smart dice on the market, but most lack the combination of both customized light patterns and audio feedback for critical rolls. Some competitors offer dice that light up, but they are typically either generic or limited in terms of features.

Our product stands out by offering not only illuminated feedback but also the added feature of audio cues for critical successes (rolling a 20) or failures (rolling a 1), which adds extra excitement and immersion to the game. This differentiation makes it more appealing to customers looking for a more engaging and fun gameplay experience.

We estimate a selling price of around $30 to $40 per die. This is based on the cost of materials (3D printing, electronics) and similar specialty gaming accessories in the market, while remaining affordable for most gamers who are willing to pay a premium for enhanced gameplay features.

2 Requirements

Must:

- Illuminate the user's rolled number on the upright face of the die.
- Have a battery life that lasts the length of a typical D&D session (4-6 hours)
- Be able to withstand the impact of a 3 foot drop.
- Play a congratulatory or disheartening noise depending on if a "20" or "1" is rolled, respectively.

Should:

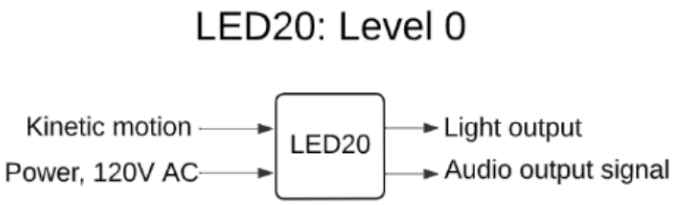
- Look aesthetically pleasing
- Be no larger than the palm of a hand (3" x 3" x 3")

May:

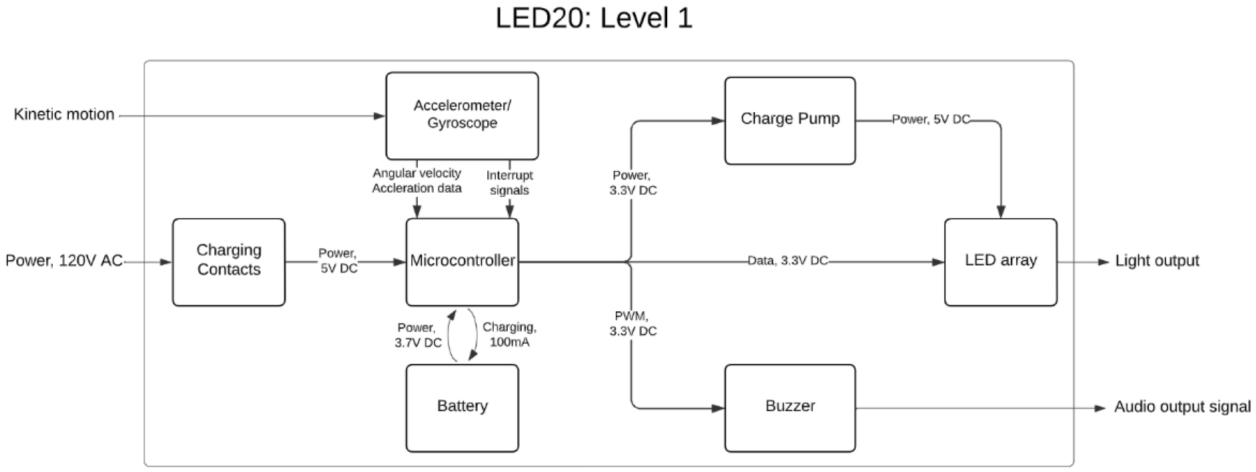
- Have different selectable lighting modes
- Have wireless charging capabilities

3 System Architecture

L0 Block Diagram



L1 Block Diagram



4 Design Specification

The design specifications for the LED20 come from a few major goals. The first goal is to package everything inside a die no larger than the average palm (3" x 3"). The second goal is that it should be designed with power efficiency in mind. Another goal is that the die must withstand the repeated impact of tabletop rolls. Lastly, it must be chargeable.

Technical Specifications

- Processor - ESP32-C6
- Sensor - LSM6DSO32-TR Gyroscope
- Actuator - WS2812 LED Array
- Power Source - One 3.7V 500mAh LiPo Battery
- Mechanical Design - Impact-resistant 3D printed half shells that thread into each other to form a twenty-sided die (D20). The shell will house the PCB, LED's, speaker, and battery.
- Programming Environment - Arduino or C
- Dimensions - Less than 3" x 3" x 3" (W x L x H)
- Battery Life - Should be more than 6 hours (consume less than 300 $\frac{mW}{hr}$)
- Audio - Piezo buzzer

A Appendix: Bill of Materials

Last modified: 2024-12-10
PCB version: 5.6
BOM revision: 5
P/NP = Place/Not Place (components marked NP are not stuffed on the board)

Cnt	Part References	P/NP	Mfg	Mfg PN	Description	Dist	Dist Part Number	Cost Ea.	Cost Total
100	D1 - D20	P	OPSCO OPTOELECTRONICS	SK6812MINI-B-00	NeoPixel Mini 3535 RGB LEDs w/ Integrated Driver Chip	Adafruit	4957	$0.20	$19.95
4	U4	P	Seeed Studio	113991254	Seeed Studio XIAO ESP32C6 Microcontroller	Seeed Studio	8543708800	$5.20	$20.80
2	Protoboard Only	NP	Adafruit	5649	QT 3V to 5V Level Booster Breakout Board	Adafruit	5649	$2.95	$5.90
4	No Ref Des	P	Shenzhen PKCELL Battery Co.	LP-523334	3.7V 500mAh LiPo Battery	Adafruit	1578	$7.95	$31.80
2	Protoboard Only	NP	STMicroelectronics	LSM6DSO32	6-DoF Accelerometer and Gyroscope	Adafruit	4692	$12.50	$25.00
10	U2	P	Diodes Incorporated	AP3602AKTR-G1	3.3V DC to 5V DC Step-Up (Boost) Output Regulator (100mA)	DigiKey	31-AP3602AKTR-G1CT-ND	$0.48	$4.81
6	U1	P	STMicroelectronics	LSM6DSO32TR	Accelerometer, Gyroscope, 6 Axis Sensor, I2C/SPI	DigiKey	497-LSM6DSO32CT-ND	$4.09	$24.56
24	C2,C3	P	Samsung Electro-Mechanics	CL10A106KQ8NNNC	10µF ± 10%, Ceramic Capacitor 0603, 6.3V	DigiKey	1276-1038-1-ND	$0.07	$1.61
12	C1	P	Samsung Electro-Mechanics	CL10B105KP8NNNC	1µF ± 10%, Ceramic Capacitor 0603, 10V	DigiKey	1276-1946-1-ND	$0.03	$0.38
20	C4,C5	P	Samsung Electro-Mechanics	CL10B104KB8NNNC	100nF ± 10%, Ceramic Capacitor 0603, 50V	DigiKey	1276-1000-1-ND	$0.03	$0.50
10	U7,U6	P	JST Sales America Inc	B2B-PH-K-S	Connector Header, Through Hole, 2-Position	DigiKey	455-1704-ND	$0.13	$1.28
10	U6	P	Same Sky	CPG-04-N-B	PC Pin Terminal Connector, Through Hole, Gold, "1mm D	DigiKey	2223-CPG-04-N-B-ND	$0.69	$6.86
10	U7	P	Same Sky	CPG-05-N-B	Contact Point, 1.55mm Head	DigiKey	2223-CPG-05-N-B-ND	$0.36	$3.58
6	LS1	P	Same Sky	CMT-7525-80-SMT-TR	Externally Driven, 3.6V, 100mA, SMD Buzzer Transducer	DigiKey	102-CMT-7525-80-SMT-CT-ND	$1.28	$7.68
10	D1	P	Adam Tech	2SH-C-03-TS	CONN HEADER VERT 3POS 2MM	DigiKey	2057-2SH-C-03-TS-ND	$0.10	$1.01
12	No Ref Des	P	JST Sales America Inc	02KR-D6S-P	2 Position Rectangular Socket Connector IDC Tin 26 AWG	DigiKey	455-2701-ND	$0.37	$4.42
8	No Ref Des	P	JST Sales America Inc	03KR-D6S-P	3 Position Rectangular Socket Connector IDC Tin 26 AWG	DigiKey	455-2700-ND	$0.43	$3.40
4	CR1	P	onsemi	S1B	DIODE GEN PURP 100V 1A DO214AC	Digikey	S1BFSCT-ND	$0.35	$1.40
4	U3	P	onsemi	MMBT4401L	TRANS NPN 40V 0.6A SOT23-3	Digikey	MMBT4401LT1GOSCT-ND	$0.14	$0.56
4	R1	P	Panasonic Electronic Compor	P.18AJCT-ND	RES 0.18 OHM 1% 1/10W 0603	Digikey	ERJ-3RSFR18V	$0.23	$0.92
								TOTAL:	$166.42

VERSION INFO

Rev	Date	Notes
v1.0	2024-11-14	First Draft of Inclusive BOM
v2.0	2024-11-14	Added Connectors
v3.0	2024-11-14	Changed QTY of BZ1 to 6 and U2 to 10 and JST 3 hole connector to QTY 10
v4.0	2024-11-29	Final Variant
v5.0	2024-12-10	Added BJT and Diode

Final version of the bill of materials (V5).