

Engineers of Catan

Project Proposal

ECE 445

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1.0 Introduction

1.1 Statement of Purpose

We selected this project because there is nothing similar available, and it presents some unique challenges with regards to piece detection and board design, due to the game's unique reconfigurable layout and pieces. We also felt that we could produce a functional, easy-to-use, and nice-looking final device that would be a worthwhile goal.

This board allows players to move through the game faster and to make sure that there are no missed resources during distribution. It also speeds up the initial game setup process.

1.2 Benefits

- Resources automatically totaled for players at the beginning of each turn
- Automatically generate the board configuration.
- Built-in random-number dice.
- Identify individual pieces (type and owner)
- Makes resource distribution easier for players
- Speeds game play

1.3 Goals

- Develop a modular board system that can be easily expanded and assembled
- Recreate very similar gameplay to the actual board game
- Have an easy-to-use interface for players that doesn't require additional learning

1.4 Functions

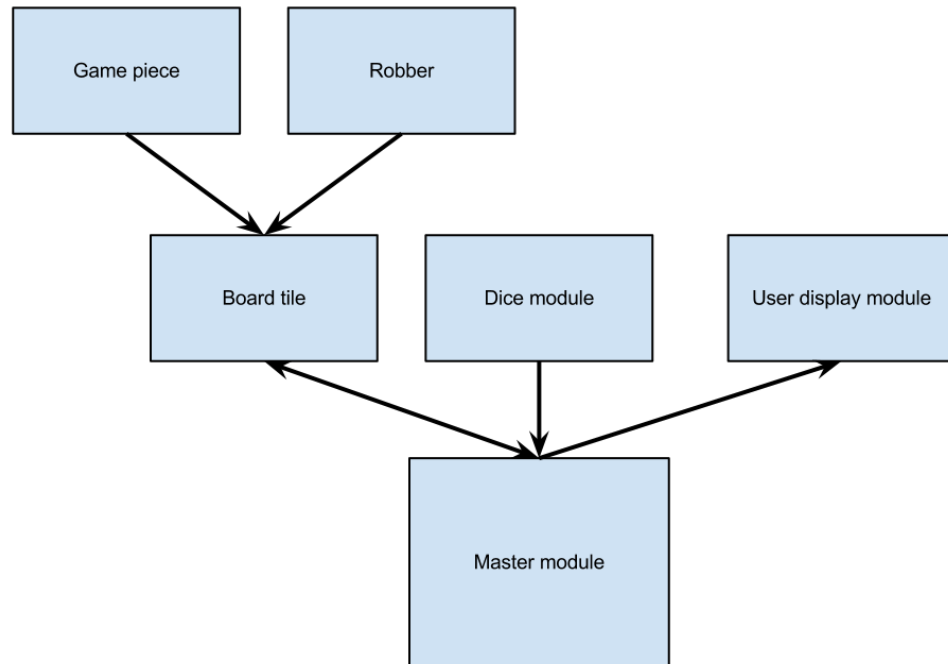
- Bright LEDs to display board layout and 7-segment displays to indicate number on each tile
- Automatic randomized board layout for each game
- Easy to read resource information for each player

1.5 Features

- Automatic board layout
- Easy-to-use resource counting feature
- Intuitive gameplay
- Contains all pieces for a 4 person game

2.0 Design

2.1 Block Diagram



2.2 Block Descriptions

2.2.1 Master Module

The master module will contain the game logic and will be responsible for controlling the board tiles, dice module, and user-display modules. The master module will be connected to the other modules via an I2C bus.

2.2.2 Board Tiles

In the traditional Settlers of Catan, the board is made up of several (19) tiles that are laid out and used to construct a unique board for each game. Each tile also gets a token with a number from 2 to 12. Our version will have those tiles assembled, but the logic in each cell will allow the layout of the board to be randomly generated. This will allow the same gameplay as the traditional version. Each tile will include an RGB LED to change the color, several piece sensors, a Hall Effect sensor for detection of the robber, and a 7-segment display to show its number.

The tiles will be identical and connected via an I2C bus to allow individual addressing and two-way communication with only two wires. This will allow us to produce several identical blocks and connect them to the board without requiring different hardware for different positions.

The board tiles will be controlled by the master module via the I2C bus.

2.2.3 Dice Module

The dice module will consist of two digital "dice." The numbers will be generated by a random number generator and displayed via LEDs. The master module will generate the numbers and send them via the bus to the dice module, which will display them. This will simulate rolling the dice for each turn.

2.2.4 User-display Module

The user display module will display the number of resources collected after each dice roll, while taking into account the position of the robber. These will be displayed using 7-segment displays. The displays will be updated by the master module via the I²C bus. This will allow players to easily decide which resources to collect after each dice roll.

2.2.5 Game Pieces

The standard game pieces will consist of different valued resistors inside of pieces. This will allow the board tiles to identify the type of piece, as well as which player the piece belongs to by measuring the voltage drop in a voltage divider. This will allow automatic totaling of the points for easy resource distribution. The pieces will allow a simple, intuitive gameplay similar to the normal game.

2.2.6 Robber

The robber will be a piece with a powerful magnet on the base, which will activate the Hall Effect sensor in each board cell in order to allow the board to sense the piece location. This will allow the robber to be used in the same way as the normal game.

3.0 Requirements and Verification

3.1 Requirements

3.1.1 Master Module

- Must send color and 7-segment display values to connected game piece modules
- Must receive data about attached pieces (including robber) from connected game piece modules
- Must receive dice roll information from connected dice module
- Must determine the resource distribution
- Must send information to the connected user-display modules

3.1.2 Board Tile

- Must have two-way communication with the master module
- Must be able to connect several together in a series and allow communication through one bus
- Must contain an RGB LED able to light up the board above the tile
- Must contain a 7-segment LED to indicate token dice number
- Must detect standard game pieces when connected
- Must detect robber when placed on top of the board tile

3.1.3 Dice Module

- Must generate random dice rolls for two dice
- Must send generated numbers to master module
- Must display the rolls from two dice

3.1.4 User-display Module

- Must receive information about received resources from master module
- Must display amount of received resources on each dice roll

3.1.5 Game Pieces

- Must be durable enough to withstand many plug/unplug cycles
- Must be easy to plug/unplug

3.1.6 Robber

- Must be easy to move around board
- Must be durable

3.2 Verification

3.2.1 Master Module

- Determine initial board layout for each game tile (color/number combo)
- Send color/number data through I2C
- Receive piece data through I2C
- Receive dice roll information from dice module
- Calculate received resources based on received piece and dice roll data

- Send received resource data to user display module

3.2.2 Board Tile

- Receive data through I2C and set color/number accordingly
- Detect attached pieces and robber and send data through I2C
- Allow a series of tiles to be connected using the I2C bus by having male connectors on one side and female connectors on the other side
- Tiles fit in the board frame when assembled
- Produce enough light (both LEDs and display) to be seen through an acrylic sheet used for the board surface

3.2.3 Dice Module

- Generate random numbers on button push
- Send generated numbers to master module
- Display generated numbers on 7-segment display

3.2.4 User-display Module

- Display counts of the five resources generated each turn
- Receive count information from the master module

3.2.5 Game Pieces

- Can withstand 1,000 use cycles
- Contains a resistor to allow the board tile to identify the piece
- Resembles the original game pieces

3.2.6 Robber

- Contains magnet to trigger Hall sensors
- Resembles original game piece

3.3 Tolerance Analysis

The component that most affects the performance of the project is the I²C bus. If the capacitance of the bus is too high, it will not work, and none of the components will be able to function. This can be corrected with an I²C buffer IC, but it is preferable not to use a buffer if not required.

In order to function, the bus must have a capacitance of less than 400pF, according to the specification. We will measure the bus capacitance when the unit is assembled to determine if it meets the specification.

We will run the test with a function generator and oscilloscope to determine the input capacitance. We will also add additional capacitance to the bus and test the response of the controller.

4.0 Cost and Schedule

4.1 Cost Analysis

4.1.1 Labor

Name	Hourly Wages	Hours Invested	Labor Total (x2.5)
Hannah	\$40	120	\$12000
Adam	\$40	120	\$12000
Labor Total		240	\$24000

4.1.2 Parts

Part	Part Number	Unit Cost	Quantity	Total
Blue LED	COM-08860	1.50	19	\$45.00
Green LED	COM-08861	1.50	19	\$45.00
Red LED	COM-08862	1.50	19	\$45.00
Microcontroller	MSP430G2553	1.33	36	\$47.88
7-Segment Display	HDSP-5501	1.60	41	\$83.20
LED Driver	TLC5917IN	1.50	60	\$90.00
Hall Effect Sensor	785-SS42R	1.64	19	\$31.16
Linear Regulator	LM7805	0.33	4	\$1.32
RCL, etc.				\$40.00
Acrylic Sheet	8505K15	72.13	1	\$72.13
Board Frame		100.00	1	\$100.00

Power Supply	9VDC 1AMP	7.16	1	\$7.16
PCB			36	\$200.00
Part Total				\$807.85

4.1.3 Grand Total

Section	Total
Labor Total	\$24000.00
Part Total	\$807.85
Grand Total	\$24807.85

4.2 Schedule

Week	Hannah	Adam
Feb 11	Learn Eagle and rough design for dice PCB	Learn Eagle and rough design for master PCB
Feb 18	Rough design for user display PCB and complete Design Review paper Sign up for DR	Rough design for board frame and cover and complete Design Review paper
Feb 25	Prototype game pieces and robbers Review/send for milling master module PCB and board frame/cover	Rough design for game tile PCB Review/send for milling dice and user display PCB
Mar 4	Solder/debug dice PCB Solder user display PCB	Finalize game tile PCB and send first for printing Finalize board frame and board cover designs and send for creation
Mar 11	Debug user display Update PCB designs Individual progress report	Debug/update PCB designs Individual progress report
Mar 18	Spring break	Spring break
Mar 25	Solder/debug PCBs	Solder/debug game tile PCB Update game tile PCB design Send game tile PCB for milling
Apr 1	Finalize user display, dice, master PCBs Order final PCBs	Solder/debug game tile PCB Order rest of game tile PCBs
Apr 8	Assemble and debug	Assemble and debug
Apr 15	Sign up for demo Assemble and debug	Start presentation Assemble and debug
Apr 22	Demo	Demo

Apr 29	Presentation, Final Paper, and Checkout	Presentation, Final Paper, and Checkout
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