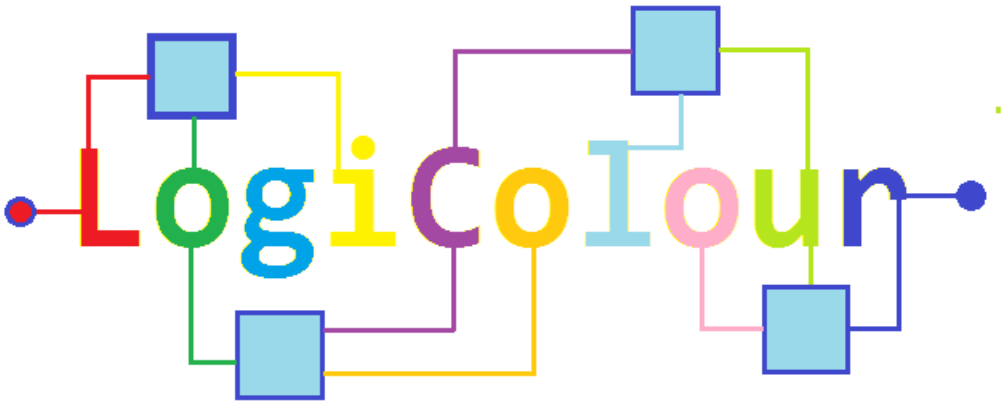

ENCM 507

Video Game project

LogiColour - A Colourful Puzzle Game

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Contents

Introduction

The purpose of this document is to provide a summary proposal outlining my term project for ENCM 507. The project is to design and develop a puzzle based video game using the Processing programming language to showcase our understanding of circuit floor planning and some of the current problems facing the industry.
This report has been broken down into four key sections following the introduction:

1. **Problem Statement:** Identifying the target demographic and the applications of the game as a solution to a contemporary need within the market. This section will also focus on making the game fun and exciting to play.
2. **Game Explanation:** This section will highlight the game mechanics, the underlying logic of the game, difficulty levels, scoring and replayability.
3. **Storyboard:** This section will showcase the proposed look of the game as to each main screen of the game.
4. **Project Management:** This section will focus on the project deliverables, the milestones, and the time management aspects of the project as well as any future extensions.

Problem Statement

Purpose of LogiColour:

With programming becoming an ever-more necessary skill and electronics becoming prevalent in all major industries, it is becoming imperative that more and more people understand and can write code. Despite the need for more programmers in workplace, many people still have lay-man's understanding of how programming actually works, and even more are purely disinterested due to a lack of exposure in their lives. LogiColour will help to bridge this gap by providing a fun and creative way to utilize logic systems to solve varying problems whilst providing a scoring system that is adaptable and allows for lateral thinking. It is the intention then, that by playing LogiColour, users will be exposed to an abstraction very similar to circuit logic that will hopefully inspire more people to learn about circuits and the underlying principles of logic systems.

Target Audience for LogiColour:

The target demographic that LogiColour is aimed at older children (aged 10-12), teenagers, and young adults as well as anyone else who would is interested in learning about logic systems who may have not previously been taught about them, including adults in industries not directly related to programming and circuitry.

Making LogiColour Fun:

In order for LogiColour to be successful in promoting logical thinking with "out-of-the-box" adaptability, there will be multiple solutions to all given problems. This will be achieved by utilizing a logic system called "Colour Logic" which will be explained in detail in Section II of this report. This multiple solution framework will allow for replayability and will encourage finding more efficient solutions by utilizing a flexible scoring system. Additionally, each successive level of difficulty will increase the complexity of the system needing to be solved, and this will allow for perpetual challenges regardless of expertise which will promote continuous fun.

Applications of LogiColour:

The purpose of LogiColour is to promote problem solving, and as such it has many applications to real world scenarios. These scenarios are easy abstracted from real world circuit planning and logic generation to help promote a general methodology which may applied in practice to Boolean logic and function design. It also incorporates constraints into the puzzles and this is found in all real-world problems. Finally, in many engineering disciplines it is necessary to come up with alternative designs for both feasibility studies and cost constraints, and by offering a flexible framework, players are encouraged to come up with creative solutions rather than just brute-forcing one solution.

Game Explanation

Goal of the LogiColour Game:

The purpose of LogiColour is to form a closed system which connects each given Input/Output (IO) Nodes in such a way that all Nodes are connected somehow to each other forming a closed net. A small caveat is present which states that all nodes must be connected with the appropriate colours such that the nodes all connect to their appropriate colours. These colours may not be present at the beginning, and thus it becomes the job of the player to utilize the "Colour Logic" system to make the appropriate colours using the given blocks.

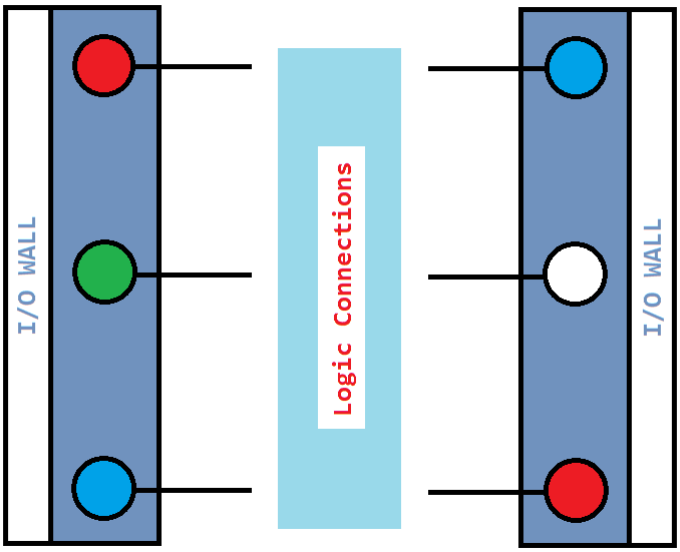


Figure 1: Proposed LogiColour Puzzle Overview

Game Play Mechanics:

Users will interact with the game interface through the use of the mouse primarily. Additional interaction may be possible through the keyboard, but for the purpose of the α-Release, the mouse will be the only form of interaction.
Users will select and place blocks from the given "Logic Bank" and will attempt to convert colours as necessary such that they can then be routed to the IO Nodes on the walls. Left clicking a block from the bank will load it at which point it can then be place onto the "Map" of the game. Users can easily delete block by Right-Clicking them on the "Map" at which point they will be deleted and all remaining logic will adjust accordingly.
Once a system has been formed and all IO Nodes are connected to each other, a button will activate allowing the user to finish the level and receive a score for their solution. Before pressing the button, the user will have the option to modify the circuit and adjust it as necessary to achieve a better score prior to finishing the level. Once the button is pressed, the solution score will be tallied and placed into a high-score list showcasing the best solutions if it is found to be a better solution.

Game Logic of LogiColour:

In order to build a solvable system for the game, the following logic system was designed. The following section will outline the various aspects of the "Colour Logic" system and how it applies to the game.

Logic Levels:

It incorporates Seven(7) Logic Values which are in turn represented by colours. The following are the given logic levels:

***Note: The order is not necessarily representative of their relationship, please see further below for an explanation of their actual relationship.**

1. W - White
2. R - Red
3. G - Green
4. B - Blue
5. r - Inverted Red
6. g - Inverted Green
7. b - Inverted Blue

LogiColour Wheel:

In order to properly show how these colours relate, the following is a graphical representation showing the "LogiColour Wheel" and the relationship between each Logic Level.

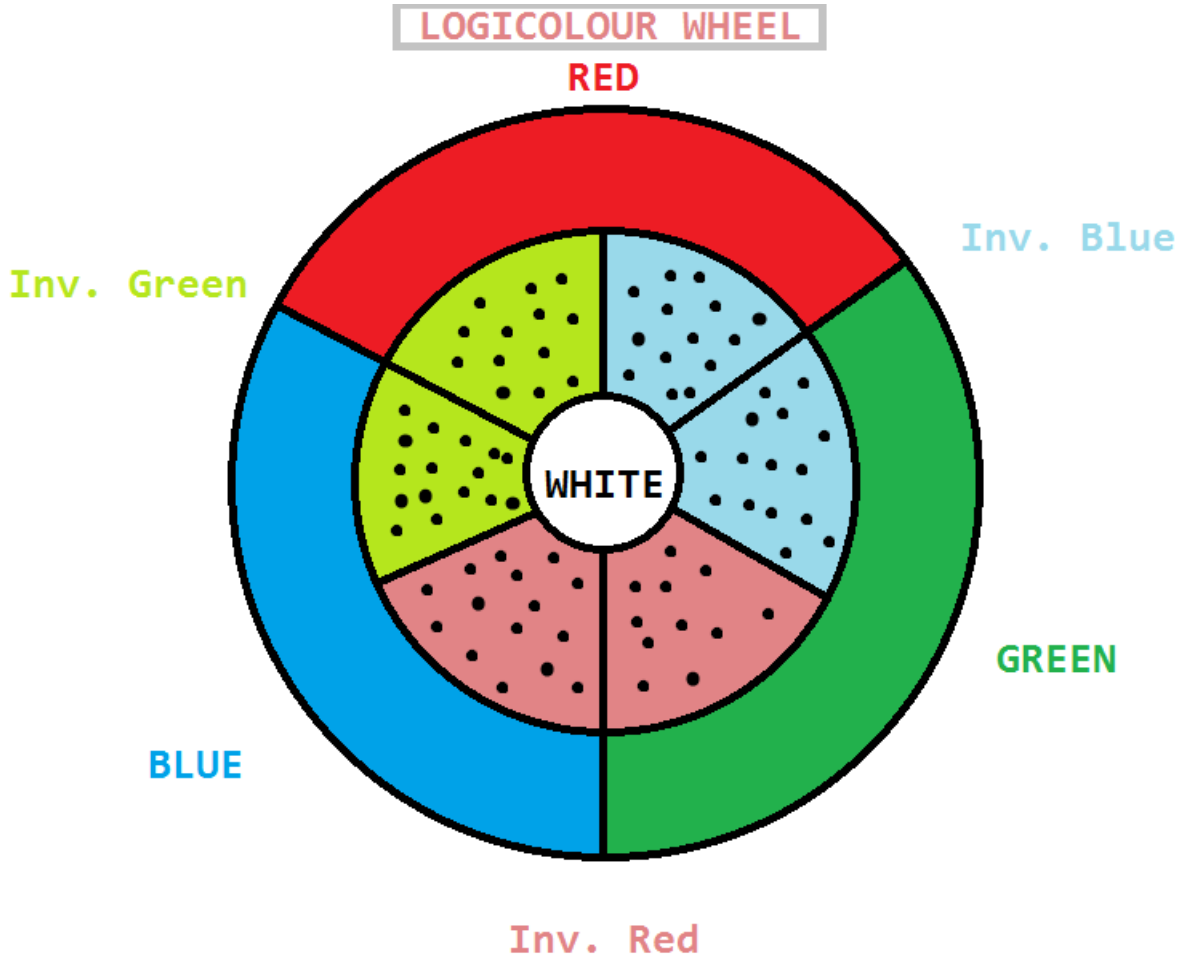


Figure 2: LogiColour Wheel - Showcasing the Relationships between Logic Levels

LogiColour "Colour Logic" Operators:

All logic systems need to have an underlying set of operations which dictate the relationships between each of the Logic Levels. The version of Colour Logic which will be implemented into the α-Release will incorporate Six(6) operators:

Operation	Associated Block	Mathematical Symbol
Addition	Mixer	+
Subtraction	Demixer	-
Clockwise Modulation	CW Gate	$\bigcup$
Counter-Clockwise Modulation	CCW Gate	$\bigcap$
Inverted Modulation	Inverter Gate	$\bigvee$
Inversion	Inverter	!

Colour Logic Truth Tables

Some of the corresponding Truth-Tables relating to Colour Logic have been stated, but for the purpose of brevity, the full set of truth tables are not included. They will be present within the final version of the report for this project.
Below are the Truth tables for the Addition and Subtraction Operations:

Addition Operator:

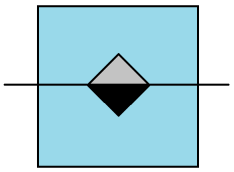
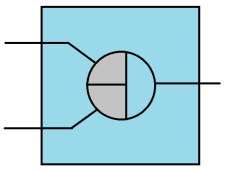
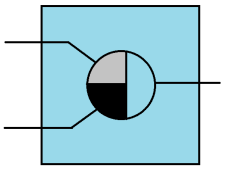
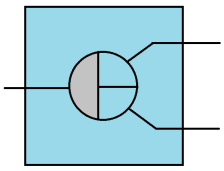
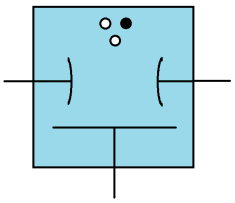
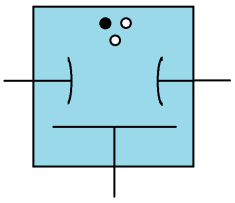
A	B	C
R	R	R
R	G	b
R	B	g
R	r	W
R	g	g
R	b	b
R	W	R
G	R	b
G	G	G
...	...	...
W	W	W
W	R	R
W	G	G
W	B	B
W	r	r
W	g	g
W	b	b

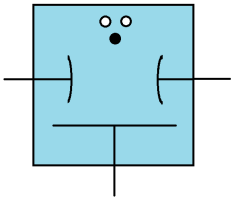
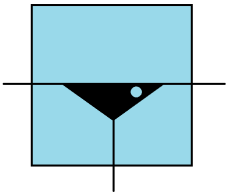
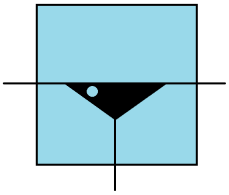
Subtraction Operator:

A	B	C
R	R	W
R	G	g
R	B	b
R	r	R
R	g	b
R	b	g
R	W	r
G	R	r
G	G	W
...	...	...
W	W	W
W	R	r
W	G	g
W	B	b
W	r	R
W	g	G
W	b	B

LogiColour Block Types:

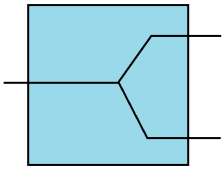
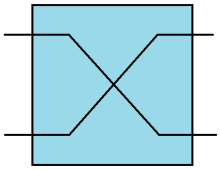
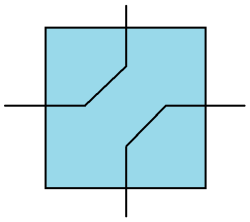
Logic Blocks:

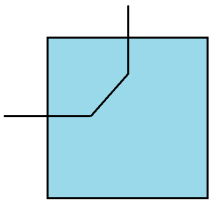
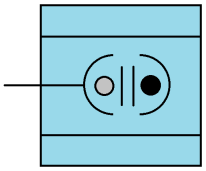
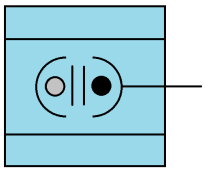
Name	Inputs	Outputs	Logical Operation	Graphical Representation
Inverter	A	B	B = !A	
Mixer	A, B	C	C = A + B	
Demixer	A, B	C	C = A - B	
Decomposer	A	B, C	$B = A \bigcap !A$ $C = A \bigcup !A$	
CW Gate	A, B	C	$C = A \bigcup B$	
CCW Gate	A, B	C	$C = A \bigcap B$	

Inverted Gate	A, B	C	C = A $\bigvee$ B	
CW Siphon	A	B, C	B = !(A $\bigcup$!A) C = !(A $\bigcap$!A)	
CCW Siphon	A	B, C	B = !(A $\bigcap$!A) C = !(A $\bigcup$!A)	

Connection Blocks:

There will also be other connection blocks used in the game. These will function as the connections between the logic blocks. The following is a list of them:

Name	Graphical Representation
Splitter	
Swapper	
Diverter	

Rotator	
Transporter (Tx)	
Transporter (Rx)	

Difficulty Levels of LogiColour:

For the α-Release, the game will incorporate between 5-10 levels with increasing complexity. The complexity be expanded via an increase in IO Nodes present within the system. The first few levels will use no more than 3 Nodes per IO wall, whilst in contrast the last few levels will use up to 5 Nodes per IO wall, and may include more than two Walls in the level.

LogiColour Scoring System:

The scoring system for LogiColour will use a delay system for tallying the points of the level. The goal will be to have the lowest cost by using the most efficient logic circuits one can think of. This was chosen to help model the real world problem of delay within circuit elements as well as accounting for the cost of building a more complex system of logic gates. Blocks will be given associated delays based on their inherent complexity and where possible, building logic blocks using smaller logic elements will tend to have a cost associated with it, and thus utilizing the complex blocks will be favoured over building equivalent logic using smaller simpler blocks.

EX:

Inverter - Cost = 2 CW Gate - Cost = 4

Replayability:

Since the scoring system is relatively flexible, and there exist multiple ways to solve a system, there will obviously be opportunities for replayability to be of some benefit. It will challenge the players to find the most optimum solution to the problem which they may not find on their first attempts.

Storyboard

Screen Layouts:

Start Screen

The following showcases the proposed main screen for the α-Release of LogiColour:

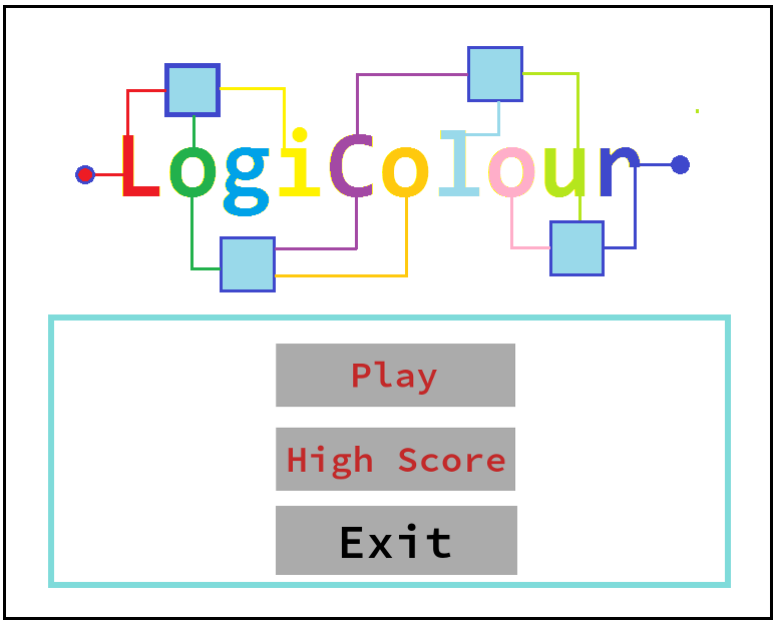


Figure 3: Proposed Main Screen View

Level Screen

The following image showcases the proposed Level Select Screen that the players will see:

Figure 4: Proposed Level Select Screen View

Puzzle Screen

The following showcases the proposed Puzzle Screen in which users will place blocks from the Block Bank:

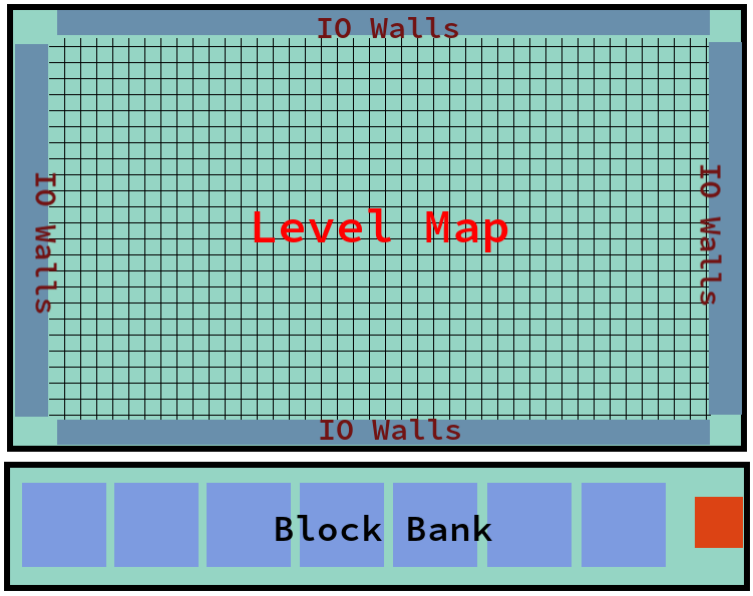


Figure 5: Proposed Puzzle Screen View

Scoring Screen

The following showcases the proposed Scoring screen upon completion of a level:

Figure 6: Proposed Scoring Screen View

Project Management

Project Deliverables:

The major deliverables for this project are as follows:

1. Initial Project Outline - (*This Report)
2. α-Release Version of LogiColour
3. Final Project Report

Project Milestones:

The milestones which will be used for this project are as follows:

1. Design Game Idea - **Complete**
2. Design Game Logic - **Complete**
3. Design Logic Block Objects - **Complete**
4. Design Difficulty Level System - **Complete**
5. Design Scoring System - **Complete**
6. Design 5-10 Playable Levels - **In Progress**
7. Develop Draft Version of Source Code - **To Be Started**
8. Debug and Refine Source Code for α-Release v0.1 - **To Be Started**
9. Test and Receive Feedback - **To Be Started**
10. Adjust α-Release v0.1 based on feedback - **To Be Started**
11. Prepare Final Report Documentation - **To Be Started**
12. Finish α-Release v1.0 and begin working on β-Release v1.1 - **To Be Started**

Time Management:

Based on the above deliverables and the milestones chosen for this project the following is a rough breakdown of the timeline for each milestone based on the sole contributions of myself:

Date	Milestone(s) Complete	Deliverables (*if any)
March 10, 2015	1 - 5	Initial Project Outline
March 17, 2015	6 & 7(Work In-Progress)	N/A
March 22, 2015	7 & 8	Draft α-Release Source Code
March 23-25, 2015	9 & 10(WIP)	N/A
March 27, 2015	10 & 11(WIP)	N/A
March 29, 2015	11 & 12(WIP)	Final Report Document
March 30, 2015	12	Final α-Release Version

Future Additions:

After achieving a successful α-Release it will be my intention to add additional functionality to the game for β-Release. The exact content has yet to be determined.