Educational Coding Blocks

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Initial Project Document and Group Identification

Divide and Conquer

Group 37

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Committee

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2.1 Project Background

This project was designed to visualize the process of programming to aid in the education of young children. Our goal is to introduce computer science concepts in an easily digestible way so that children can begin to understand and apply them in their daily lives. As technology is becoming more prevalent, our team wanted to create a way to make it more accessible to any age group. Some members in our team also have extensive experience teaching children robotics and programming, so this was a topic that we felt very passionate about. We understood that children all learn in different ways, so we wanted to create a more hands-on approach to introducing programming. The majority of other products include tablets or computer programs that can be overwhelming for the younger age groups, so we felt that we could use our coding knowledge and experience in educating children to create a product that will result in a better learning experience, while still being unique and exciting.

When designing an educational tool, especially for younger children, the main goal is to make it simple to understand and use. We needed to make sure that the coding blocks were intuitive and simple to put together. We did this by making the connections look like common toys, such as legos and by using simple terms to define our block's functionalities. The blocks will be slotted into place and also have grips to make them simple to remove and swap out. We are also aiming to limit any screens in order to keep the learning experience exclusively physical, as many kids either do not have experience with tablets or computers, or associate them with video games or videos, and can lead to distractions.

Another important goal was to make sure our coding blocks were durable enough to withstand daily use in a classroom. Electronics can be sensitive and combining that with a classroom of excitable children can lead to some technical failures if not carefully designed. The blocks will be constructed of a lightweight material to prevent any injuries if dropped, as well as a durable material to make sure that even when handled carelessly, they will still function properly. The part that we anticipate being the most easily damaged is the connection between the blocks, so we plan to reinforce that segment more with thicker material.

The next goal is to make the coding blocks applicable to a wide range of computer science concepts and interact with a range of devices. The aim is to allow teachers or families to create endless lessons or games with the coding blocks, leaving their creativity to be the limitation instead of our blocks. We also want to make our product scaleable to introduce more block types in the future. One such example would be coding a simple robot car with the blocks, which includes loops, conditionals, and driving directions for it to follow. This will further increase the educational value of the coding blocks and allow them to be used in curriculums for months without repeating an activity or concept.

Looking at products already available in the market, the most recent and similar attempt at physical code blocks is Project Bloks, developed by Google. The goal is to achieve a similar effect as Project Bloks, but to add our own functions and capabilities to it. Where Project Bloks' goal is to create an open ended platform for developers to create tangible coding experiences for kids, this project seeks to simplify the goal and create a single experience as the project rather than a platform for creating many different experiences. This is affected by how fast progress is made and what feels feasible.

Another product with heavy influence on this project is the high-level block-based visual programming language Scratch. Although this is a purely software based program, the goal is to translate the idea of block coding into a physical activity using real life blocks. Using what makes Scratch such an easy to use language, this project should also be just as easy to pick up and fun to experiment with. Additionally, the use of bright colors, satisfying shapes, and the act of putting puzzle-like components together will be transferred onto this project as a reference to Scratch and its features. Knowing all of this, it is important to point out that the scale of projects possible on Scratch would be considerably higher as the software has no need to consider the cost blocks and space constraints. The goal is not to replicate Scratch into a tangible toy, but to apply the knowledge gained from what makes Scratch amazing for younger kids to our solution and objectives.

Our general design for this project has changed considerably over time, first requiring the use of wireless technology to connect the code blocks to a robotic car, to its current design, which is a robotic car that will have the block slot directly onto it. This eliminates the need of any non-physical connection, and allows us to simplify our project, as well as reduce costs. On this car there will be 15 slots for the user to code with. Some types of blocks will include a "move forward", "turn right, "turn left", and "move backward" for our initial testing. The car will be able to move in any direction because of our inclusion of omnidirectional wheels on all four corners of the robot's frame. Using these types of wheels makes the process of turning much simpler to program and implement. The car takes inspiration from a turtle as the "head" is where we will locate the PCB, while the "shell" is where the coding blocks will be. The team felt that relating the design to an animal would lead to better engagement with children and also happened to align with our design specifications.

2.2 List of Requirements and Specifications

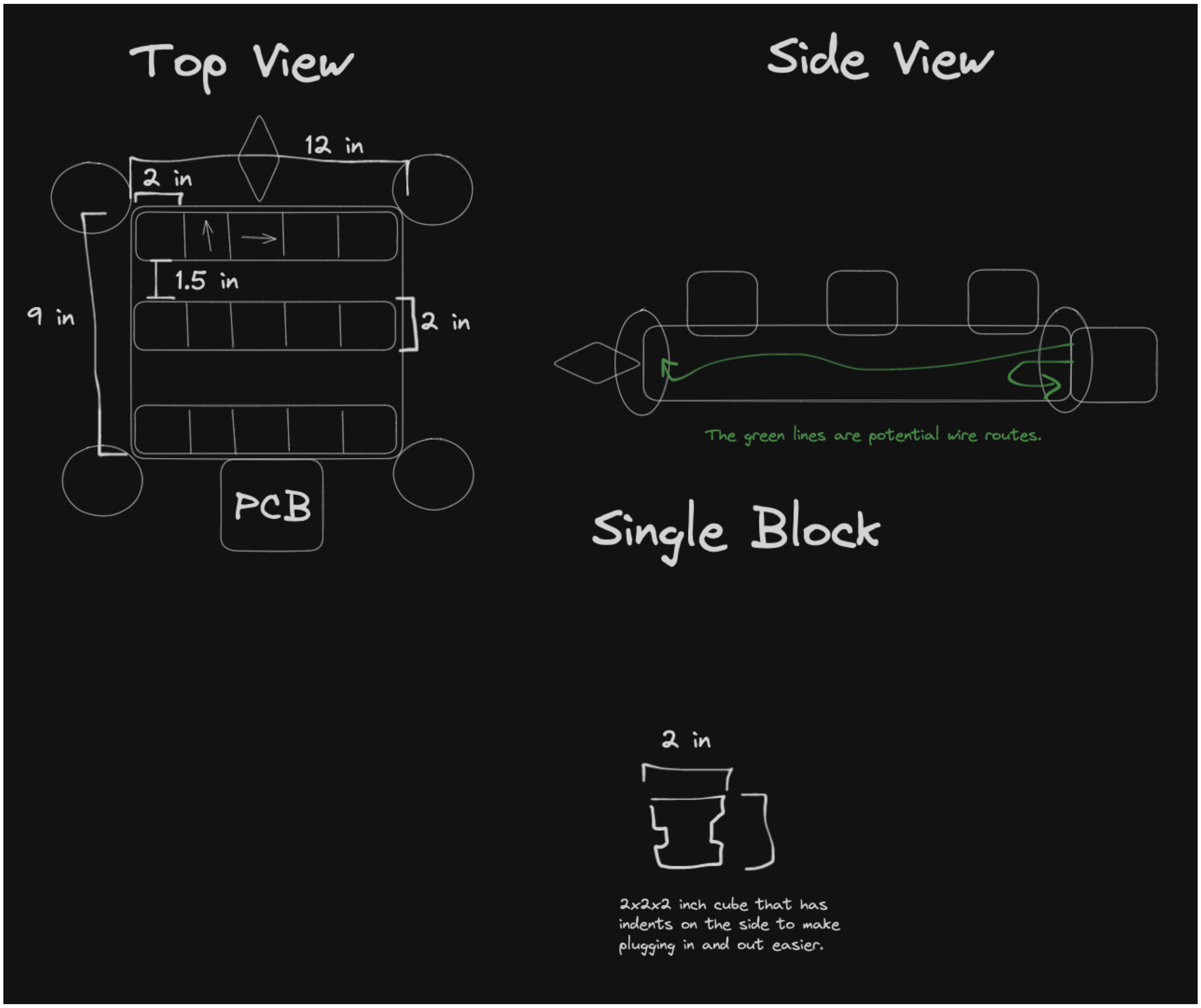
As a requirement, the project must employ the use of a PCB. The PCB will be found on a block designated as a “starting” block, which will also house the power supply and whichever component chosen for connectivity to external devices. Each coding block should be identifiable by the color or text on it, as well as identifiable by the starting block in some way. Below are the quantitative requirements and specifications for this project.

Hardware Specifications

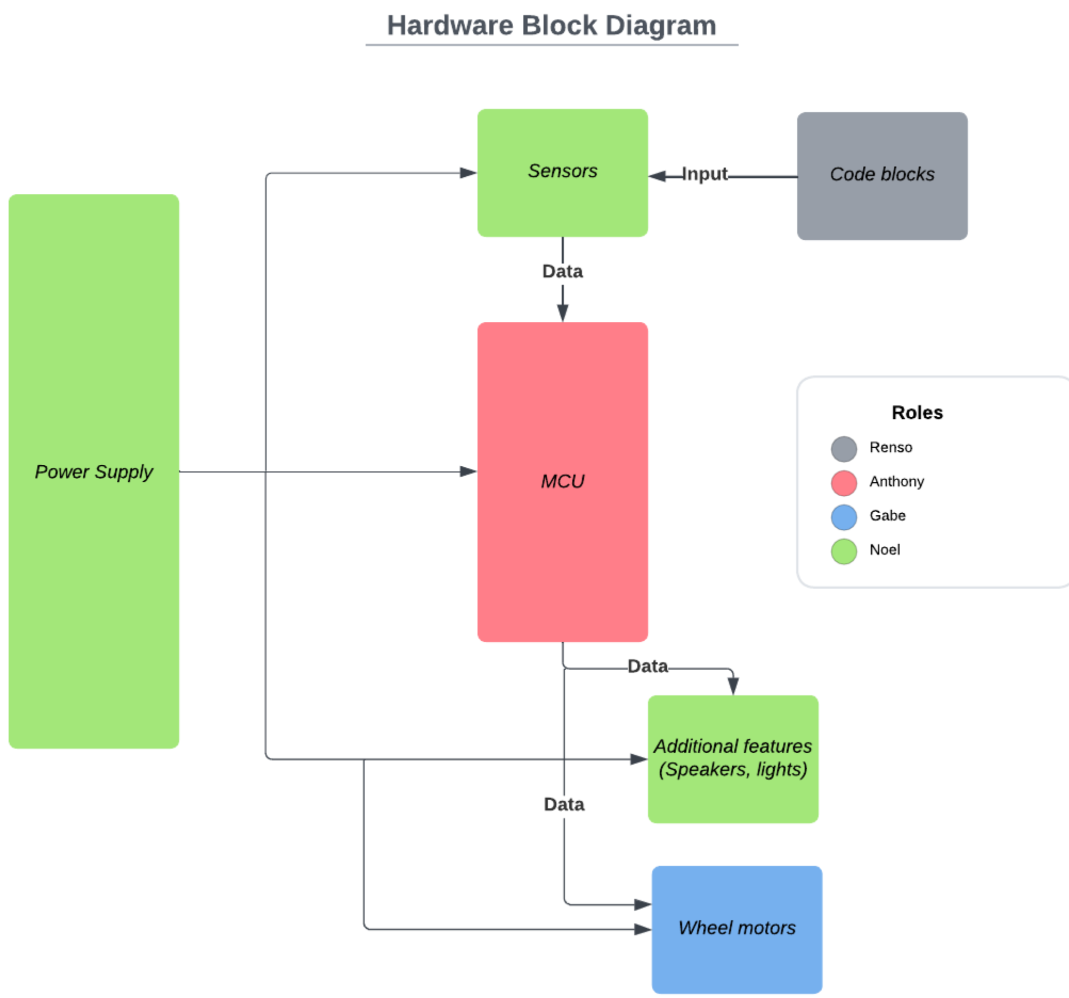
Characteristic	**Specifications**
Motors	4 motors, 11W
Power Supply	6v
Block dimensions	2in x 2in x 2in
Car Weight (Fully Loaded)	15lbs
Car Dimensions	12in x 9in x 3in
Wheel Specifications	200mm, Omnidirectional
Response Time	< 5 seconds
Precision	90 degree turns
Collision Detection	1 foot

Software Requirements

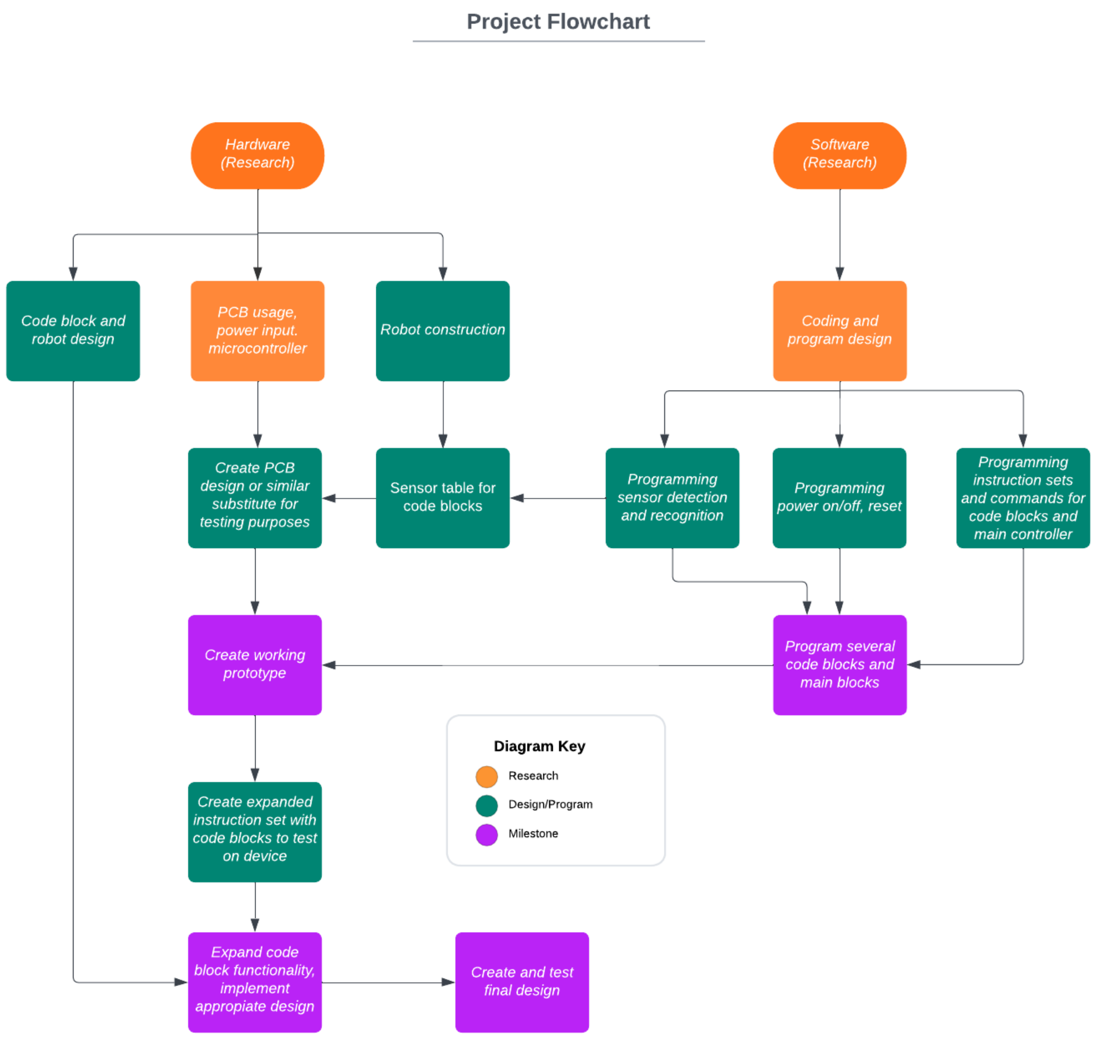
1.0	Robot will communicate with sensor table
1.1	Robot will have a functional power button and reset button
1.2	Robot will perform given actions from code blocks
1.3	Robot will accept any combination of code block commands


Top View
12 in
2 in
1.5 in
9 in
2 in
PCB
Side View
The green lines are potential wire routes.
Single Block
2 in
2x2x2 inch cube that has indents on the side to make plugging in and out easier.

3 Hardware Block Diagram



3.1 Project Flowchart



3.2 Block Status and Member Assignment

Bold indicates primary member assignment.

Group Member	***Project Block***	***Block status***
	Hardware	
Gabe, Noel	Code block and robot design	Research
Gabe, **Noel**	PCB usage,power input	Research
Gabe, Noel	Robot construction	Research
Gabe, **Noel**	Sensors	Research
	Software	
Anthony, **Renso**	Programming sensor detection and recognition	Research
Anthony, Renso	Programming functionality and robot commands	Research
Anthony, Renso	Programming instruction sets and commands for code blocks and main controller	Research

4 Project Budget and Financing

Our budget will be self-funded.

ITEM	QUANTITY	PRICE ESTIMATE
Microcontroller (Main code block)	1	<$30
Main PCB	1	$5-10
Servo motors	4	$10-15
Omni Wheels	4	$15-25
Power supply	1	$10
Sensor board RFID	1	~$15
Code blocks	15	$1-10
Robot frame	1	$10-50

5 Project Milestones

Number	*Milestone*	*Planned Completion Week (SD1&2)*
1	Idea Discussion	1
2	Project Selection, Role Assignment	2
3	Divide and Conquer Report	3
4	**Research and Documentation**	7
5	PCB research and selection for code blocks, microcontroller research for the main block	8
6	Coding language research, programmability of blocks research, programmable device research	9
7	Prototype built	13
8	Final Document	15
9	2nd Prototype Built	24
10	Software and Hardware review	25
11	PCB final design and manufacturing	26
12	Final Project Assembly	29
13	Final Presentation	32

6 Decision Matrix

The purpose of this decision matrix located below was to help narrow down the various ideas our group had for the topic of our project. We selected our favorite ideas and created a decision matrix to help eliminate and narrow down the best project that fits the criteria we were looking for. The scale on which we graded our ideas is shown below.

Scale:

1	Poor
2	Below Average
3	Average
4	Above Average
5	Excellent

	Affordability	Familiarity	Educational goals	Motivation	Complexity	Total
Project 1	4	5	5	5	4	22
Project 2	5	4	3	3	2	17
Project 3	1	3	3	2	5	14
Project 4	4	4	4	1	3	16
Project 5	3	1	4	3	3	14
Project 6	3	2	1	4	1	12

Project 1 is the project we decided on, scoring the highest out of the projects listed in the matrix. The coding block idea fits well with the qualities our group was looking for. It scored the max on familiarity, educational goals, and motivation as three of our members are computer engineering majors and some of our members have a lot of experience working with young kids interested in a STEM career and would like to pursue something that could help stimulate interest. The project is also relatively affordable compared to the other ideas we considered.

Project 2 was a fencing box to help make the subjective side of refereeing fencing more objective. This box is wired to the tip of the sword and transfers data on who hit the other person first and where the person was hit. The box would be paired with a phone application which would display the data for the user to see. This idea scored well with affordability being the most inexpensive idea we considered. Motivation and Familiarity scored high because some of our members are familiar with the sport and were interested in attempting a project in that field. This project fell short on complexity as we felt this idea wasn't robust enough to be the subject of our two-semester-long project.

Project 3 is a robotic platform that would follow a user around a warehouse and assist in lifting and carrying heavy objects. This project scored high in complexity because of the multiple moving parts it would require but scored low on affordability and motivation as it would be the most expensive project and require a lot of mechanical engineering, which our group did not want to commit to. Ultimately led to the decision not to go with this project.

Project 4 had an idea to create a text-to-speech headpiece that would aid in identifying and reading texts for someone with impaired or no vision. The device is placed on their head and as they walk around it scans text in their vicinity and reads it out loud to the user. This project idea scored high on affordability and educational goals but fell short on motivation, complexity, and familiarity.

Project 5 was a Muscle activation sensor to assist in maintaining and achieving perfect form and muscle activation when working out to maximize the users' workout experience. The sensors would detect when the user isn't activating the proper muscles and send back the data on what areas to fix. This project scored high on motivation as some of our members frequent the gym and are interested in exploring the idea. The project fell short of familiarity as most of our members have little experience with the sensors necessary to read and record muscle activity and have no experience in interpreting the information to create suggestions with it.

Project 6 was similar to the muscle activation project but instead of analyzing form and muscle activation, it would analyze the users' posture. The sensors would use an algorithm to help detect when the user has poor posture and send out an alert to correct it. The project scored low on complexity as we felt it was a one-dimensional idea which ultimately led to it not being selected as our project.