Deliverable 2

by Fuad Oduola

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1. Executive Summary

Our proposal, which came under deliverable 1, is for a smart, fully autonomous scooter charger that would start charging the scooter without minimal user interaction. The specifics of how it will operate and the reason behind its implementation will be provided in this report.

The introduction to this report will describe how and why we came up with the idea, and a comprehensive flowchart with exact instructions will explain each and every function. All of the state equations and justifications for each input and output are included in the state diagram. The block diagram will also display all the various parts and sensors that our project will need. The section on alignment will describe how our project designs will match inside the constraints and criteria. All of the inputs and anticipated outputs from the circuits will be described by accurate testing of the circuits utilizing mutism. The grant chart, a thorough component of the plan that includes a work breakdown structure and a Gantt chart, will assist us break down each deliverable and the due dates for finishing each assignment. The project scope may be broken down and all the tasks needed to finish it can be seen using the work breakdown structure. Also, a short description of risk management will be included in this section, outlining the constraints and how we plan to handle them.

Moreover, there is also a budget plan with each financial choice made apparent in order to finish the project within the allocated budget. Also, our marketing strategy will detail how we want to concentrate on the specific markets that we believe will benefit us the most. The references and all the appendix are listed at the end of the report.

Table of Contents

Table of Figures

Section 3

Section 5

Introduction

Electric scooter use is growing worldwide, which presents a dilemma for businesses, governments, and consumers. Many scooters are dispersed around the world, which costs businesses a lot of money since they must go pick up and recharge each one individually. When the scooters are maintained randomly, the authorities will work to keep them in a certain area and not limit traffic on the roads and sidewalks. Due to the fact that most users don't store their scooters in one location and instead scatter them around a significant geographic region, if a user needs to use a scooter and it indicates that the battery is low, they are unable to do so.

We have developed a smart, fully autonomous scooter charger which is an IOT based using Arduino to address these problems. To begin charging the scooter, all a user needs to do is bring it to a specific charging station and place it above a specific panel that will be located nearby. The panel will then automatically detect the scooter and begin charging. The e-scooter businesses will profit from this since they will save money traveling to each scooter and picking them up, while users will gain perks like free trips, more minutes, and more. Also, no more hassle for the government in order to maintain the issues stated above.

Nevertheless, one of the main benefits of our product is that it will encourage more people to use electric scooters, which will really reduce CO_2 emissions. If we strategically place the charging stations close to public transportation, educational institutions, IT parks, and workplaces, e-scooters will be highly used and in great demand.

Our team has decided that the e-scooter industry will be our major focus since we are aware of the growing need for alternate, sustainable forms of short-distance transportation or who knows for long distance as well.

2. Design

Flow Chart:

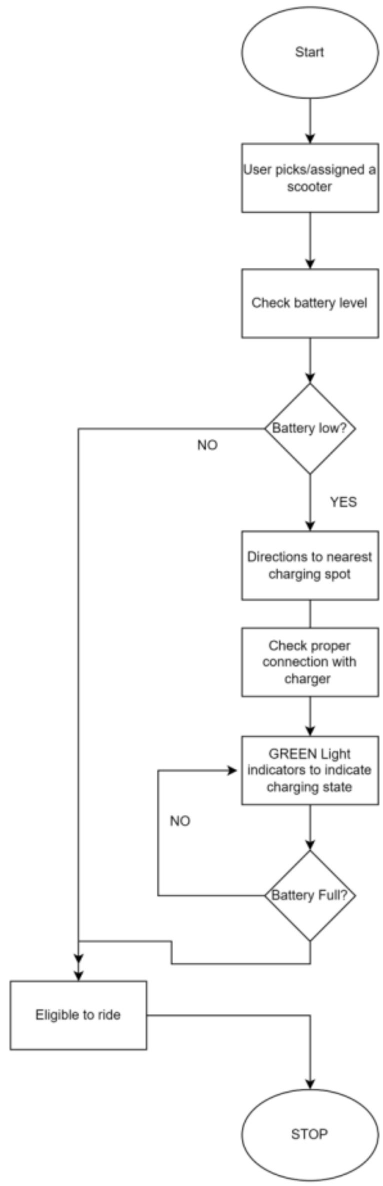

Figure 3-1: Flow Chart

State Diagram:

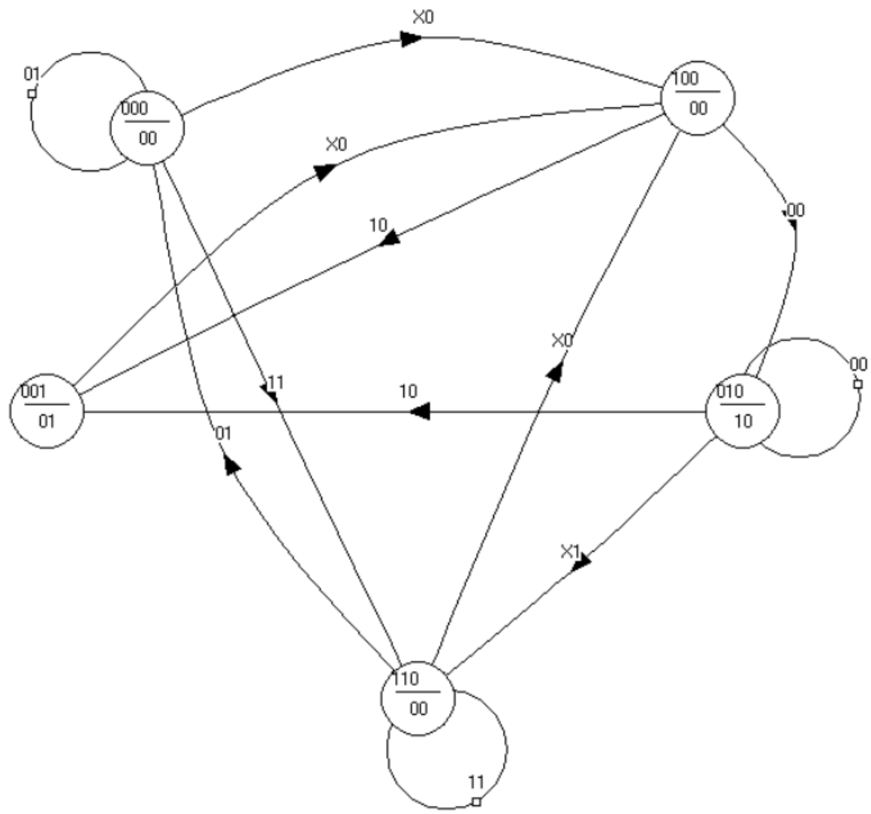

Figure 3-2: State Diagram

The possible state for our project are represented by the following 3 input binary code (Q0Q1Q2):
000 - IDLE
100 - ASSIGN CHARGING STATION
010 - CHARGING
110 - RIDING ALLOWED/RIDING
001 - ALARM/LOW BATTERY/RIDING NOT ALLOWED

The state machine has 2 inputs:
E1 - User wants to ride
I0 - Battery

Inputs are read as:

E1 I0

The machine's output is represented as:
O0 - LCD

S1 - Alarm

State diagram output is interpreted in this order:
S1 O0
Explanations for each state:

State 000 - IDLE: In this state, the scooter is unused, but operating down to its most basic task such as blinking an LED to indicate it is operational or putting the processor in low power mode. This helps conserve the battery life. From the state diagram, we can deduce that the scooter remains idle if the inputs E1 I0 = 01, meaning that there are no available riders and battery life is sufficient (E1 I0 = X0). Regardless of the availability of riders and, if the battery is low, the scooter is assigned and a charging post nearby through the e-scooter's mobile app.

State 100 - Assign a charging station: On the mobile app, the user is shown battery levels of the scooters and if one with a low battery charge is selected, directions to a nearby charging station to recharge is given. When at the charging station, the scooter has to be properly parked to indicate its not in use and placed on the wireless charging pad to induce an electric current for charging. This state is represented with E1 I0 = 00.

State 010 - Charging: In this state, the scooter is charging and remains in that state as long as the user doesn't pick up the scooter and the battery levels are still low (E1 I0 = 00). In this state, an LED blink indicator is activated to signal charging and stops when the device is sufficiently charged and moves into ride mode, user input doesn't matter (E1 I0 = X1).

State 110 - Riding Allowed/ Ride Mode: In this state, the scooter is available for use and waiting for potential riders or being ridden at the moment. While the user is riding and the battery is sufficient (E1 I0 = 11), the scooter will loop around this state. Once the battery goes down a certain level, regardless of whether the rider is utilizing the scooter (E1 I0 = X0), the state transitions to state 100(Assign a charging post).

State 001 - Alarm/Low Battery/Riding Not Allowed: In this state, the battery is low and non-operational. If a user attempts to ride the scooter, an alarm is sounded to alert the user. Once the battery is below a certain threshold, the device locates its nearest charging spot for a recharge.

System (created in Multisim)

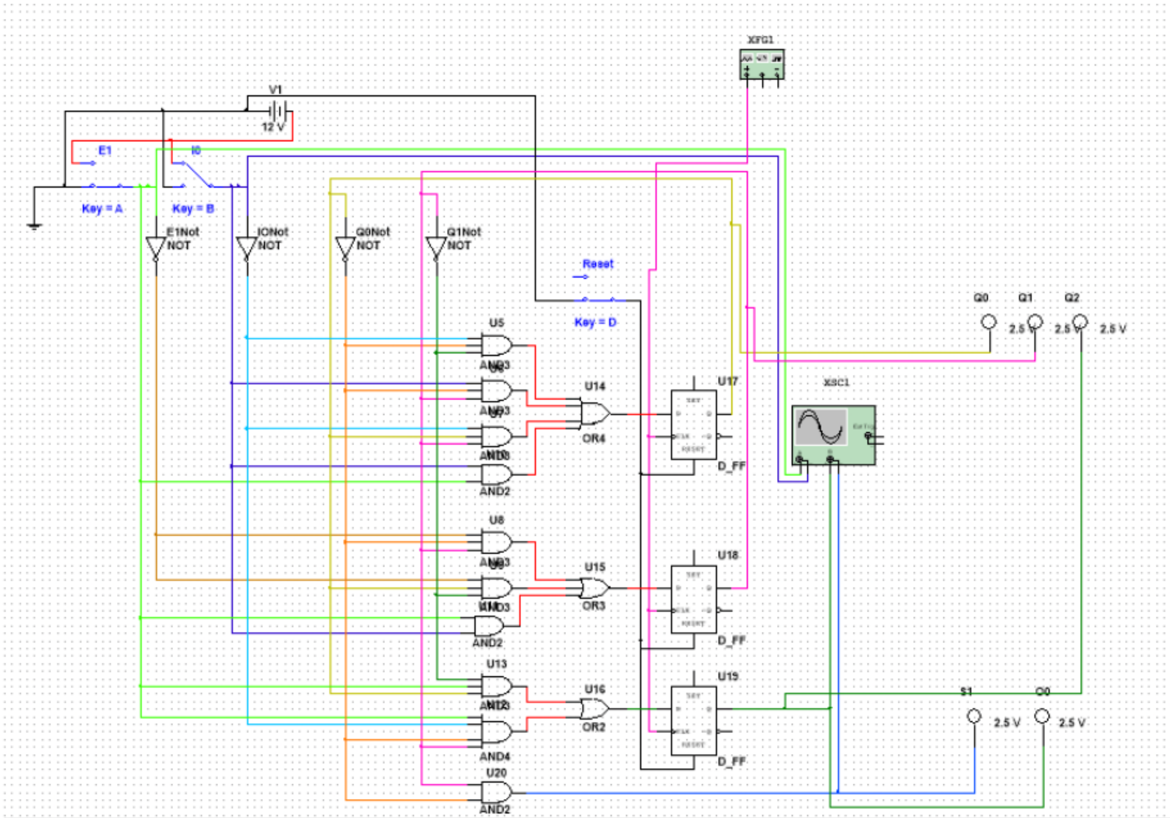

Figure 3-3: System (created in Multisim)

D-Flip Flop Equivalent Circuit:
Output O0:

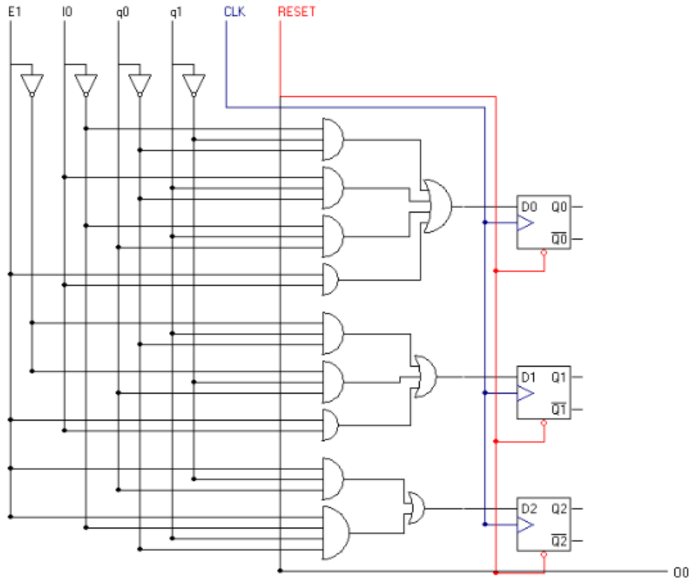

Figure 3-4: State Machine output for O0

Output S1:

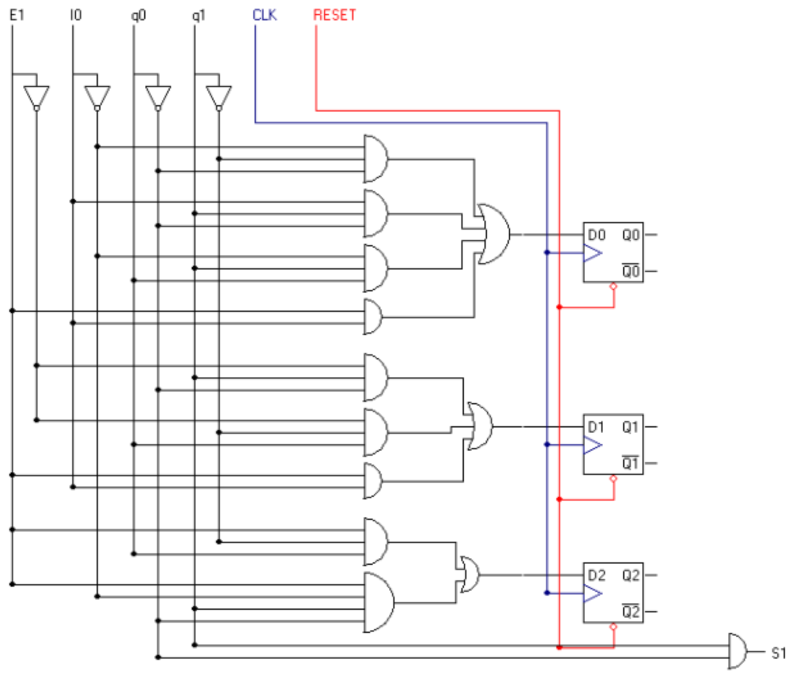

Figure 3-5: State Machine output for S1

Block Diagram:

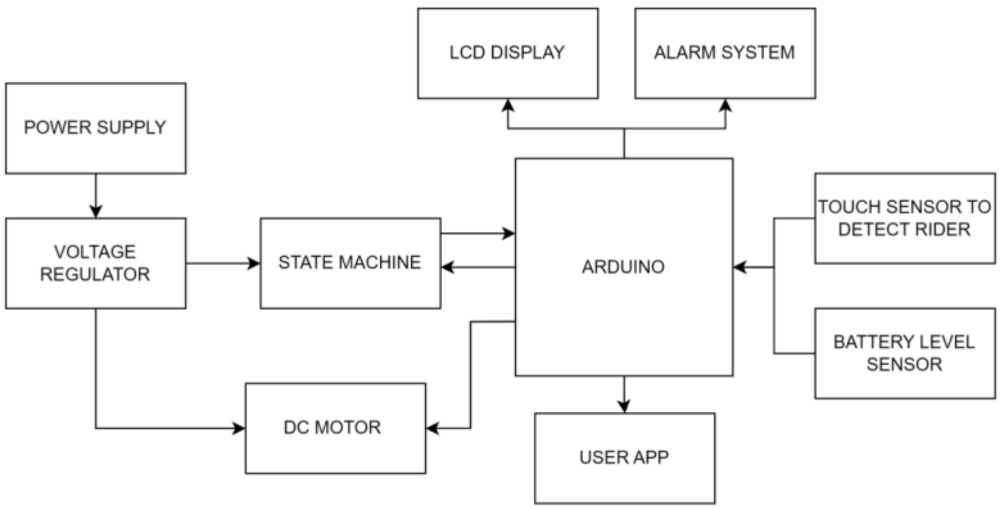

Figure 3-6: Block Diagram

Timing Diagram:

Frequency - 5Hz

t (s)	State	Input	Output
0.0	0	0	0
0.2	1	0	0
0.4	2	1	1
0.6	3	0	2
0.8	1	1	0
1.0	3	1	2
1.2	1	0	0
1.4	2	3	1
1.6	4	2	0
1.8	0	0	0

State	
0	000
1	100
2	010
3	001
4	110

Input	
0	00
1	10
2	01
3	11

Output	
0	00
1	10
2	01
3	11

Figure 3.7: State, Input and Output with respect to time

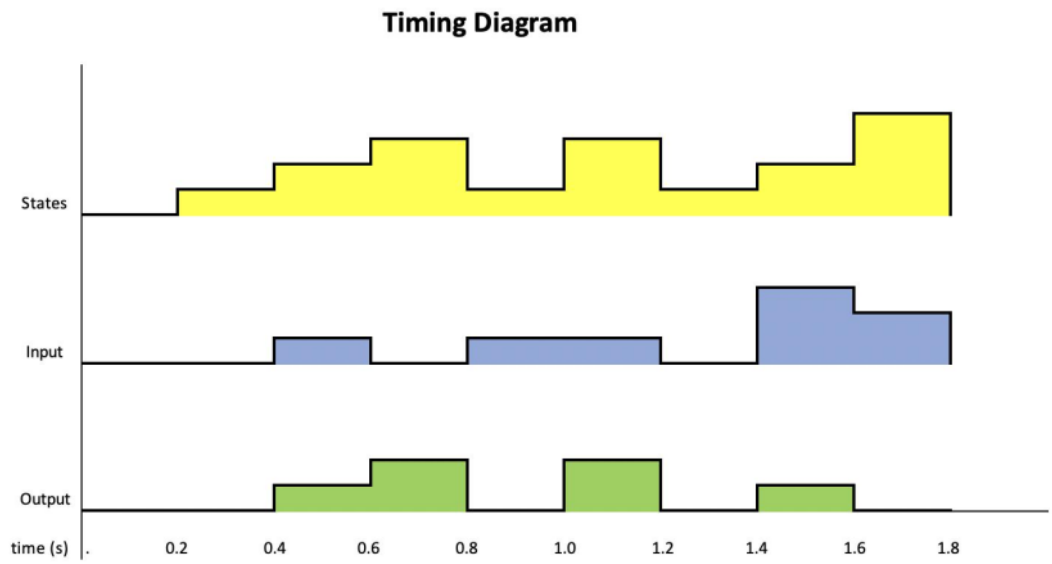

Figure 3.8: Timing Diagram

3. Alignment

Our project meets all the requirements needed with the state machine, a DC motor, 2 sensors which are a touch sensor to detect a rider and a battery level sensor that informs the rider to take it to a charging station. Moreover, the LCD display lets the rider examine the scooter's information. As mentioned before, our project meets all the requirements and will be mainly focusing on Requirement 1 where the state machine is the core of the system.

Our main constraint is that widespread adoption will take a long time since careful planning and study are required to determine where and how many charging stations should be installed in a certain area. We have a general notion of where to put them, but it will take some time to determine placements.

In our prototype, we'll be using two sensors: a touch sensor that tells the company whether the scooter is in use or idle, and a battery level sensor that alerts the user via the LCD display when the battery level is low and directs them to a charging station or, if the battery is completely dead, turns the scooter off automatically.

Hence, when a user transports a scooter to a charging station and sets it on the charging panel, an automated panel that identifies the scooter using motors will magnetically connect to the scooter from the underbody, and a green light will signal that charging is underway.

4. Testing

I assumed the device was in state 000 when I initially started testing.

States: Q0Q1Q2

Inputs: E1I0

Outputs: S1O0

1.

a. Previous State: 000; Input:00; Current State: 100; Next State: 010; Output:00

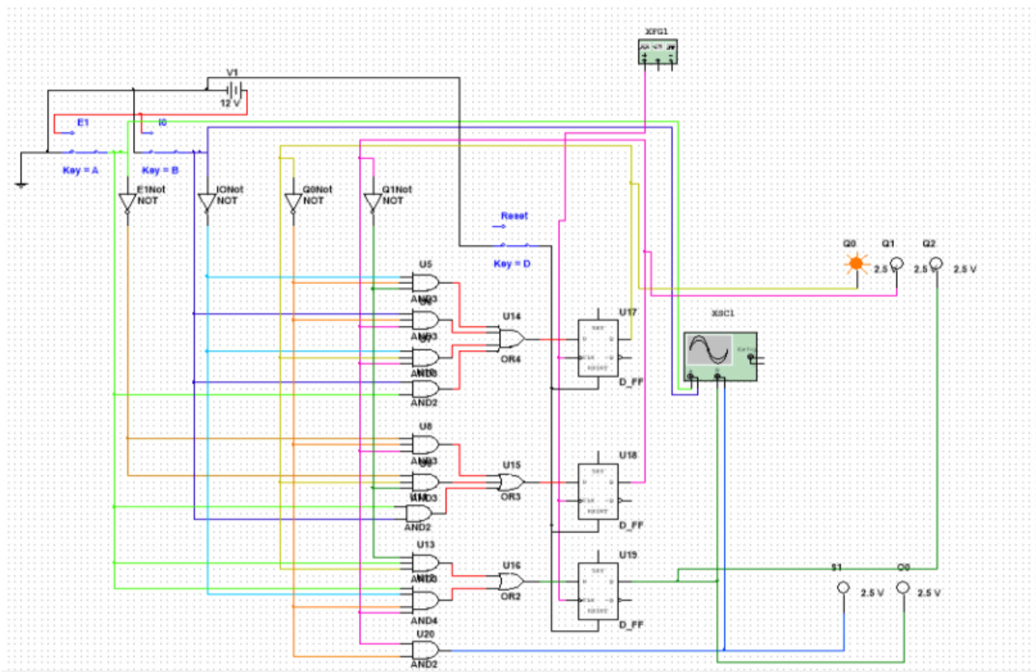

Figure 5-1: State 100

b. Previous State: 100; Input:00; Current State: 010; Next State: 010; Output:10

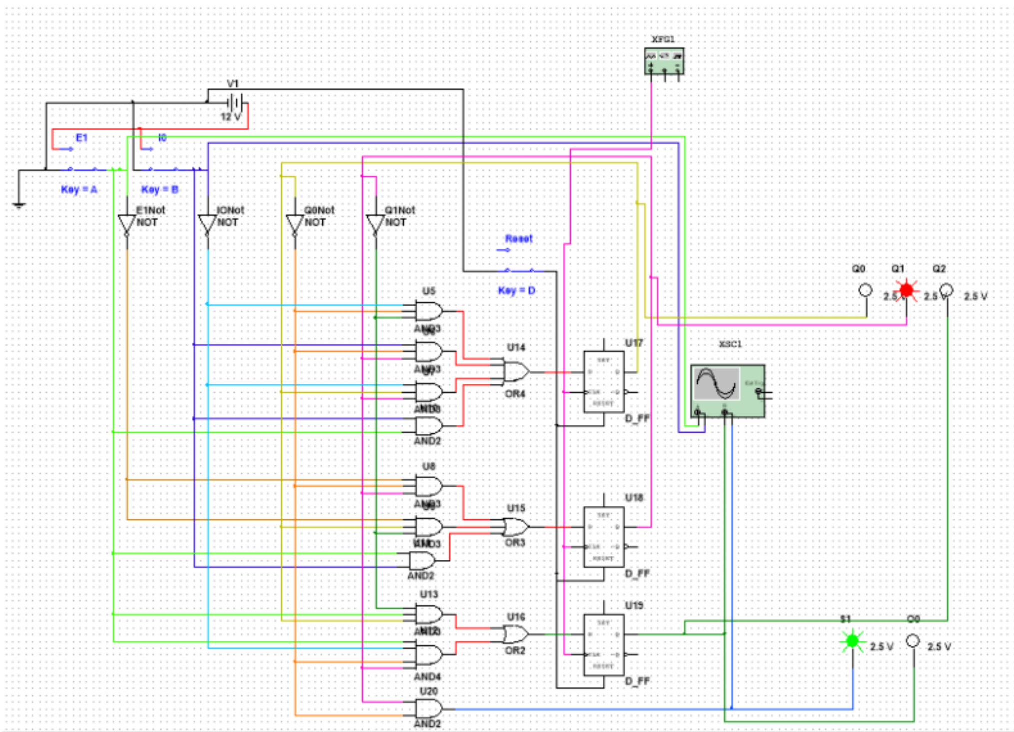

Figure 5-2: State 010

If I keep it running, there will be no change since, as seen in the state diagram, when 00 is input at 010, it does not transition to a different state but instead stays at the same.

c. Previous State: 010; Input:10; Current State: 001; Output:01

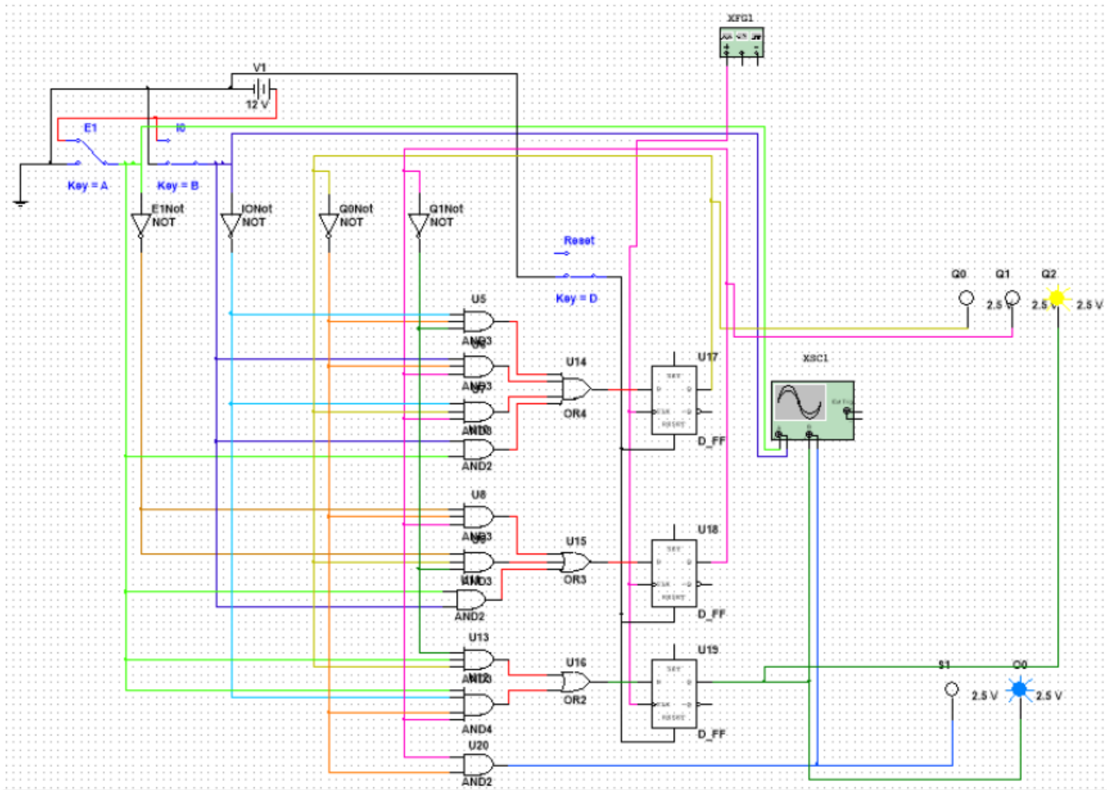

Figure 5-3: State 001

2.

a. Previous State: 000; Input:11; Current State: 110; Next State: 100; Output:00

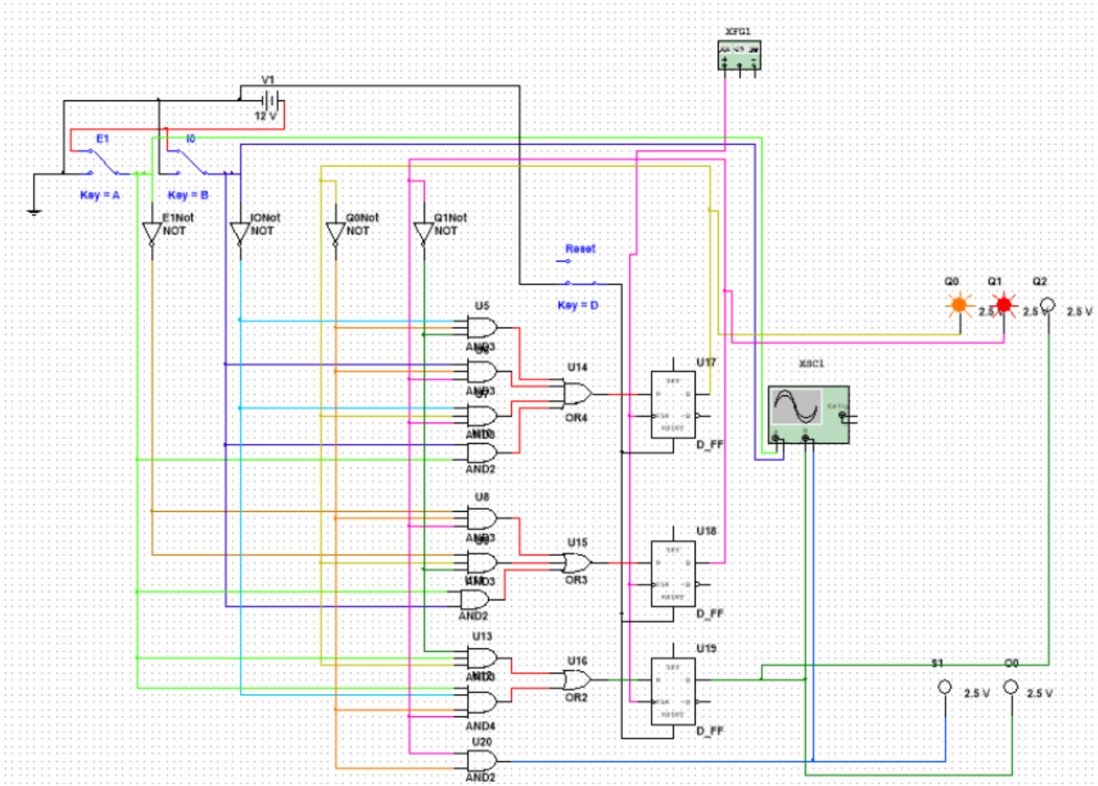

Figure 5-4: State 110

b. Previous State: 110; Input:00; Current State: 100; Next State: 010; Output:00

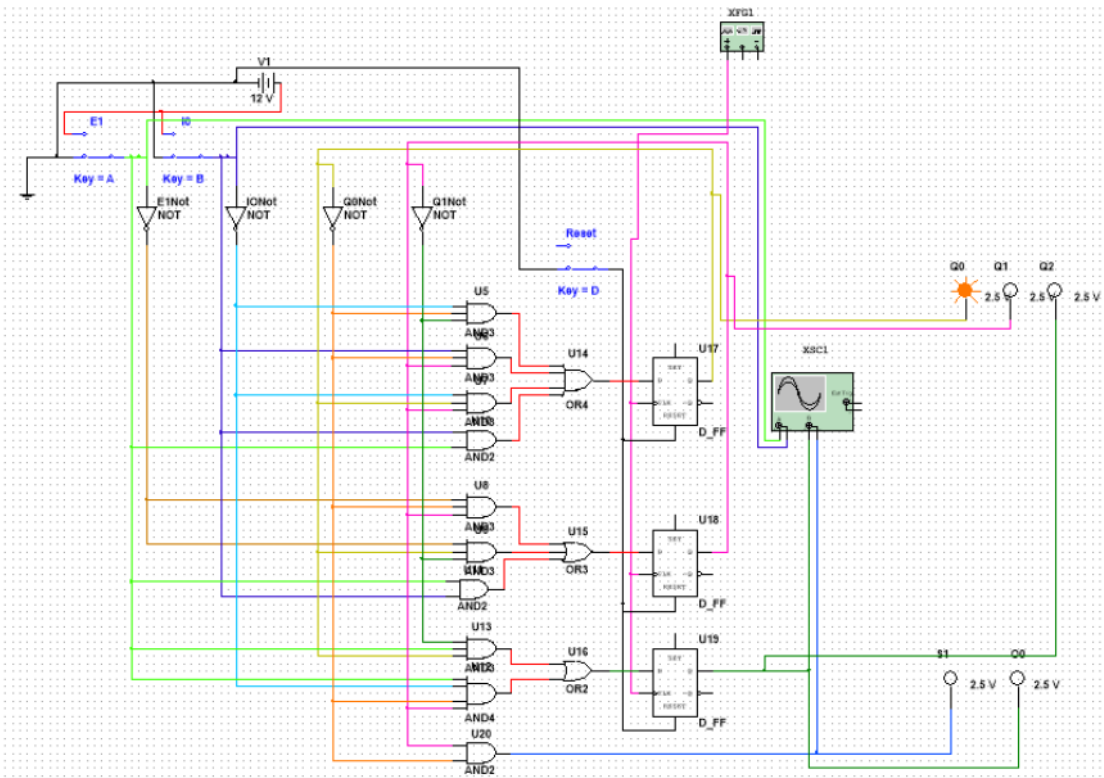

Figure 5-5: State 100

c. Previous State: 100; Input: 00; Current State: 010; Output:10

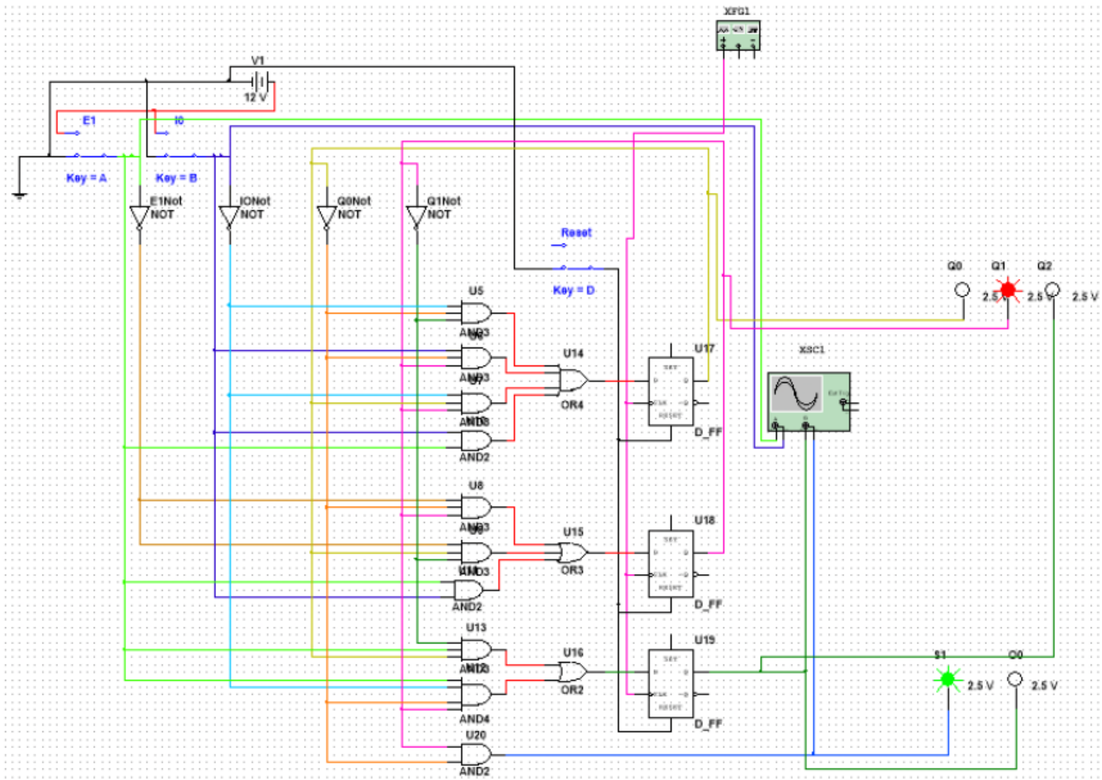

Figure 5-6: State 010

3.

a. Previous State: 000; Input:10; Current State: 100; Next State: 001; Output:00

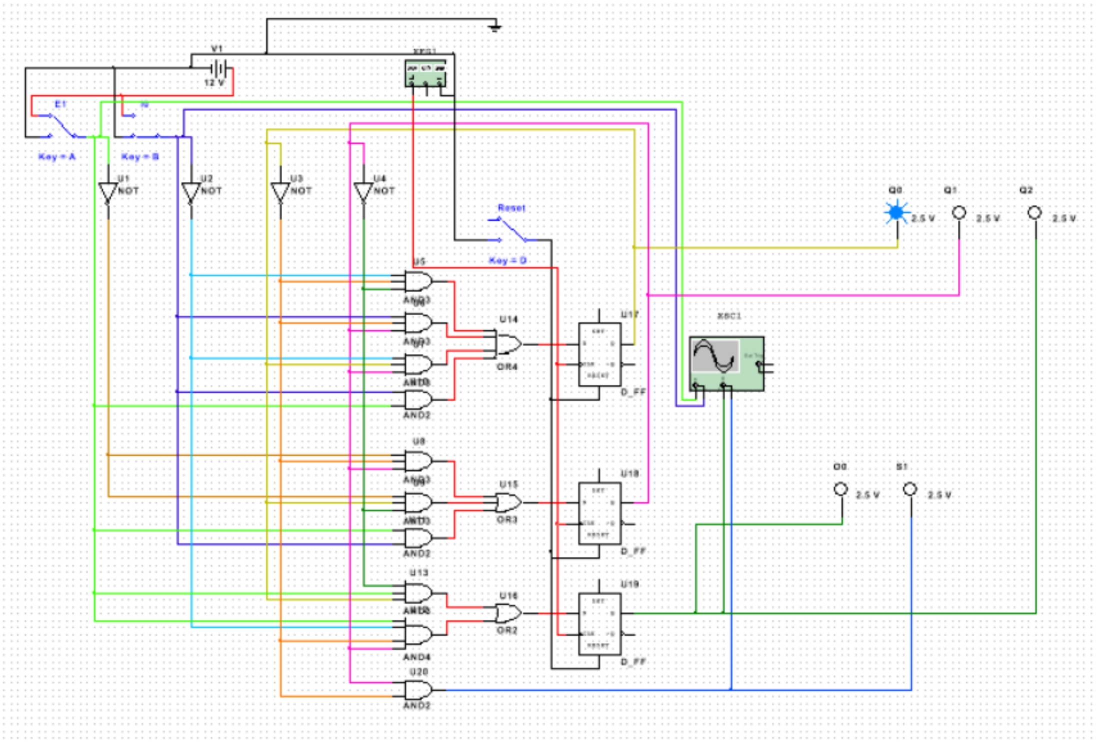

Figure 5-7: State 100

b. Previous State: 100; Input:10; Current State: 001; Next State: 100; Output:01

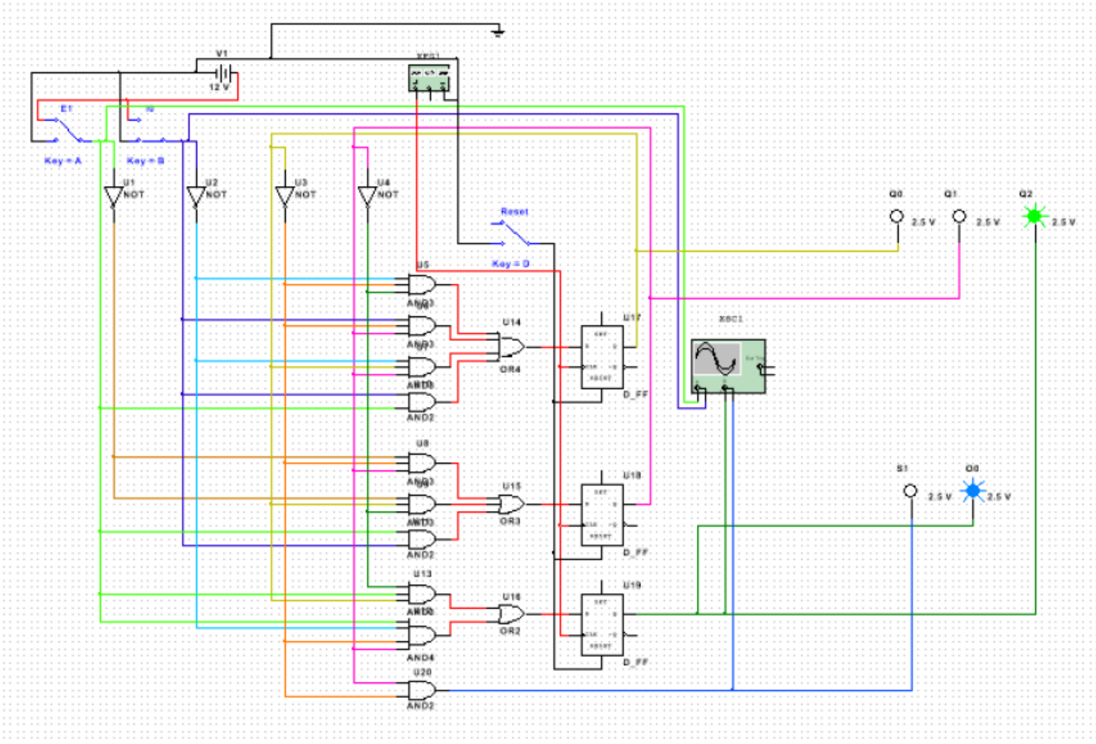

Figure 5-8: State 001

c. Previous State: 001; Input:10; Current State: 100; Next State:010; Output:00

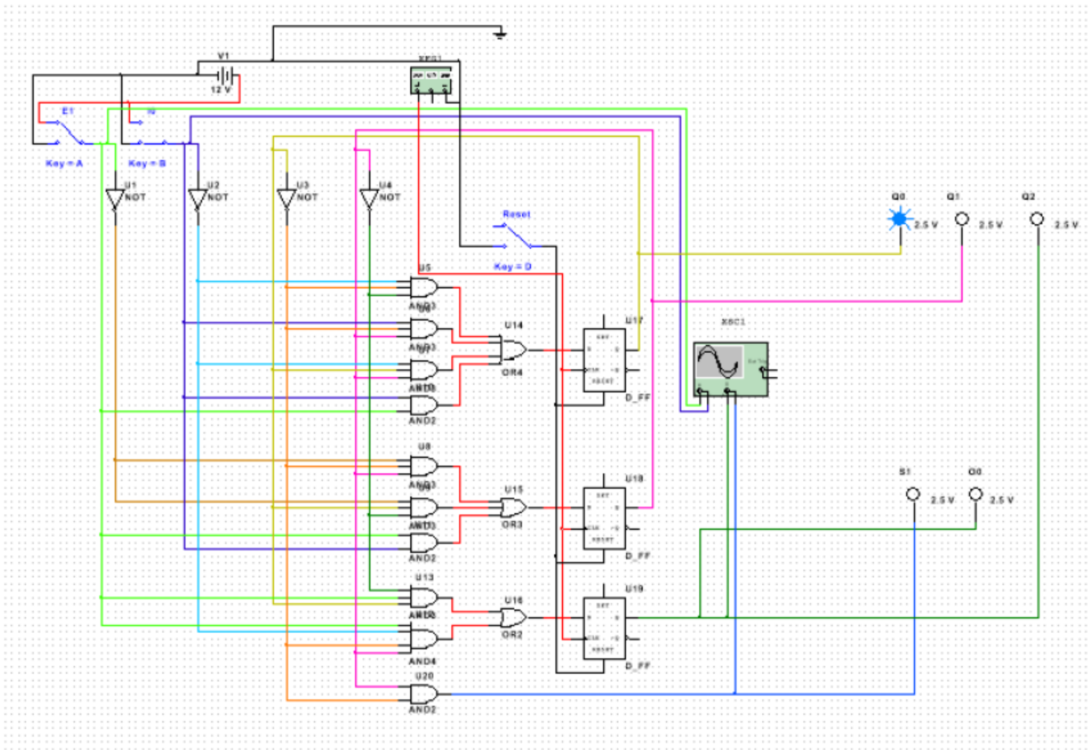

Figure 5-9: State 100

d. Previous State: 100; Input:00; Current State: 010; Next State:110; Output:10

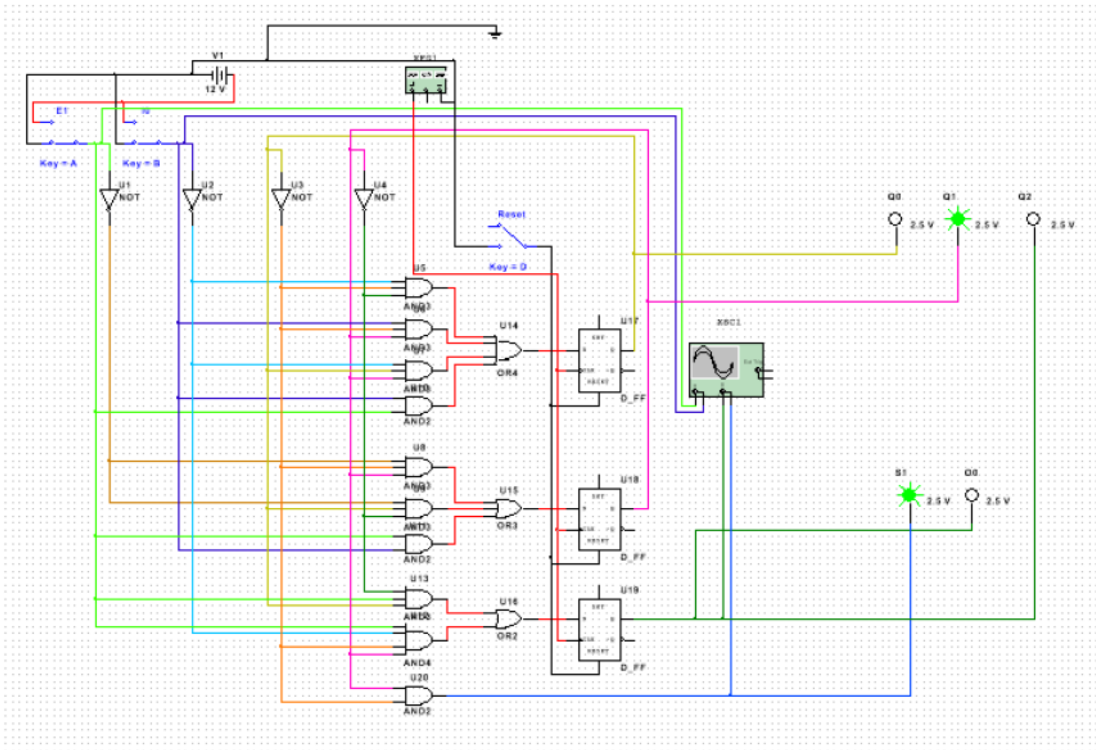

Figure 5-10: State 010

e. Previous State: 010; Input:11; Current State: 110; Next State: 000; Output:00

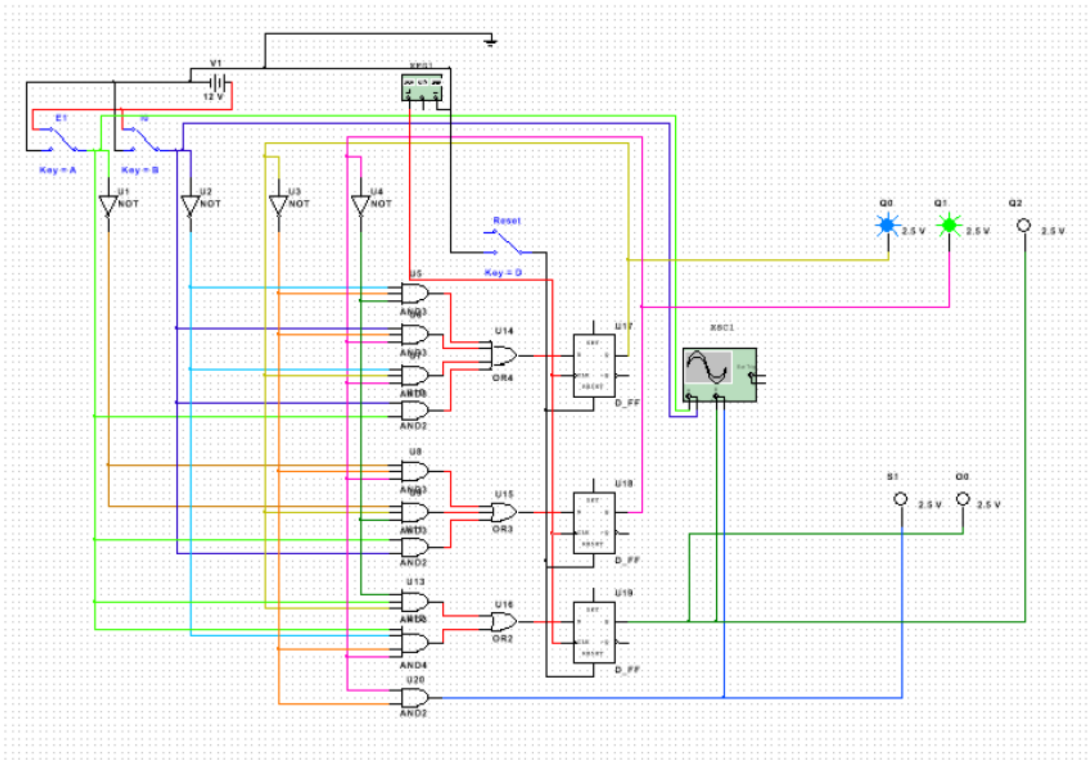

Figure 5-11: State 110

f. Previous State: 110; Input:01; Current State: 000; Output:00

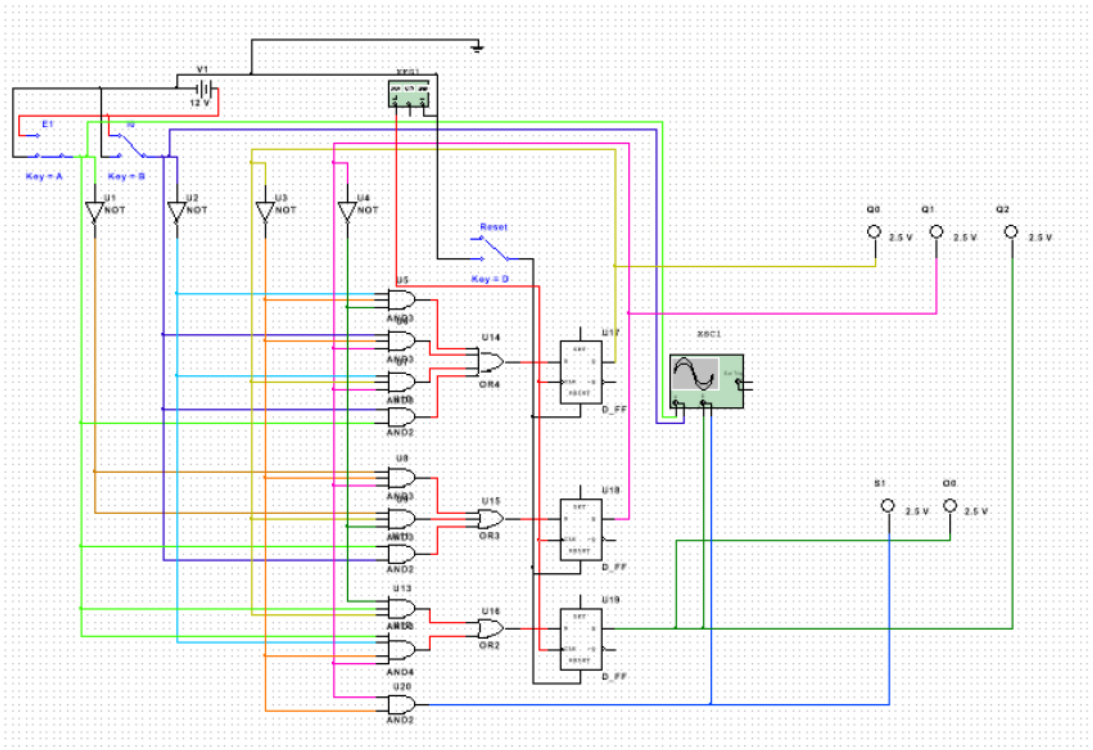

Figure 5-12: State 000

5. Plan

5.1 Deliverables

For this season of the course, we had to come up with ideas that would comply with the theme “Internet of things”. In our first deliverable, we had to come up with two ideas and present them through a presentation with external land internal judges. Our team came up with a total of 8 ideas; however, we picked the best two which were the “Smart autonomous scooter charger” and “Smart medicine dispensing machine”. Our team worked very well and I managed to win the first and the best awards for this deliverable. Our idea “Smart autonomous scooter charger” got picked as the best idea.

For the second deliverable, we had to write a detailed report, not exceeding 4000 words, explaining our aim and intention with the project. We divided the work among our teammates and managed to finish 2 days before the deadlines, which allowed us to consult with our tutors regarding the report. We submitted the report in week 7 of the second semester.

Deliverable 3's goal is to show Design Simulation through a concise Technical Report. In this report, schematics, diagrams, and tables should be used to describe the design. This is mostly done to target the project's hardware results. This should also address the professor's feedback from the prior deliverable. This deliverable is expected to be on week 10 of semester 2. This deliverable should also contain the team members' reflections.

Groups must provide a brief report on a breadboard-based prototype for deliverable 4. This deliverable's goal is to construct the circuit necessary to implement the team's concepts using a breadboard and the project's required materials. The inputs must be delivered exactly as planned to see how the circuit behaves per the project design.
This simulation must be completed by week 4 of semester 3.

Deliverable 5 requires groups to create a brief report on a breadboard-based prototype. The goal of this deliverable is to use a breadboard and project materials to construct the circuit that will carry out the functions for the team's concepts. The inputs must be delivered exactly as planned to see how the circuit behaves by the project concept. This simulation must be completed by week 4 of semester 3.

The final design report is included in Deliverable 6. Design calculations, breadboard design, and the final Arduino circuit design should all be included. This report must include the testing results, processes, and discussions. Each team member's function, as well as their major achievements and contributions to the project, must be clearly stated. This must be turned in by week 9 of semester 3.

Deliverable 7 will be the final prototype design presentation, as well as testing and implementation. This should be completed in semester 3 week 9. Graphics and visuals are strongly advised for this presentation. The team's performance should also be documented, as should a comparison of the prototype to the original plans. The marketing plan and commercialization must also be described explicitly. This must be presented in 10 minutes, with 5 minutes set out for questions.

The Innovation Fair 2023, which will take place in week 10 of the third semester, is Deliverable 8. All team members are required to attend, with the presentation accounting for 5% of the final mark. A PE session will be held, with the results due by the end of the Innovation Fair day. The groups must present the project prototype at the Innovation Fair.

5.2 Work Breakdown Structure

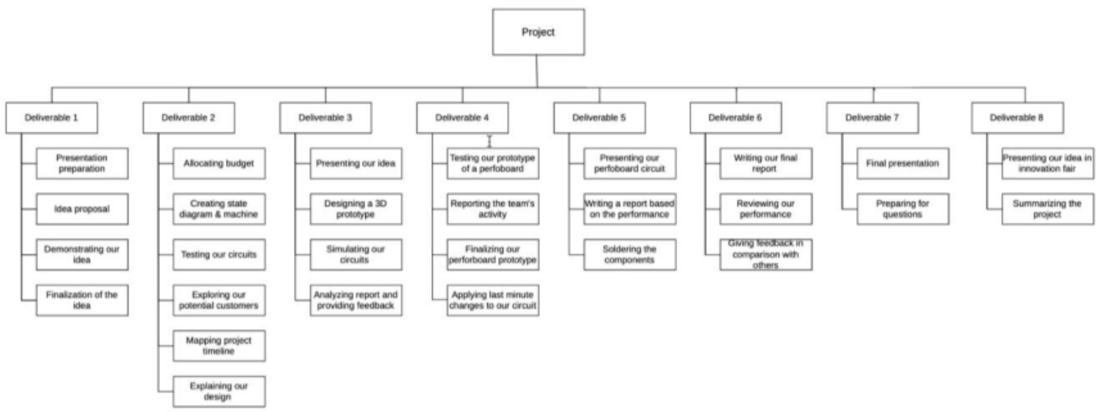

Figure 6-1:

5.3 Gantt Chart

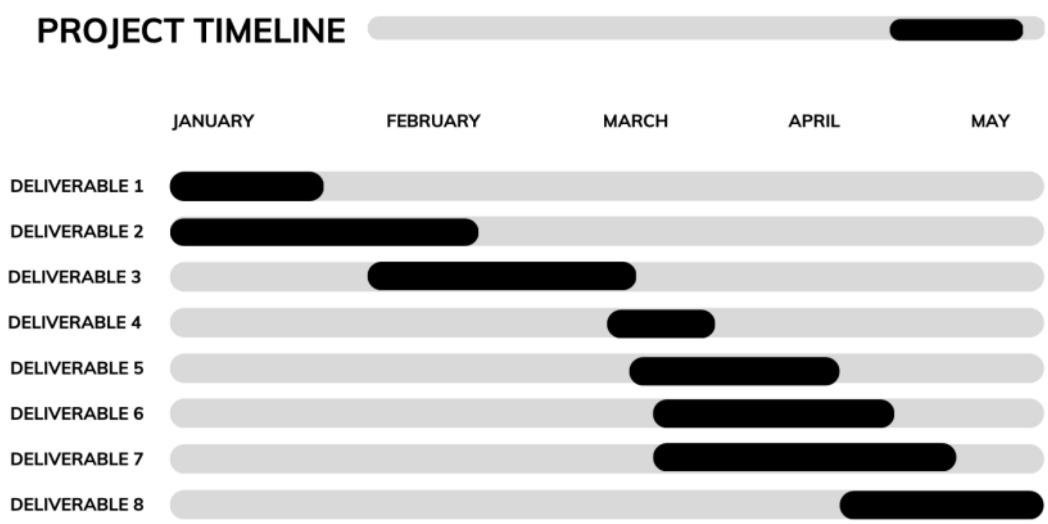

Figure 6.2:

5.4 Risks

There are several potential risks associated with the preparation of our project. One of them is the danger of working with electrical products, which can result in shocks or severe accidents. While working with solder, the same precautions should be used. This is easily addressed by taking the proper precautions, such as donning safety equipment when preparing to build the circuit. Another issue that could be significant is technical troubles caused by the charging function. We managed to tackle this issue by using a wireless charger for our demonstration and avoiding any unnecessary risk or danger.

6. Budget

6.1 Return of investment

Our team performed conducted another survey with the scooters in public to gather their battery level and usage percentage. We found out that at most, 80% of the scooters would be under use in busy areas. The only scooters which weren't under use were the ones with no battery charge. That's a straight-up loss for the company during peak demand timing. Here are some data which we managed to gather while conducting the research:

Scooter companies charge 1 AED per minute for a ride.

Each scooter has a range of 30 KM which equates to 30 minutes of the ride.

The scooter will need 5-6 hours of charging time to reach 100% battery.

The scooter can be used for a MAXIMUM of 40 minutes per day on a single charge.

If our system is implemented, scooters can have up to 300% time more uptime regarding the charge. That would dramatically increase the maximum usage per day to 120+ minutes per day.

We envision our complete model to cost 3000 AED to manufacture and we would set a retail price of 10000 AED Per unit for 5 scooter capacity. If the company decides to purchase the device, it will have a capacity of 5-10 scooters depending on their demand. If they choose the 5-scooter capacity, they will have an additional income of 400 AED per day if it's in high demand. The company will get the investment back in 25-30 days. This will make it highly viable as it's easy to implement and maintain.

Part Name	**Units**	**Unit Price (AED)**	**Total Price (AED)**
Arduino Kit	1	600	600

LM2936 (Voltage Regulator)	1	9	9
74HC02(NOR gate)	2	4	8
NE555 Timer	2	5	10
74LS08 (AND gate)	3	4	12
74HC74(D flip-flop)	3	4	12
74LS00 (NAND gate)	2	4	8
FlexiForce Pressure Sensor	1	80	80
Wireless Charger	1	40	40
Temp & Humidity Sensor	1	17	17
Scooter	1	275	275
		TOTAL	1,071.00

6.2 Parts Cost

6.3 Labour Costs

DELIVERABLE	HOURS	PRICE (AED)
Deliverable 1	05	900
Deliverable 2	05	1500
Deliverable 3	04	1200
Deliverable 4	06	1800
Deliverable 5	08	2400
Deliverable 6	10	3000
Deliverable 7	07	2100
Deliverable 8	12	3600
	Total Hours	57
	Total Amount	**16,500.00 AED**

6.4 Consultation Costs

Weeks	Hours	Price (AED)
Week 2 (Academic Staff)	01	500
Week 5 (Lab Engineer)	01	400
Week 6 (Tutor)	01	300
Week 10 (Lab Engineer)	01	500
	Total Hours	**04**
	Total Amount	**1700 AED**

7. Marketing

Our project is mainly aimed at businesses and governments since it won't be viable for individuals. We have a total of 4 customer types which consist of:

1. Smart Governments
2. Scooter Companies
3. Large corporate offices
4. Universities

Smart governments

As developing cities invest their time and money into a greener environment, they will typically implement new ways of transportation to reduce CO_2 emissions and to reduce traffic. Many governments have taken the approach of adding scooter pathways and parking throughout the city hot spots. One such city is Dubai; they have rental scooters right next to metro stations and in tourist spots. We conducted a survey in JLT which is a very attractive area to many, hence it contained a lot of scooters. We found an average of 30 scooters per square kilometer which came from 3 scooter rental companies. Out of all the scooters we surveyed, 72% of them had less than 80% of battery charge available. 45% had less than 50% battery. 23% had less than 15% battery. 6% had no charge at all.

If the government decides to implement our solution, more than 50% of the scooters will be always charged above 75% of battery. This will be the best option for both the consumer and the scooter companies since a standard charging system will increase their scooter uptime by a huge margin.

Scooter companies

The scooter rental companies can implement our solution and design a propriety charger for the scooter which will help them challenge the competing companies. This will attract more customers for that brand since the scooters will be active more frequently.

Large corporate offices

Many of the top companies around the world have offices that span more than kilometers apart. Some of these include Apple HQ, Google HQ, Meta HQ, etc... These companies already do have smart biking and scooter systems, but they haven't implemented a charging solution. Using our system, people working in that environment will have a much better expense using the scooters.

Universities

Most universities around the world have huge campuses which will create an unpleasant experience for students and teachers. By using our system, members of the university can transport easily between campuses. Some examples are AUS and Harvard university, students usually use vehicles for transportation since their campus is very large.

8. References

Balacco, G., Binetti, M., Caggiani, L. and Ottomanelli, M. (2021). A Novel Distributed System of e-Vehicle Charging Stations Based on Pumps as Turbine to Support Sustainable Micromobility. *Sustainability*, [online] 13(4), p.1847. doi:https://doi.org/10.3390/su13041847.

Hardt, C. and Bogenberger, K. (2019). Usage of e-Scooters in Urban Environments. *Transportation Research Procedia*, [online] 37, pp.155–162. doi:https://doi.org/10.1016/j.trpro.2018.12.178.

Rose, J., Schellong, D., Schaetzberger, C. and Hill, J. (n.d.). *HOW E-SCOOTERS CAN WIN A PLACE IN URBAN TRANSPORT*. [online] Available at: https://web-assets.bcg.com/img-src/BCG-How-E-Scooters-Can-Win-a-Place-in-Urban-Transport-Jan-2020-rev_tcm9-237992.pdf.