

Algorithm for Efficient Battery Management in a System Powered by Renewable Energy

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ABSTRACT

We all know that Bangladesh is a country which has substantial shortage of electricity. It is generally stated that at the end of 2009, the demand for electricity is around 5000MW whereas the generation capacity is around only 3000MW, thereby measuring a shortfall of 2000MW, which is increasing day by day. One of the most important factors for a country for development is its power generation capacity. If we want to improve the general condition of our country, then we must find ways to meet our demand for electricity.

So in this situation what can us in Bangladesh do? If we want to meet the shortage, then we have to build big power plants. But unfortunately it is not possible due to of lack of financial resources. A good substitute could be renewable energy, like solar panel or wind turbine.

Every individual house with solar panel could be an individual power plant. This would reduce dependency on carbon based power plant demand. These renewable projects are somewhat costly. Therefore, it is important for us to efficiently design such system and use the generated energy properly. In our work we have proposed a battery management circuit which will intelligently take necessary steps to use the generated renewable power properly.

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Above everything we thank our Almighty, Allah, for giving us the ability, scope, patience and energy to complete this commitment efficiently.

AUTHORIZATION PAGE

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TABLE OF CONTENTS

ABSTRACT	2
ACKNOWLEDGEMENTS	3
AUTHORIZATION PAGE	4
TABLE OF CONTENTS	5
LIST OF ILLUSTRATIONS	6
LIST OF TABLES	7
1. INTRODUCTION	8
1.1. AUTOMATED MANAGEMENT SYSTEM.....	8
1.2. OUR PROPOSAL.....	8
1.3. THESIS CONTENT.....	9
2. PLANNING AND DESIGNING	11
2.1. FUNDAMENTAL STEPS OF DESIGNING A CIRCUIT.....	11
2.2. FINDING A FLOWCHART.....	11
2.3. STATE MACHINE.....	13
2.4. TRUTH TABLE.....	15
2.5. EQUATIONS OF THE SYSTEM.....	17
2.6. LOGIC CIRCUIT FROM THE EQUATION.....	19
3. IMPLEMENTATION	21
3.1. SIMULATION.....	21
3.2. SIMULATION SOFTWARE.....	22
3.3. MICROCONTROLLER.....	23
3.4. SIMULATION ANALYSIS.....	26
3.5. SOFTWARE RELIABILITY.....	29
4. PCB BOARD DESIGN	30
4.1. PCB DESIGN:.....	30
5. FINAL IMPLEMENTATION	32
5.1. MATERIALS DESCRIPTION.....	32
5.2. MOTOR AND LCD DISPLAY.....	32
5.3. IN THE FINAL IMPLEMENT.....	33
5.4. ELECTRONIC RELIABILITY.....	34
6. APPLICATION	35
6.1. SOLAR CAR / RICKSHAW.....	35
6.2. SOLAR BOAT.....	36
7. DISCUSSION AND CONCLUSION	39
8. FUTURE WORK	40
9. REFERENCE	42
III. APPENDIX A: PROTEUS	43

LIST OF ILLUSTRATIONS

FIGURE 1: SCHEMATIC DIAGRAM OF THE SYSTEM.	8
FIGURE 2: FLOW CHART OF THE SYSTEM.	12
FIGURE 3: STATE DIAGRAM OF THE SYSTEM.	13
FIGURE 4: SCHEMATIC DIAGRAM OF THE LOGIC CIRCUIT.....	19
FIGURE 5: LOGICAL CIRCUIT FOR THE SIMULATION.	20
FIGURE 6: SIMULATION FIGURE IN PROTEUS.....	21
FIGURE 7: ATMEGA32 MICROCONTROLLER.	24
FIGURE 8: ATMEGA32 MICROCONTROLLER PIN CONFIGURATION.	25
FIGURE 9: SIMULATION FIGURE FOR CASE 1.	27
FIGURE 10: SIMULATION FIGURE FOR CASE 2.	27
FIGURE 11: SIMULATION FIGURE FOR CASE 3.	28
FIGURE 12: SIMULATION FIGURE FOR CASE 4.	29
FIGURE 13: THE ORCADE MODEL FOR PCB DESIGN.	30
FIGURE 14: BEFORE THE AUTOMATIC FOOTPRINT GENERATION STAGE BEFORE ROUTING.	31
FIGURE 15: THE FINAL STAGE OF ROUTING OF LAYOUT.....	31
FIGURE 16: GDM1602A DISPLAY.	33
FIGURE 17: THE FINAL IMPLEMENTATION CIRCUIT.....	34
FIGURE 18: MODEL PICTURE OF SOLAR RICKSHAW.	36
FIGURE 19: MODEL PICTURE OF SOLAR BOAT.	37
FIGURE 20: APPENDIX PICTURE FROM PROTEUS.	43

LIST OF TABLES

TABLE 1: TRUTH TABLE OF THE STATE DIAGRAM.	16
TABLE 2: K-MAP TABLE FOR THE FIRST COLUM.	17
TABLE 3: K-MAP TABLE FOR THE SECOND COLUM.	17
TABLE 4:K-MAP TABLE FOR THE THIRD COLUM.	18
TABLE 5: TABLE FOR MATERIALS LIST.....	32

1. INTRODUCTION

1.1. Automated Management System

From the general sense we can easily get an idea about the automated management system. Management system means to operate or arrange the system. And automated means it will work as individual's automated management system is the system which will use its intelligence to take necessary decision. It will use its logic and take decision that which will be best for the system.

Our management circuit is able to do this type of work. Our circuit will take data from its storage (battery), and then convert it into a binary data then send it in to a logic circuit and it will decide what will be the next step and automatically it will do this. If it needs to recharge the storage (battery) then it will connect it to the source (charging panel) and if it needs to supply the power then it will connect the power supply to the output system.

1.2. Our proposal

According to the above subject we have tried to get something new which could be helpful for a country like Bangladesh. To save the loss of energy we need some management system. So we build this management system. This is also very efficient and cheaper. This circuit will be able to supply or manage the power system of a boat or min taxi or we can use it as our household power supply system.

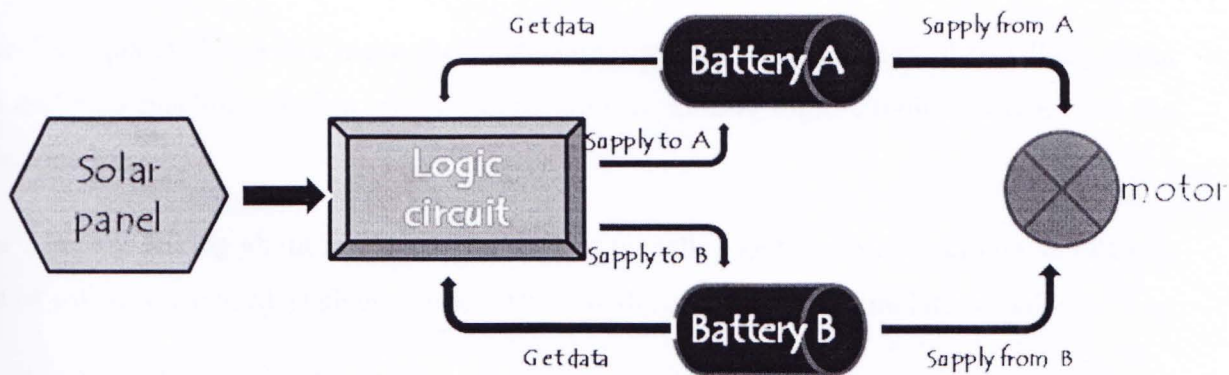


Figure 1: Schematic diagram of the system.

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Above diagram is the schematic view of our work. The main part of our system is the logic circuit or the control circuit. First it will get data from the battery "A" and battery "B". Then it will analyze the data like compared the data between two battery, comparing the data with some predefine values (the pre define values will be set on the basis of the battery life.) Then on the basis of the result of those comparisons the control circuit will take the decision. If the value of the battery "A" is enough to run the system (motor), then it will send the A to run the system. At the same time it will send the battery "B" for charging, (to the renewable energy source) if the "B" has not enough charge. Control circuit will do exactly the opposite thing for "A" and "B" if there values change to exactly the opposite. If both battery has enough charge or full, then it send he battery "A" for run the system .in this case it will give priority the "A". If both batteries are empty then control circuit will connect the system (motor) with the solar panel or the renewable energy source.

Battery life cycle:

We divided the batteries output in difference section, like 30%, 31%~70%, 71%~95%. These are not the arbitrary values. We decided these values by observing the battery life cycle. In this project we used 12V Batteries. Here we know that when this type of battery gets full charge then it will supply 12 to 13 Volt, and when it considered as empty then its voltage get down to 10 to 11 Volt. We used actually the amperes rating of the battery. Here voltage will remain around same but current rating will change rapidly. So these type changes were considered in our project for different type of states [1].

1.3. Thesis Content

Here in chapter 1 we discuss about the introduction, our motivation and about the thesis content.

In chapter 2 we planned how we make the fundamental step of circuit design, then talking about flowchart and step machine. At last we discussed how we getting logic circuit equation from the truth table equation.

In chapter 3 we are talking about implementation. Here we talk about our project circuit simulation, what type of software we used, such as proteus. Then we discuss about the simulation analysis.

In chapter 4 we are talking about how PCB boards design developed and manufactured.

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In chapter 5 we discuss about final implementation of our project. Here we give a short description about the circuit materials and then how we continuing our final implementation and how it operates.

In chapter 6 we talked about some application of our project, such as solar panel using in car or rickshaw and in boat.

Then in chapter 7 we give some short discussion and conclusion about our project.

In chapter 8 we give some description about the future work of our project.

2. PLANNING AND DESIGNING

In planning and designing section we will discuss about how we first start the work. What are the steps to make a logic circuit? How did we find the state diagram? What are the procedures for find out the equation of a system from the truth table etc.

2.1. Fundamental steps of designing a circuit

- ❖ First of all, we decided what we want to do, that means our circuit will do such and work such as desired by us.
- ❖ Then we designed a flowchart which represents the total mechanism or total management system.
- ❖ Then we established a state machine which will work as a brain (decision maker) of the circuit.
- ❖ Then we turned the state machine into a mathematical equation using truth table and Boolean algebra.
- ❖ Finally, we made a switching circuit which gives this mathematical equation a physical form.

2.2. Finding a Flowchart

Finding a flowchart is not that easy as we thought. A flowchart represents the whole system in a simple diagram. A flowchart is the easiest way to understand a system within a very short time. A flowchart should be like documentary in a diagram that if any people watch a flowchart of a system then he will get a overall idea about the system.

So with all of this consideration we were very much careful to make the flowchart of our system. What we can do and what we want to do, what would be the best for a power management system we consider all of these stuff. We designed several flowcharts. After many unsuccessful trials finally we designed a final one which almost fulfilled all of our requirements.

flowchart of the system

A=Battery A
 B=Battery B
 We divided hole charge in to 4 part
 0~30%
 31~70%
 71~90%
 91~100%

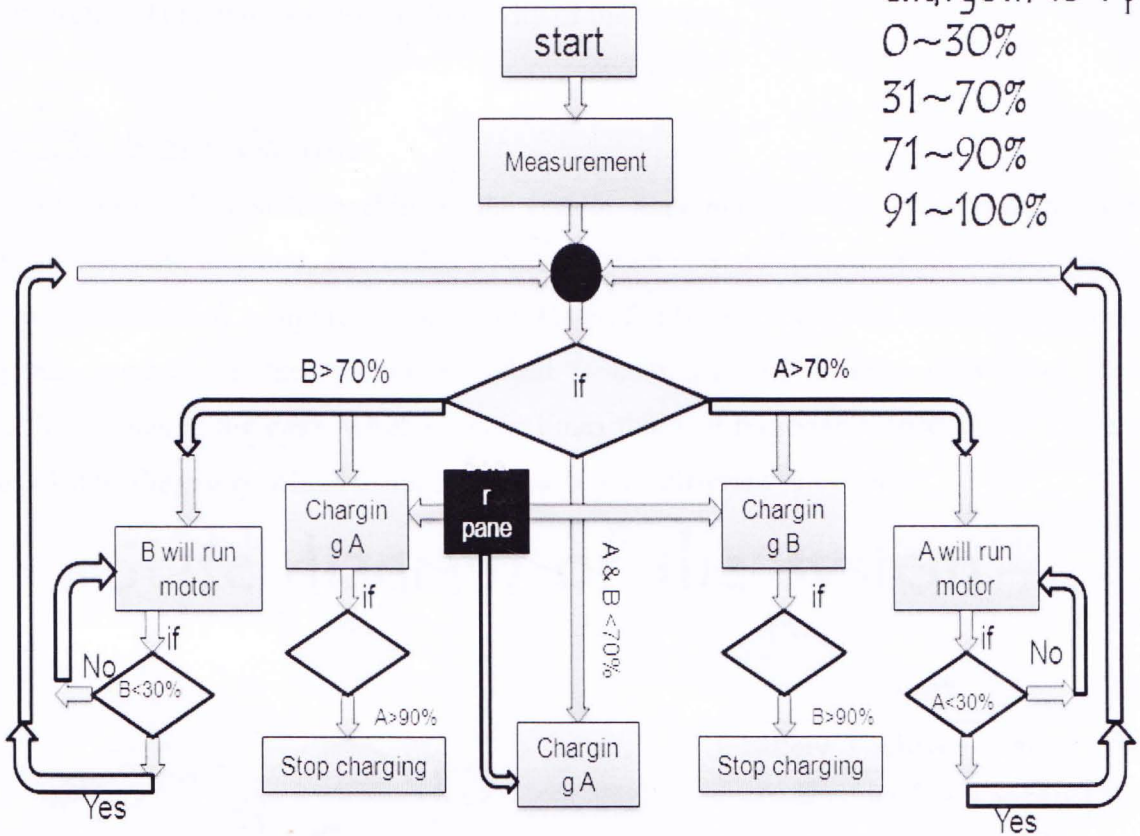


Figure 2: flow chart of the system.

This is the figure which represents the theme of our project operation; it means what is the operation of our circuit.

This is a power management system flowchart; this system is able to manage two battery difference functions. Here from the flow chart we can see that first when we will start the system then it will first measure the values of two batteries. Then if battery 'A's charge is greater than 70% and 'B's charge is what ever it will supply power to the system From battery 'A'. here it will give priority to 'A' when both battery's charge is same. And on the value of 'B' it will decide what it will do with battery 'B'. If 'B' is less than 70% then it will send it to get charge.

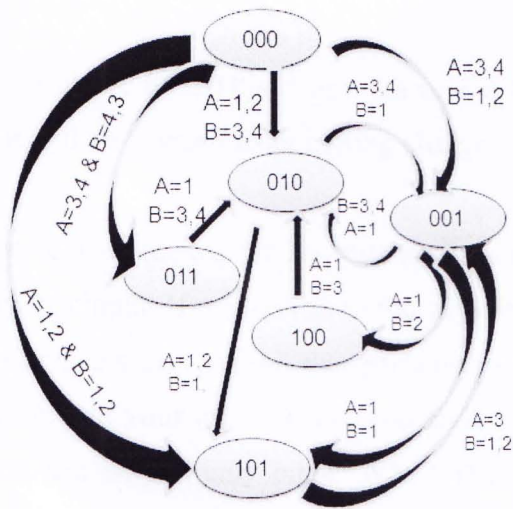
In the mean time the circuit always checkup the values from two batteries. If the battery 'A' is running the system, then it's discharged. When 'A''s charge will be less than 30% then it will automatically switched the source. Then A will get charged and B will run the system.

There is another operation we had done which is when any battery will get charged above 90% then it will stop charging. This will increase the longevity of the battery.

2.3. State Machine

Our next step was to make a state machine of the system. State machine is the way to represent the system logically. A state machine, also called a state diagram or state chart diagram A state diagram is a type of diagram used in computer science and related fields to describe the behavior of systems. State diagrams require that the system described is composed of a finite number of states; sometimes, this is indeed the case, while at other times this is a reasonable abstraction. There are many forms of state diagrams, which differ slightly and have different semantics.

State diagram of the system



input

battery	charge	mark
A ,B	0~30%	1
A ,B	70<c>30 %	2
A ,B	95<c>70 %	3
A ,B	95~100	4

State	Operation of the state
000	Start up the system
001	A run the motor & B get charge
010	B run the motor & A get charge
011	A run the motor & B is full charged
100	B is charging and A is empty.
101	A is charging and B is empty.

Figure 3: state diagram of the system.

Undergraduate Thesis

Making a state machine was also not very easy because there are some rules and way to do it.

Here in this state machine we drew the logical view of our system. Our circuit will work on the basis of the battery values. And for different values of charge the circuit will work differently. So for the simplicity and considering the lifetime of the battery, first we divided all the batteries into different sections.

From 0% to 30% of the total charge we consider it as the empty mode. When any battery's charge is less than 30% then it must have to be stopping discharging, no matter what is the condition of the other battery or the system. That means if battery A is running the system and discharging-because of discharging once its voltage will come down to 30% and the battery will automatically goes to charging mode.

Now from 30% to 70% is the operation region. This means 70% to 30% the battery will run the system. Battery 'A' is running the system and it is discharging. when it's voltage value come down to below 30% then it will stop giving energy and at the same time if battery 'B' charge is above 70% then the system will shift into 'B' and will take energy from the battery 'B'.

And third stage is above 70% to less than 95%, in this stage the battery is fully ready to run the system. Any battery will go to the operational mode, only when its charge will be between 71% to 95%.

Final stage is above 95%. This is the idol region for the battery. When a battery gets charged above 95% then it will be stopped from getting charge.

From the state diagram we can see that each state hat two or one input but there could be more input. Why this input. If we look in to the work on the each state then we will see that each state will do difference work. and on that particular state its output only could be those, so now any one could say that your input is four and state is six so your combination should be more than 100.but you use only twenty eight. Why? Then the answer is we only uses those conditions which are possible. Because when the state diagram will run them it will never face that type of input for the next state which is impossible. So our output for particular state is fixed.

Now from the state diagram and its input and the state table we can easily find out how it will work. Say when our system is at "010 states, that's mean, "B" is running the motor and "A" is charging. in

this situation what could be the next batteries output. definitely when “B” will run the system then it will discharge and get down to the below 30%, that’s means “B” could be “1”.at the same time “A” charge will be increase, so it could be “3” or “4”.so when the logic circuit will get those combination of the input, then it will shift to the “001”state, that’s mean A will run the system and “B” will get charge.

again if the weather is bad or any how battery “A” is unable to get full charge, or it charging but still billow 70%.so “A” output could also be “1” or “2” and “B” output must will be “1”.in that case, for those combination system next state will be “101” that’s mean “A” is charging and “B ”is empty, So the motor will shut down.

2.4. Truth table

Our next step was to derive the truth table. Because when we will be able to find the truth table, then easily we can find an equation for each output and that will give a logic circuit which will represent the state diagram. Now we know the rules for making the truth table. Current states then input finally next states. Current state is representing the system present situation. Then input which is come from the batteries, and next states are the states what it the suitable for the system for the current input.

Current state	A		B		Next state
000	1	0	0	0	001
000	1	0	0	1	001
000	1	1	0	0	001
000	1	1	0	1	001
000	0	0	1	0	010
000	0	0	1	1	010
000	0	1	1	0	010
000	0	1	1	1	010
000	1	0	1	1	011
000	1	0	1	0	011
000	1	1	1	1	011
000	1	1	1	0	011
000	0	0	0	0	101
000	0	0	0	1	101
000	0	1	0	0	101
000	0	1	0	1	101
001	0	0	0	1	100
001	0	0	1	0	010
001	0	0	1	1	010
001	0	0	0	0	101
010	0	0	0	0	101
010	0	1	0	0	101
010	1	0	0	0	001
010	1	1	0	0	001
011	0	0	1	0	010
011	0	0	1	1	010
100	0	0	1	0	010
101	1	0	0	0	001
101	1	0	0	1	001

Table 1: Truth Table of the state diagram.

2.5. Equations of the system

To represent the system we used 6 states, for which we needed only 3 bits to be able to define each state. Using Boolean algebra and karnaugh's-map we derived 3 difference equations. 3 equation because our next states is in 3 bit, so three difference equation for the three column of the next state. Later on we implemented these equations.

	0000	0001	0011	0010	0100	0101	0111	0110	1000	1001	1011	1010	1100
000	1	1	1	3	2	1	16	1	17	19	18	1	32
001	1	4	1	5	7	6	20	21	23	22	1	37	39
011	12	13	15	14	28	29	31	30	44	46	47	46	60
010	8	9	11	10	24	25	27	26	40	41	43	42	56
100	64	65	67	66	80	81	83	82	96	97	99	98	112
101	68	69	71	70	84	85	87	86	100	101	103	102	116
111	76	77	79	78	92	93	95	94	108	109	111	110	124
110	72	73	75	74	88	89	91	90	104	105	107	106	120

Table 2: K-Map Table for the first column.

Equation for the 1st Column is $A'B'D'C'F' + A'B'D'E'F' + A'D'C'F'G'$

	0011	0010	0100	0101	0111	0110	1000	1001	1011	1010	1100	1101	1111	1110
000	1	1	3	1	2	16	17	1	18	1	18	32	33	36
001	5	1	7	1	8	20	21	23	22	36	37	39	38	52
011	3	1	15	1	14	28	29	31	30	44	46	47	46	60
010	9	1	11	1	10	24	25	27	26	40	41	43	42	56
100	65	67	1	66	80	81	83	82	96	97	99	98	112	113
101	69	71	70	84	85	87	86	100	101	103	102	116	117	119
111	77	79	78	92	93	95	94	108	109	111	110	124	125	127
110	73	75	74	88	89	91	90	104	105	107	106	120	121	123

Table 3: K-Map Table for the second column.

Equation for the 2nd Column is $B'C'D'E'F'G' + A'B'C'F' + A'D'E'F'C$

	0000	0001	0011	0010	0100	0101	0111	0110	1000	1001	1011	1010	1100	1101	1			
000	1	1	1	3	2	1	16	17	19	18	1	32	33	35	34	40	49	
001	1	4	1	5	7	6	20	21	23	22	1	36	37	39	38	52	53	
011	1	1	13	1	15	1	14	28	29	31	30	1	44	45	47	46	60	61
010	1	1	9	1	11	1	10	24	25	27	26	1	40	41	43	42	56	57
100	64	65	67	66	80	81	83	82	96	97	99	98	112	113				
101	68	69	71	70	84	85	87	86	100	101	103	102	116	117				
111	76	77	79	78	92	93	95	94	108	109	111	110	124	125				
110		73	75	74	1	88	1	89	91	90	104	105	107	106	120	121		

Table 4: K-Map Table for the third column.

Equation for the 3rd Column is $A'D'E'B'F'G' + ADE'B'CF' + A'B'C'F' + A'C'F'G + A'DB'C'$

The tables 2, 3, 4 are the K-map tables for the three different equations. We use K-Map software for the table. There is an issue with K-Map table is we use only few cells. Most of the cells are empty, so the result from K-Map could be the wrong for our system. Then we consider rest of the rooms as don't care(X). But unfortunately, our free K-Map software was unable to find out the solution. Our computer got hang several times. Then we had decided to find out the equation by hand. So 1st we find out the point of the table that which point is "A" which point is "B" as the same for the C ,D ,E ,F , and "G". Then we make the pair of the cells, and finally got the three equations from the difference three tables.

2.6. Logic circuit from the equation

Logical circuit is nothing but the combination of the gates like AND, OR, etc. in our logic circuit we use exactly the same thing. In the first part we define the input or the source and the current state. In the second part we convert the logic equation into a logic circuit by using those gates.

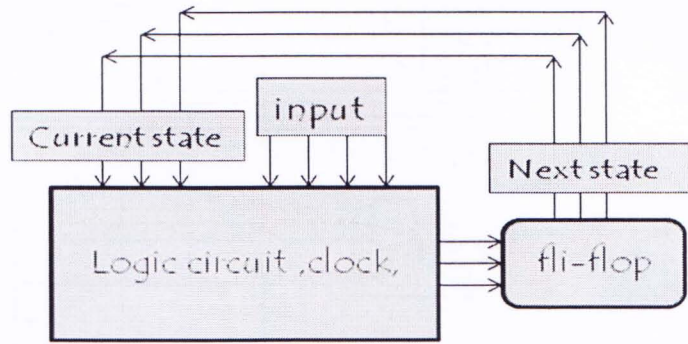


Figure 4: Schematic diagram of the logic circuit.

Our circuit work on the basis of current state and its input, so for monitoring this two we use a clock and a flip-flop, which will continuously give a pulse and will make a bridge between the current state and next state, because when it shift to the next state then this will be the current state for the logic circuit.

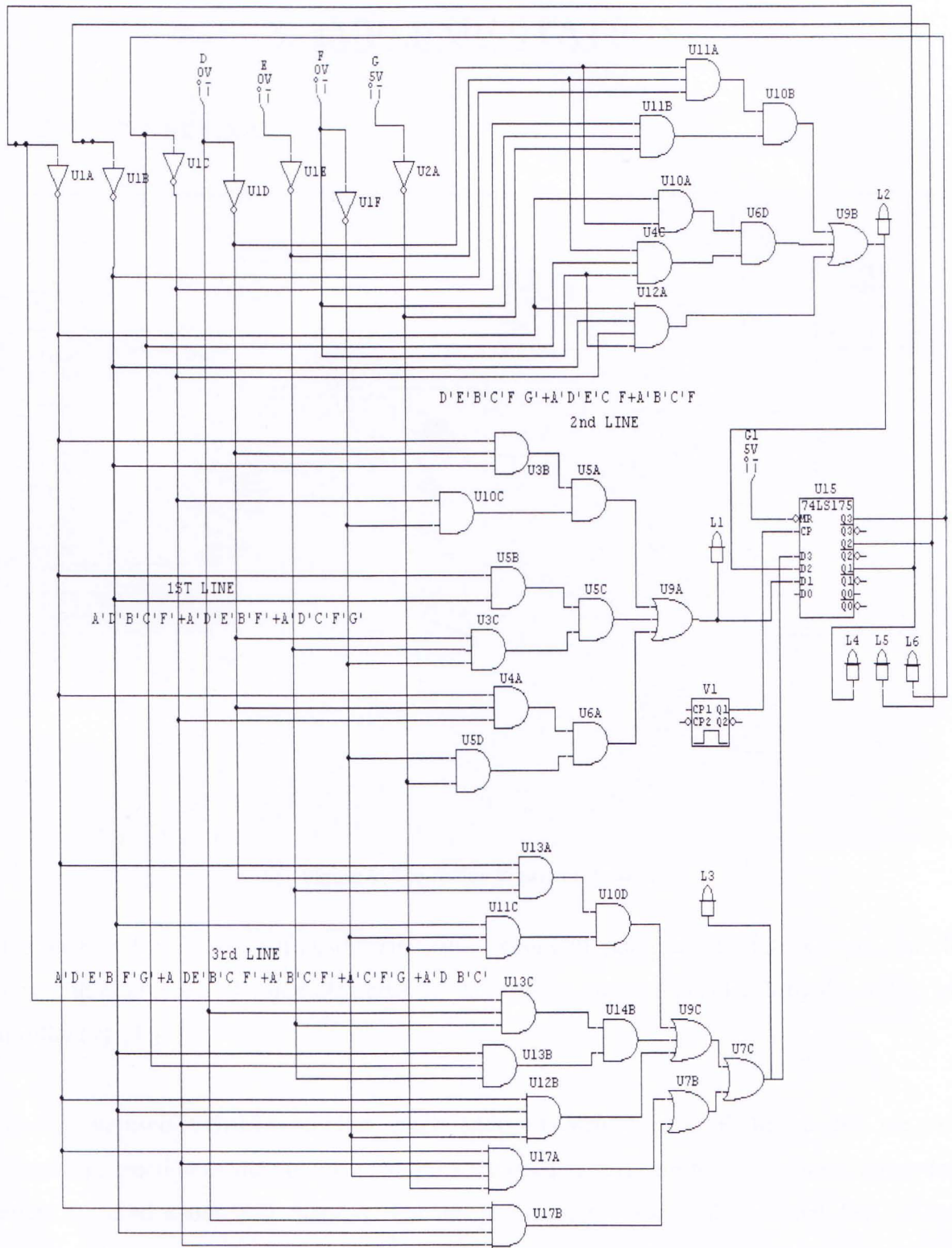


Figure 5: logical circuit for the simulation.

3. IMPLEMENTATION

3.1. Simulation

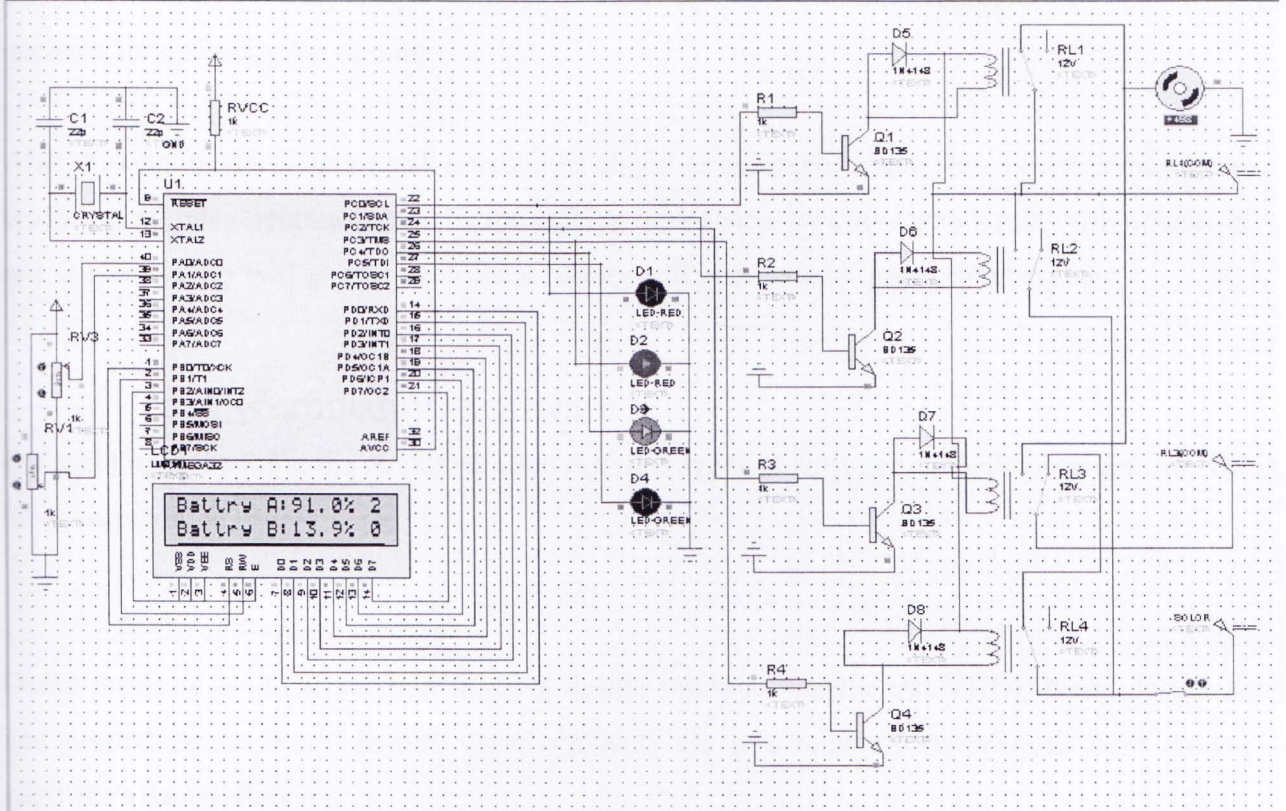


Figure 6: Simulation Figure in Proteus.

We used proteus software for getting the simulation result of our project. Here we put the all components with microcontroller and also give the work instruction of this circuit by the coding of microcontroller [2], [1][3].

For this coding we used ATMEL compiler, where code was written in AVR. In the code we will give the overall instruction of the circuit work. First we need to compare the two battery values for which battery we used which will charging. For this comparison we used the internal ADC of the microcontroller. Before inputting the value in ADC we step down the voltage of battery 12 to 5 volts. Because the ADC will operate in 5V Dc. Then in coding we compared the two battery voltage with the help of ADC equation. After the completing of battery voltage comparison we will goes to

future step that what to do with the comparison results. Here we used a 12MHz crystal for clock generation which will continue the code. Then we go to next step where we initialize the LCD display for observing the battery voltage percentage level. Then we give the information about our state and for which condition it will stay in which state we will define these things in this section. Then we continue a loop where code will check up those condition continuously and make the decision for operating the circuit.

After making the decision we will operate the circuit as our expectation. Here decision means that we have four relay operations and by the making of decision we know which relay will operate or not. By the battery will goes to motor and battery will goes to solar panel for charging?

3.2. Simulation Software

For building and testing the circuit we used different types of software. In bellow we describe about those software.

A. Orcad Capture

Orcad products are total solution for core design tasks: schematic and VHDL based design entry; and printed circuit board layout. orcad products are is a suite of applications built around an engineer's design flow.

We use orcad to design the main Circuit board.

B. ATMEGA32 Compiler

This software we used for developing our microcontroller coding.

C. Keil μ Vision

We use Keil to write the firmware code for microcontroller.

D. Proteus

In proteus we mainly design the circuit and simulate the circuit by using the microcontroller.

Some part of Microcontroller coding:

```

uint8_t comp = (out_v/100);
if(comp <30) bstate = 0;
else if(comp >=30 && comp<70) bstate = 1;
else if(comp >=70 && comp<98) bstate = 2;
else if(comp >=98) bstate = 3;
LCDGotoXY(15,1);
char cc = bstate + 48;
LCDsendChar(cc);
}
if(state == 0)
{
    if(astate ==2 && bstate ==0 ) state = 1;
    else if(astate ==2 && bstate ==1 ) state = 1;
    else if(astate ==3 && bstate ==0 ) state = 1;
    else if(astate ==3 && bstate ==1 ) state = 1;
    else if(astate ==0 && bstate ==2 ) state = 2;
    else if(astate ==0 && bstate ==3 ) state = 2;
    else if(astate ==1 && bstate ==2 ) state = 2;
    else if(astate ==1 && bstate ==3 ) state = 2;
    else if(astate ==2 && bstate ==3 ) state = 3;
    else if(astate ==2 && bstate ==2 ) state = 3;
    else if(astate ==3 && bstate ==3 ) state = 3;
    else if(astate ==3 && bstate ==2 ) state = 3;
    else if(astate ==0 && bstate ==0 ) state = 5;
    else if(astate ==0 && bstate ==1 ) state = 5;
    else if(astate ==1 && bstate ==0 ) state = 5;
    else if(astate ==1 && bstate ==1 ) state = 5;
}
else if(state == 1)
{
    if(astate ==0 && bstate ==1 ) state = 4;
    else if(astate ==0 && bstate ==2 ) state = 2;
    else if(astate ==0 && bstate ==3 ) state = 2;
    else if(astate ==0 && bstate ==0 ) state = 5;
}
else if(state == 2)
{
    if(astate ==0 && bstate ==0 ) state = 5;
    else if(astate ==1 && bstate ==0 ) state = 5;
    else if(astate ==2 && bstate ==0 ) state = 1;
    else if(astate ==3 && bstate ==0 ) state = 1;
}
else if(state == 3)
{
    if(astate ==0 && bstate ==2 ) state = 2;
    else if(astate ==0 && bstate ==3 ) state = 2;
}

```

3.3. Microcontroller

A microcontroller is such type of small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, watchdog, serial and analog I/O etc. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a, typically small, read/write memory.

In this project we used ATMEGA32 microcontroller. The ATMEGA32 is a low-power, high performance CMOS 8-bit AVR microcontroller with 32Kbytes of Flash programmable and erasable read only memory (PEROM).By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), The resulting architecture is more code efficient while

achieving throughputs up to ten times faster than conventional CISC microcontrollers. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the ATMEGA32 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

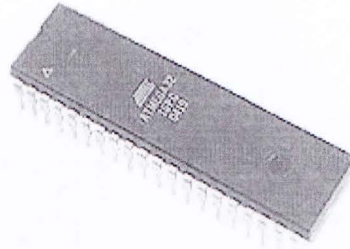


Figure 7: ATMEGA32 Microcontroller.

Pin Descriptions

VCC Digital supply voltage.

GND Ground.

Port A (PA7..PA0) Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7..PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the ATmega32 as listed on page 57.

Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink

and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs. The TD0 pin is tri-stated unless TAP states that shift out data are entered. Port C also serves the functions of the JTAG interface and other special features of the ATmega32 as listed on page 60.

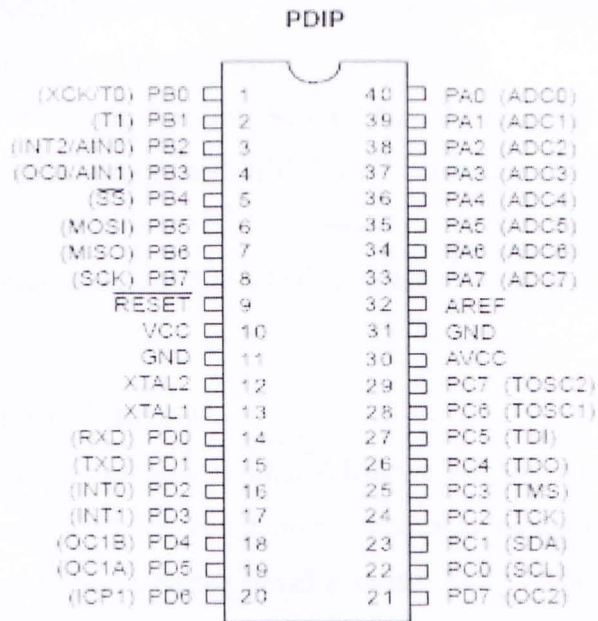


Figure 8: ATMEGA32 Microcontroller pin configuration.

Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs. The TD0 pin is tri-stated unless TAP states that shift out data are entered. Port C also serves the functions of the JTAG interface and other special features of the ATmega32 as listed on page 60.

Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the

pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega32 as listed on page 62.

RESET Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Table 15 on page 37. Shorter pulses are not guaranteed to generate a reset.

XTAL1 Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2 Output from the inverting Oscillator amplifier.

AVCC AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF AREF is the analog reference pin for the A/D Converter.

3.4. Simulation Analysis

In this section we first discuss the simulation results. When we run the simulation by the observing the LED condition we will justify our expected output and also took the consideration of LCD display. First here we show that if our A battery level is under 30 or 70 percent then battery A will start charging itself. The first led will show the red and at that time if battery B level is also less then 30-70 then motor will not running.

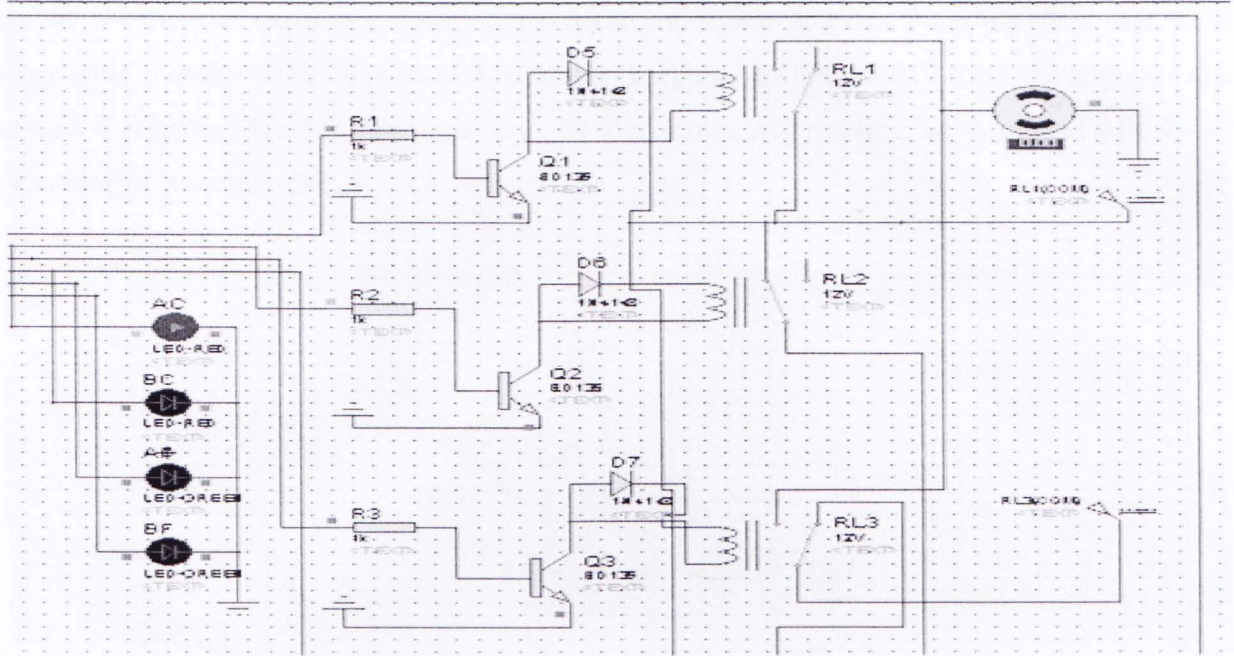


Figure 9: Simulation figure for case 1.

We have just seen our expected output and for this case the motor will not run. Then we show that if our B battery level is under 30 or 70 percent then it will charging, so second LED will show the red color and at that time if A battery level is indicates charge greater then 70, in that case the motor will run. The third LED will turn on in green as battery A is fully charged.

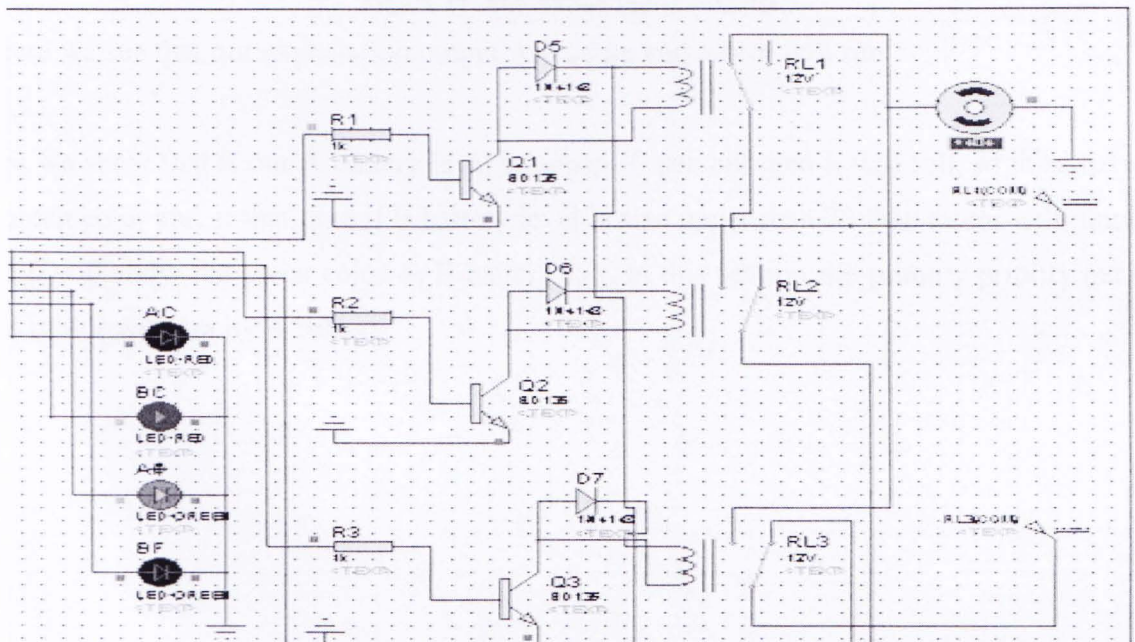


Figure 10: Simulation figure for case 2.

Here we see that our expectation output will come and motor will run. Next we show that if our A battery level is under 30 or 70 percent then it will charging, so first led will show the red color and at that time if B battery level is also upper then 70 then motor will running, so fourth led will show the green color as B battery full.

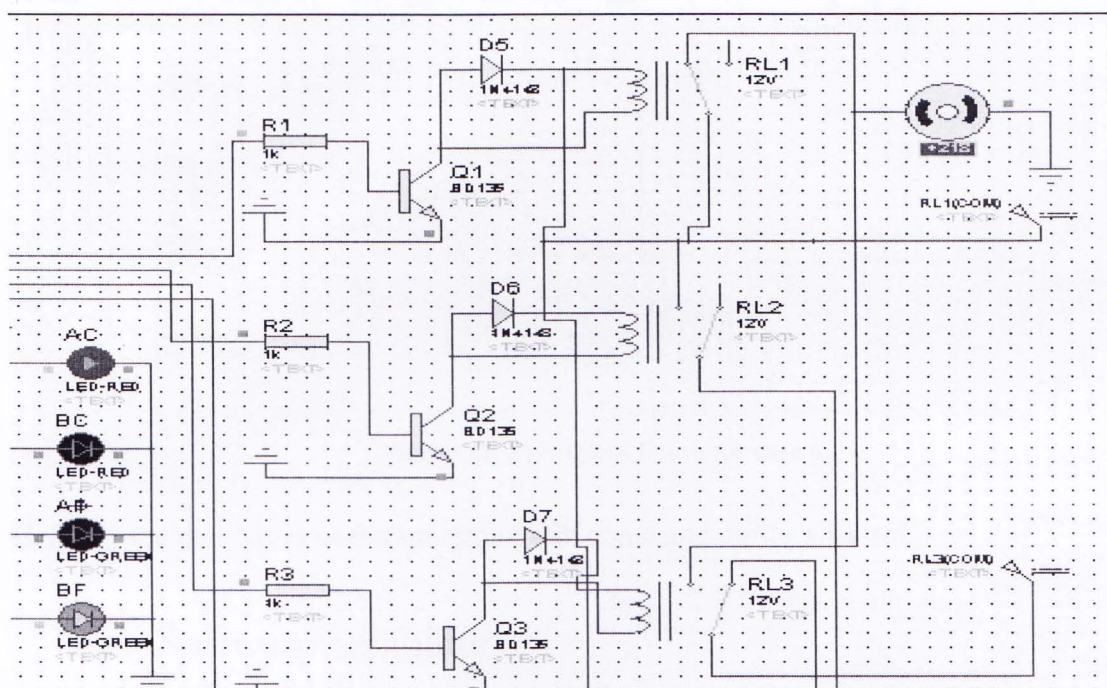


Figure 11: Simulation figure for case 3.

Here we see that our expectation output will come and motor will run.

Fourth here we show that if our A battery level is upper 70 percent then it will full, so third led will show the green color and at that time if B battery level is also upper then 70 then motor will running, so fourth led will show the green color as B battery full. in this section the primary priority get s A battery and motor will run by A battery.

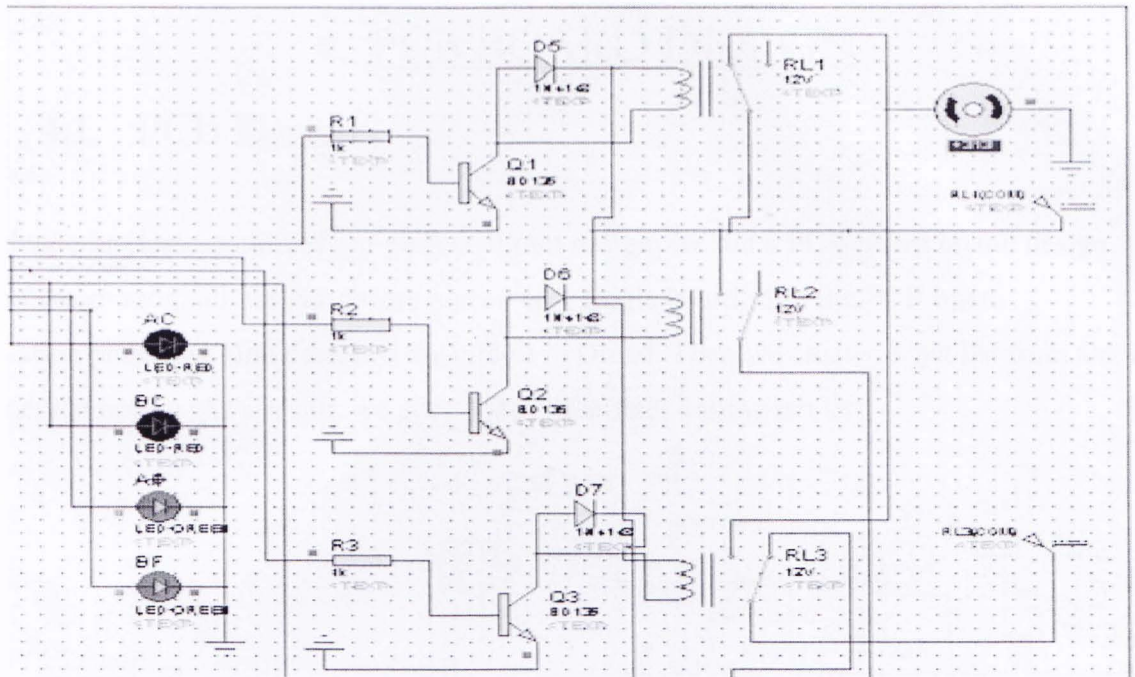


Figure 12: Simulation figure for case 4.

Here we see that our expectation output will come and motor will run.

3.5. Software reliability

Software reliability is another important manner to be considered. Here in our project the main software is the microcontroller instruction for relay operation. So if any error occurs all the devices will malfunction. Steps were taken to make sure there were no errors in code.

4. PCB BOARD DESIGN

4.1. PCB Design:

For the hardware implementation of our project circuit design, we did a PCB board layout design. During implementation, all our parts were placed on a single board. For the PCB board implementation phase, we first designed the circuit in Orcad. Then we created a net list from Orcad using the net list option. As a result, we got “.MNL” file after creating net list.

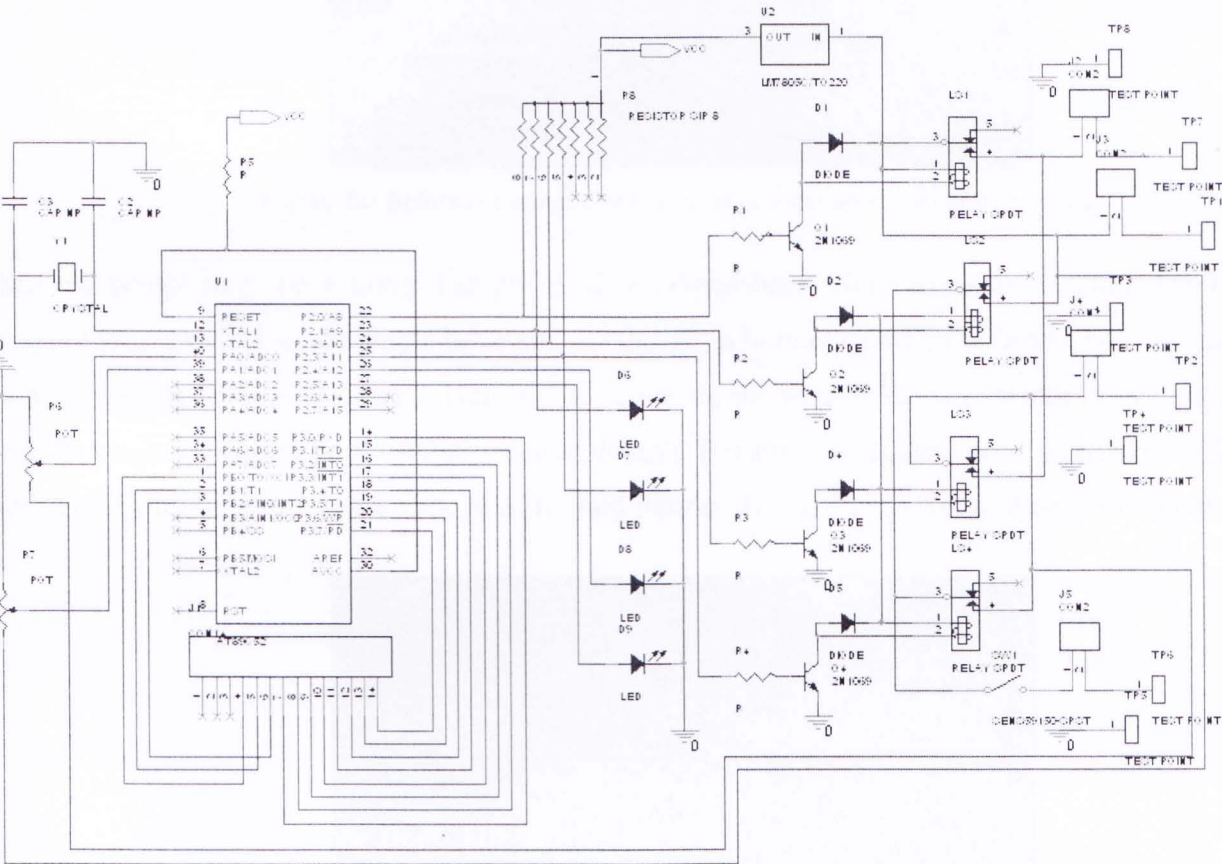


Figure 13: The orcade model for PCB design.

When that “.MNL” file we opened in layout in Orcad. After that it needs to create footprint and here some footprint will generate automatically and some needs to shows by user (here by us).

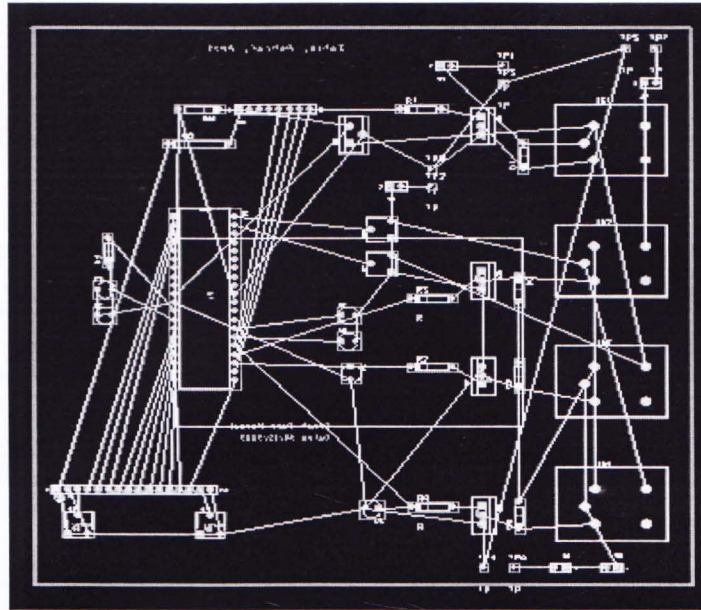


Figure 14: Before the automatic footprint generation stage before routing.

Then we completing the routing and go to view spreadsheet. Here we also selection the layer selection where we select the single layer and put design in bottom of the PCB board. We considered the net selection at time of routing. Here net selection means what is the wire width in layout. Why we used single layer and why used multilayer doesn't. Because we doesn't need multilayer and the benefit of the multilayer is there is no need to used jumper. In our circuit we used one or two jumper.

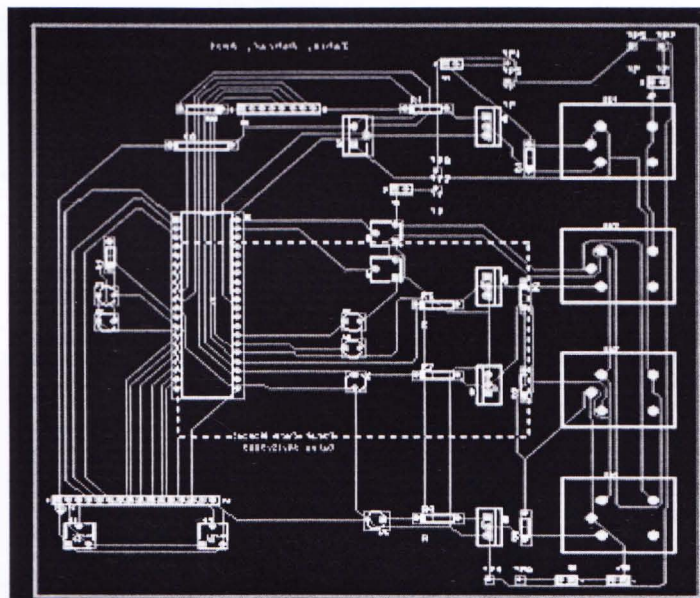


Figure 15: The final stage of routing of layout.

5. FINAL IMPLEMENTATION

5.1. Materials Description

Here we implemented the main project circuit in PCB board which we design in previously. Here we used some list of components which given below:

NO:	Name or Model No:	Quantity:
01	Microcontroller (ATMEGA32)	01
02	SPDT Relay	04
03	BD135	04
04	LED	04
05	Diode	04
06	Crystal 12MHz	01
07	Resistor 1K	04
08	Capacitors 22p	02
09	POT 100K	02
10	POT 1K	02
11	DC Motor	01

Table 5: Table for Materials List.

5.2. Motor and LCD Display

DC MOTOR

A DC motor is an electric motor that runs on direct current (DC) electricity. It works by converting electric power into mechanical work. This is accomplished by forcing current through a coil and producing a magnetic field that spins the motor. The simplest DC motor is a single coil apparatus, used here to discuss the DC motor theory.

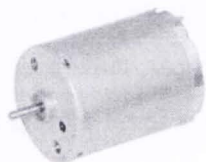


Figure: DC motor

Line LCD Display

We used GDM1602A 16*2 line LCD display for observing the Battery charging percentage. It has some feature such as;

1. 5X8 dots with cursor

2. Built-in controller (KS0066U or Equivalent)
3. +5V power supply (Also available for +3.0V)
4. 1/16 duty cycle
5. BKL to be driven by pin1, pin2, or pin15, pin16 or A,K
6. N.V.optional



Figure 16: GDM1602A Display.

5.3. In the final Implement

After putting those element in main PCB board we completing the soldering. Here for getting supply from battery A and B we took two UPS battery. Those are stay in lab as unused. And for supply from solar panel we used A DC power supply as solar panel. Then observing the final output we used a DC motor. Which operate by 12V DC supply. Here we used 2 variable resistances POT of 100k for controlling the load and by this we show that our battery voltage percentage how decreases or increase. Because it very difficult in presentation for showing that how battery will decrease or increase its voltage level sequentially. Because it will take times so it is not possible for viewer to stay for long time for observing these things. So we used those POT. We also used another 10K POT for controlling the LCD display.

In practical presentation we controlling those 100K resistance and how satisfy our condition by hole circuit it will shows. Here when we POT value of respective battery will increase the respective battery will shows the low charge level and by keeping the others respective POT value of respective battery in low the motor will operate by second battery. By doing the same vice versa things we will show that the motor now operate by first battery.

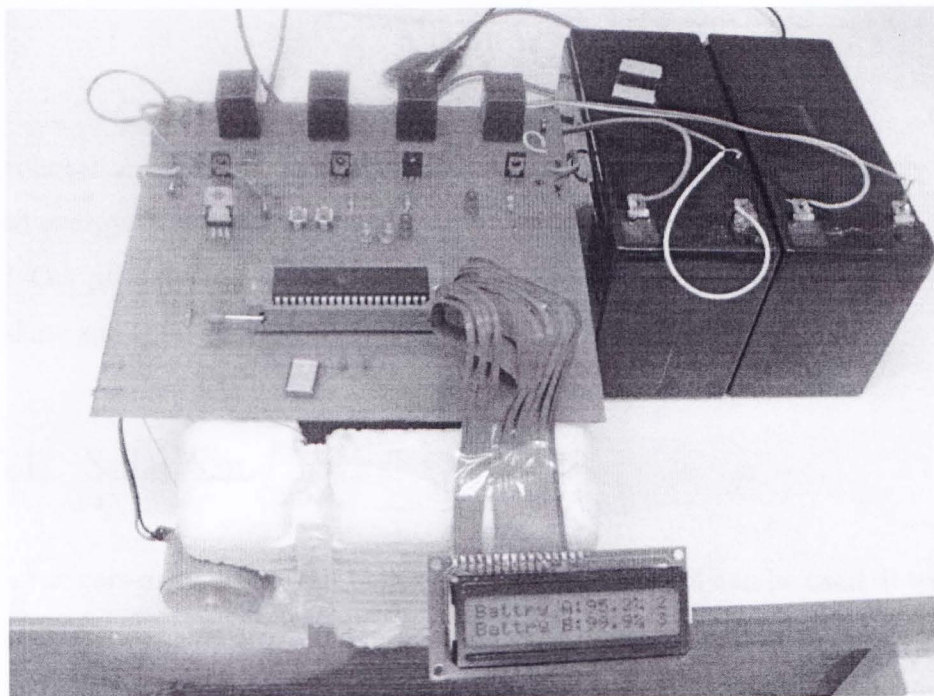


Figure 17: The final Implementation Circuit.

5.4. Electronic Reliability

One reason of electronic malfunction is unexpected behavior for power management. To ensure this problem in our project we used power IC for supplying the necessary voltage for microcontroller operation.

6. APPLICATION

This project proposes an algorithm to manage a battery powered by renewable energy sources, such as solar or wind energy. This system can be used in various applications where renewable energy can be utilized. Our primary considerations for application have been limited solar powered electrical rickshaw and solar powered lightweight boat.

6.1. Solar Car / Rickshaw

In solar energy run cars or rickshaw our battery management system can be used. It will be very cost effective and efficient and also environment friendly. The rickshaw will go on to the street running on battery A, as rickshaw will be running from battery power so first at least one battery or battery A has to be fully charged to supply enough power to run the rickshaw motor. As battery A loses charge below 30, the circuit switches to battery B, while the solar panels charge up the battery A. There will be indicators on the driver's panel with digital view for speed, battery power levels and estimated running time. These indicators on the driver's panel will let the driver know the charge levels of the batteries. Then indicator on the panel will let the driver know how much driving time the rickshaw has. Based on available power he will determine when he should stop his rickshaw. If the solar power charge up is slow, that will also make the charging of the batteries slow.

For solar rickshaws, the roads will also have to be smooth. The purpose is to cause minimum power loss of the battery by minimizing abrupt movements of the solar rickshaw on the road, because the more resistance on the road more power will be lost. And another thing is that solar rickshaw or car will have to be light as well for our circuit. If some changes done in relays and other switches of the circuit and with wider area solar panel it will be then good enough to handle heavier vehicles. Here main problem we faced that how we manage for maintaining the vehicles motor by our battery output through a inverter. Because those type of vehicles motor have a lot of torque, so we need to use high rated inverter for operating the vehicles.

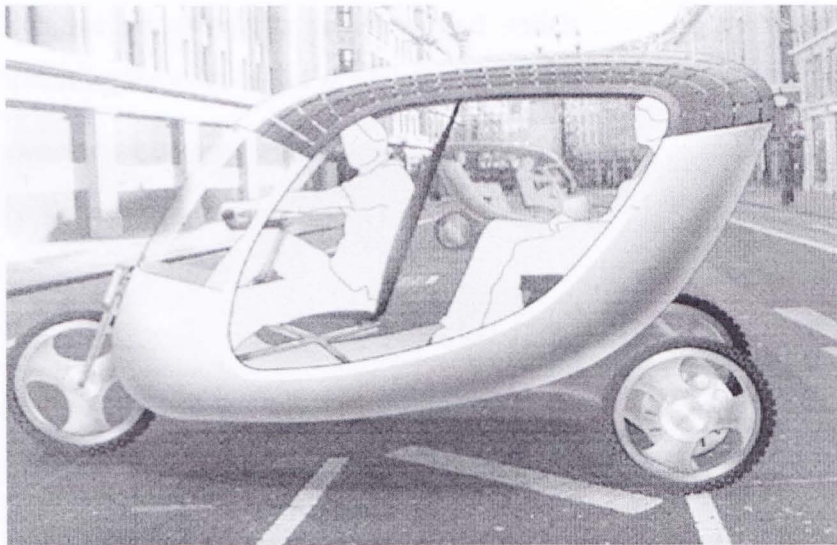


Figure 18: model picture of solar rickshaw.

6.2. Solar Boat

In solar boats our power management system can be utilized. And we think it will be very efficient for solar boats, and our battery management system could be very vital as back up of energy is very crucial in open water like river, where no energy backup could bring disaster. So a back up of energy is absolutely vital on water as there could be sudden change in the weather or bad light may appear, so backup is a must. And it will also be very eco friendly especially for the water environment and water species. The idea is to run the boat with solar power.

The boat will run on battery A. same as rickshaw, the boat will be run based on the available power in the batteries. If the solar intensity is low, the charge up of batteries is slow, and then the boat will automatically reduce its speed to adjust itself to the available power. This is because we do not want to drain the battery more than a safe amount otherwise the boat might be stuck in the middle of a river or lake. In the boat there will also be a digital view on drivers panel to monitor speed, battery power levels and estimated running times. On water estimated running times shown on the digital display will be measured on the basis of battery power levels and solar intensity-this is absolutely vital for boat on water so that driver can make wise decision on where to stop boat and also at which speed he should be running the boat. In boat have such type of diesel engine for operating the high rated motor those used for rotating the boat's wheel. So here we mainly faced the problem for

replacing those diesel engine for using the battery output which charging by solar. And how we setup the inverter for operating the boat motor it's a huge issue.

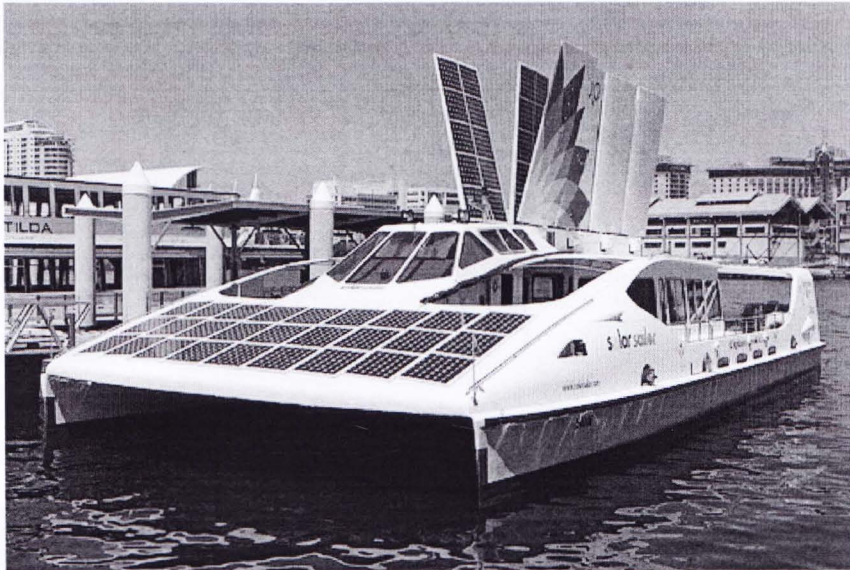


Figure 19: model picture of solar boat.

In the context of global warming, world is now well aware of implementing renewable energy like Solar or Wind to reduce CO₂ omission. In that case proper or efficient management of renewable power will be absolutely crucial. Our power management system can serve the purpose of better management of solar or renewable power.

So in every area of life where there is dependence of power, our battery management system can be very effective for better management of Solar Power, because better management is absolutely vital to have the option of a ENERGY RESERVOIR as backup as the amount of electricity we get from solar or renewable energy is not huge, and also the fact that solar energy is depended on weather condition, so backup of energy is crucial. Our proposed application area of solar rickshaw or solar boat can very effectively serve the purpose of reduce CO₂ omission-which will serve the purpose of the world going green [4].

Our system can also be used for below purposes:

1. Our Power management circuit can be used for small and medium load solar vehicles on the street or in water to run small boats.
2. We can use this to heat water which is a daily necessity of our life.

3. This system can also be utilized for pumping the paddy fields of our country. In that case we may need to use more batteries or battery with high voltage.
4. This can also be used for room appliances which are run by electricity.
5. We can use this technology for cooking purpose also (like microwave oven) which will definitely reduce a huge amount of CO₂ omission in our country [5].

7. DISCUSSION AND CONCLUSION

In a country like ours it is good news that solar and other renewable energy is getting a lot of attention and is looked into for rigorous implementation. In the future the need to utilize solar power will become more and more critical. So we developed this battery management system which we think if implemented will make renewable energy more appealing for use in our country in many ways. Not only in our country can this system be implemented but all over the world where renewable energy such as sun light is reliably and abundantly available. Our proposed application area of transport on highway or water can have very significant impact on environment, cost and other vital areas of our life. With some modification on our system this could be use for higher load or our energy backup reservoir can be made bigger by more batteries for serving higher power demand. So one of the most vital issue of the world today that going green regarding energy, this could be implemented by solar and solar can be more useful by better management. And our battery power management system offers better power management for solar systems. The system can also be easily modified and updated for use in many fields that has already been discussed previously in the future work section. With easy modification this system can be applicable for newly or upcoming technologies also, as the basic purpose of our system is to have options of energy storage for better solar energy management which we did by developing an algorithm or an equation that we put in the microcontroller as a code, so for various purposes this code can be changed or modified according to the requirements of that particular purpose. That summarizes our effort-algorithm for better power or battery management for proper management of batteries which will open a door for faster implementation of renewable energy like solar in various aspect of our life.

8. FUTURE WORK

1. If we use components such as switches and batteries that is more better with performance and microcontroller with faster decision output our system could have been more efficient.
2. Our System initially was a combinational circuit which we then converted into a code for the microcontroller. The equations we developed for the combinational circuit were for controlling two batteries, but by developing equations for more batteries and using higher capacity components and switches or relays we can make it usable for higher loads.
3. To implement our system on road the road has to smoother enough to cause less jerking to minimize abrupt movements of the vehicle which could damage our system. By adding automated control circuit with our system these abrupt change in movements can be minimized.
4. On water the idea of back up energy is vital but our circuit provides backup for one extra battery which may not be sufficient always, our system needs to redefine for the control of more than two batteries.
5. Those places where sun light is not available or not sufficient enough to produce enough electricity our system would show some limitation and pressure on battery can be a factor there for constant swapping. In this regards better algorithm could be used.
6. Our system is not appropriate to control asynchronous power generator like windmill. We hope to work on that on future.
7. Our system is about battery management of power generated from solar and we think this can be used in solar run systems on space where energy backup and management is vital. We hope to work on that on future.

Undergraduate Thesis

8. On paddy fields or in production of other crops water irrigation is absolutely vital. Our power management system can be used in running pumps by solar power.
9. Our system can be used for running some home appliances using renewable energy with some modifications that is with better shape in size to be easily installed or integrated with solar panel or home appliances.
10. Our battery management systems can also be installed in solar water heating, which includes integrated collector storage systems, air systems, direct circulation and indirect water heating systems with some changes reflecting initial design requirements for these kinds of systems.
11. With modification that is with knowing exact requirement it can be used in Industrial process heat systems, which include both low temperature (air and water based) applications and solar steam generation systems-the changes can come into microcontroller code or components with higher capacity or both. These could very cost effective for the industries as solar is absolutely free.
12. By updating our system in relay and coding our system can be implemented in solar power stations also where high voltage batteries can be used and managed by our system.

9. REFERENCE

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- [4] A. Shrinath and A. Emadi, "Electronic control units for automotive electrical power systems: communication and networks," *Journal of Automobile Engineering*, Proceedings of the Institution of Mechanical Engineers, vol. 218, Part D, pp. 1217-1230, Dec. 2004.
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10. APPENDIX A: PROTEUS

The tool Proteus was used to model and simulate the circuit to ensure its design correctness and the microcontroller code accuracy. It is critical that the complete is tested before the actual circuit board with components is built.

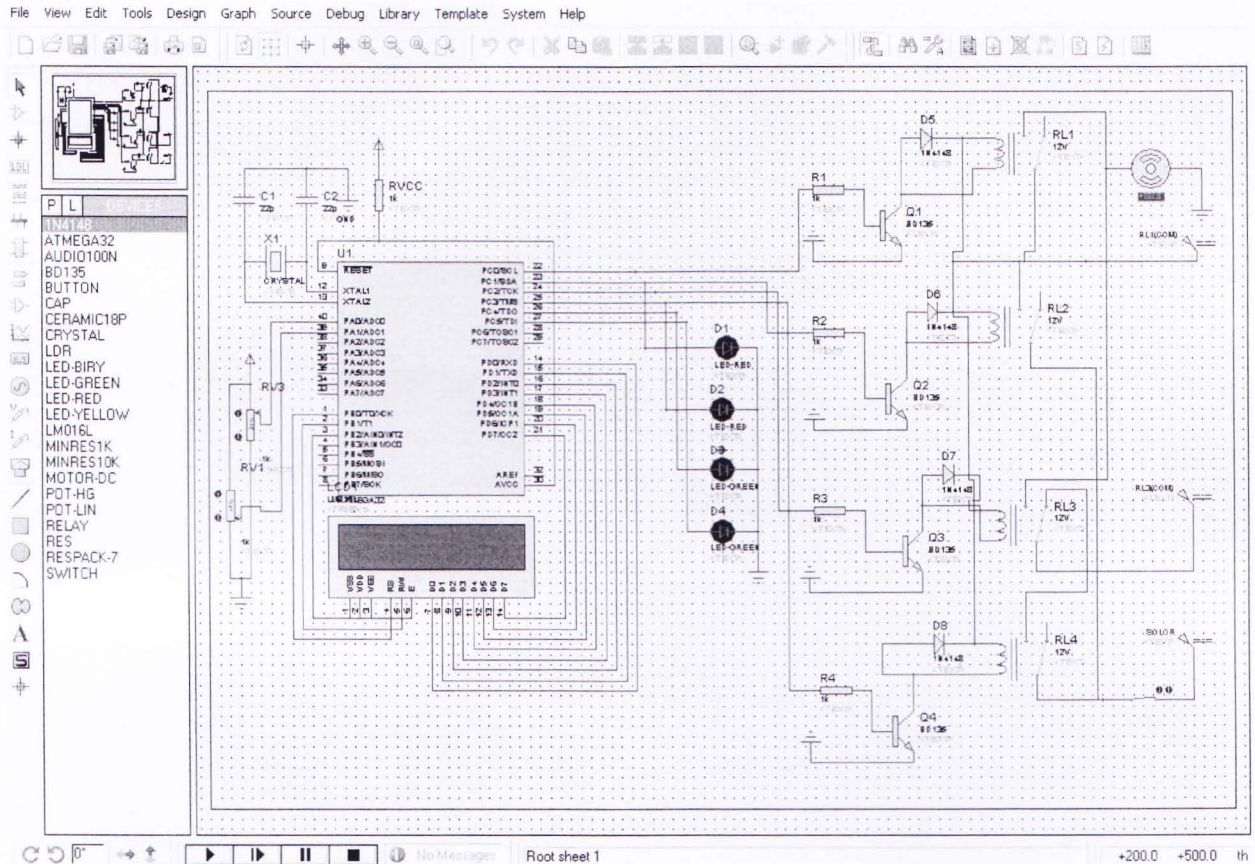


Figure 20: appendix picture from Proteus.

The above figure shows the schematic diagram of our circuit before running the simulation. Here we connected all of necessary component for observing the simulation result.