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Energy Meter Design to reduce Power Consumption

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Abstract

The present major challenge facing our nation is the inability to supply the power demand. Preserving power is as important as producing power. Hence, the primary aim of the paper is to provide an efficient technique to preserve/ save power. The paper deals with the use of a psychological technique - if a person is aware of the energy consumption (in terms of capital), the person would certainly try to reduce the cost which in turn would reduce the power consumption. For this purpose, the paper proposes an Energy meter design which is used to display the cost and energy consumption of each and every port of the network i.e. (each and every switch in a room of a house). The above said design is implemented by making use of the applications of digital logic circuits. This also helps to avoid any fraudulent practice. For enhanced convenience, the system can be designed in such a manner that the user automatically gets updated with the power consumption in their mobile device with the use of GSM technology.

Keywords

Energy meter, Database, Sequence decoding, cost and time calculation.

1. Introduction

The proposed energy meter is primarily designed to bring awareness to the people about the power consumption of each device so that they could manage the use effectively. The users, practically, would be stringent and more careful in their power consumption if they are made aware of their energy consumption. In this proposed energy meter design, certain logic has been adapted for the calculation of power consumption of each and every device [1], [2].

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2. Disadvantages of prevalent energy meter system

The energy meter which is currently being employed has a significant disadvantage. The prevalent energy meter is capable of calculating only the total number of units consumed in a household. The user is seldom aware of the energy consumed by each of the equipment in the house and hence often has no control over the energy consumption.

3. Advantages of proposed system

To overcome the disadvantages of the prevalent system, we suggest the use of proposed energy meter design. The proposed system primarily focuses on calculating the energy consumed by each and every device in the house which in turn enables the user to have knowledge about the same. Thus the proposed system, rather than using techniques to generate energy, focuses on conserving the prevalent energy efficiently [3].

4. Scenario

Consider a house in which there are four rooms. Let those be notated as R1, R2, R3 and R4. Let the switch boards in each room be SB1, SB2, SB3 and SB4 respectively. The number of switches in the switch circuit is considered to be three in this case and named as 1 , 2 and 3 for switchboard 1(SB1) in the room R1. Similarly, the other switches are named as (4, 5, 6), (7, 8, 9) and (10, 11, 12) for other switchboards in the respective rooms.

The considerations are:

- We have one energy meter per house which has a micro controller coupled to it.
- All the rooms have switches which are predefined [11].

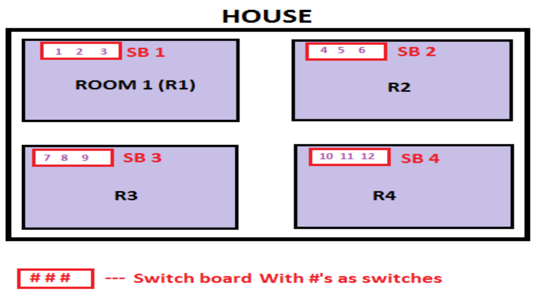

Figure 1: Overall Diagram.

In the display section of energy meter, we have all the ports of network defined. An option to take a hard copy of the bill for each and every month has also been provided on the condition that the hard copy is generated only on the first day of every month which eliminates the process of billing (explained in detail below).

5. Database creation

- First step is the identification of number of rooms in the house. This corresponds to the first class of division.
- Each room is assigned a unique name such as hall, bedroom1, bedroom2, Kitchen, etc.
- The next step is to find the number of switch boards in each room. This gives the number of ports that the processor should contain. Example: Suppose if the number of switch boards in each room be as follows: Hall=2, bedroom1=2, bedroom2 =3, kitchen=1.
- Then the naming of switch boards will be in the following manner: hall_board1, hall_board2, bed_room1_board1 and so on.

6. Internal Circuit

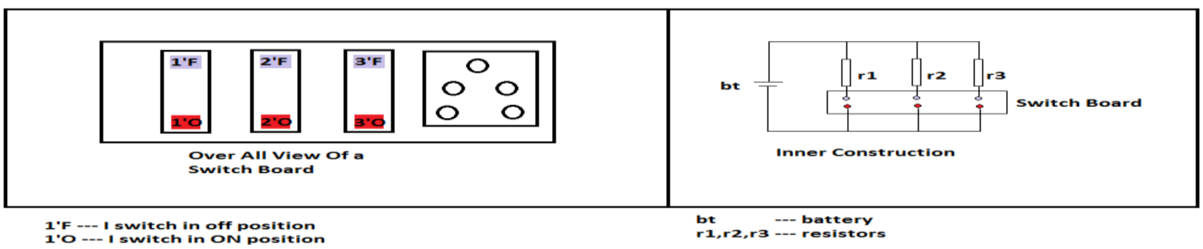

Figure 2: Internal Circuit.

In the left half of the diagram, we have shown the general switch board in a room (say SB1 in R1). Let us assume that switches 1, 2 and 3 represent tube light, fan and external port respectively. The violet box represents OFF terminal of the switch and the red box represents ON terminal. When the user turns ON the switch, the switch would be in the position 1'O (first switch ON) (similarly 1'F if the first switch is OFF). We need a configuration of the switches as shown in right side of the figure. We have a branch in which a suitable resistor and two terminals of the switch are attached as shown in the figure 2. (r1 resistor: violet dot indicates OFF terminal and red dot indicates ON terminal) . Each branch corresponds to a switch and hence according to this example, there are three such branches connected in parallel to a voltage source. Such an arrangement is required for the decoding of the sequence which is explained below [3].

Identification of switch board:

1. Each port (switch board) is assigned a separate memory location to store its data and other functions that need to be executed based on the changes.
2. The first identification required is to find if there is any change in sequence of the code sent to the port. This sequence corresponds to the state of operation (i.e. ON or OFF) of the equipments present.
3. If it identifies any change, then the switch board has to be identified accordingly.
4. Based on this, it has to direct the new sequence to the memory and the program allotted to the corresponding port.

Program

Begin:
{

```
Compare(sequence1old==sequence1new)
if(same)
no action;
else goto 1:
….
Compare(sequenceN old==sequenceN new)
….
Switch(n)
{
Case 1: program for switch board 1
….
Case n: program for switch board n
Default go to begin
}
}
```

7. Decoding of sequence

In figure 3, consider case (1). We consider one switch to be closed which is represented with a short circuit of violet and red dots. When there is a closed path in the loop, current I1 flows as shown in case (2) due to the voltage source connected. Considering the above circuit, the bus of three wires is connected and this bus is now coupled to the microcontroller. As there is a current flow, the bus carries the current which is represented as 1 (digital representation). The number of arrays is proportional to the number of rooms and number of array elements is proportional to the devices (read switches). When the switch is ON, the corresponding wire of the bus goes to high state. Subsequently the array stores the value 1. Therefore an array is formed as shown in the figure 3. Similarly in case (2), considering the two switches are ON, the respective two arrays are represented as ‘1’ [2], [3].

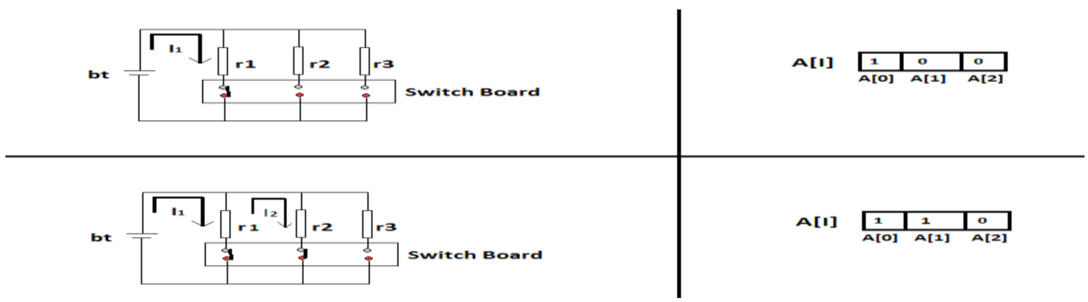

Figure 3: Circuit diagram.

8. Calculation of time

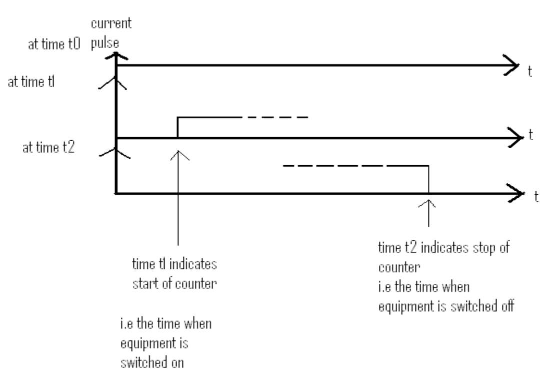

Figure 4: Time graph.

Assume the initial condition as t0. It is defined as the time when all the switches are in the OFF position. The time when a change happens from the OFF to ON state is indicated by time t1. This indicates the time at which the timer has to be started. The counting of timer is continued till the time t2. It indicates the time when the state of switch changes from ON to OFF state. The counter thus indicates the time for which the equipment is switched ON. It is indicated by the difference between t2 and t1 [1], [4].

9. Cost Calculation

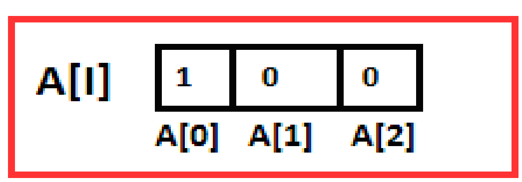

Figure 5: Array.

Let us assume that switches 1, 2 and 3 represent tube light, fan and external port respectively.
From the above figure,
A[0] = 1; A[1] = A[2] = 0;
Therefore, Tube light is at ON position.
We know that the Tube light consumes 40 W of power.

10. Identification of cost

1. This part of the program is executed only when there is a change in the sequence.
2. When there is a change in current I, it indicates the change in position of the switch (ON or OFF)
3. Suppose if they are switched ON, the timer associated with the switch has to start or if equipment is switched OFF, the timer has to be correspondingly turned off.
4. A delay program has been used to count an interval of 1 second.

The delay program is executed continuously as long as there is no change in the state of the switch after it has been switched ON.
Let's assume that the tube light is in ON state for a time period of 1 hour (calculated from the delay program using static variable j1).
Energy consumed (KWhr) = Power*time
Number of units per month = 40*1hr*10-3 * 30 days = 1.2 units/month.
Cost calculation can be done based on the norms of the state/country [8], [9], [10].

Program for Switch Board 1

```
Sequence = QWERTY // Q=W=E=R=T=Y= 0 OR 1
{assign(A[1]=Q;A[2]=W;--------A[6]=Y)}
Compare(A[1].OLD==A[1].NEW)
{
if same
No action
else
if(A[1].NEW==1)
Start counter
Until A[1].NEW==1
{
call delay
Time=time +1
}
}
….
Compare(A[N].OLD==A[N].NEW)
….
}
```

11. Flowchart for Energy meter design

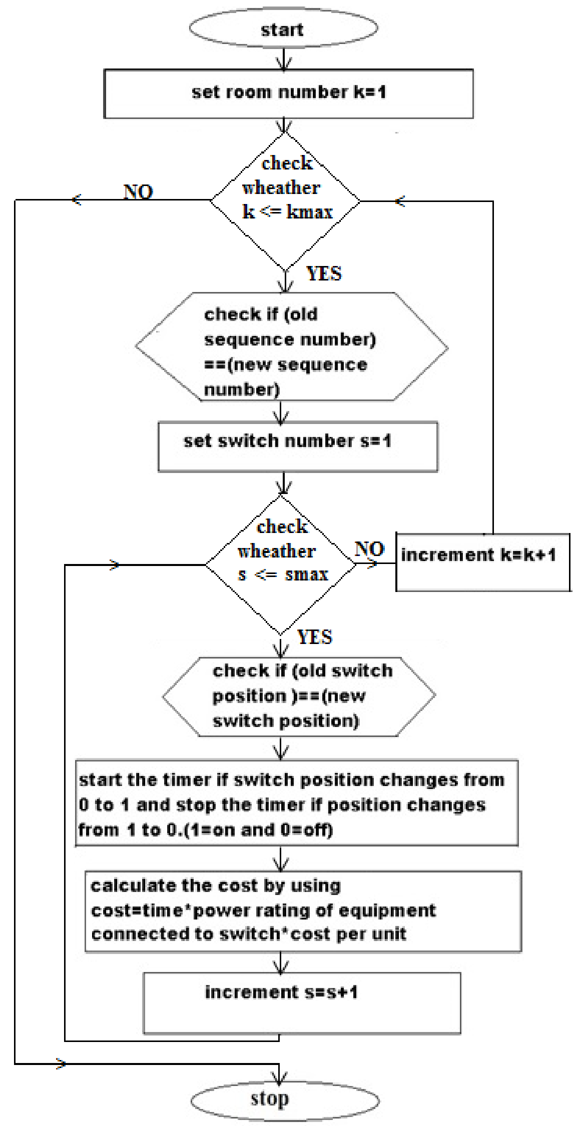

Figure 6: Flowchart for Energy meter design.

12. Conclusion

Thus with the proposed system of energy meter design, the user can be aware of the power consumption of each and every device in the house. As a result, the user can manage the consumption of energy effectively. Also, the prevalent energy meter system is capable of calculating only the total number of units consumed in a household and hence the user often has no control over the energy consumption. The proposed system would overcome these disadvantages and act as an efficient tool to conserve the prevalent energy.

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