A 64-Point Community Electronic Route Indicator.

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ABSTRACT

It has been observed over the course of many years that visitors to new towns and communities, such as a University campus, have had difficulties in finding their directions, thus making it time-consuming for them to get to their destinations. This project was undertaken to alleviate difficulties experienced by such people who have problems finding their bearings. A portable system was built on which the map of the community (specifically the author's university) was imposed. The various principal landmarks of the university were indicated on this system by means of Light Emitting Diodes (LED). Combinations of these diodes light up to indicate the routes to such landmarks as the user requests. The lighting of the diodes is controlled by a program that is resident in the program memory of a microcontroller. Early tests of the system indicate that first time visitors find it much more convenient to move about the campus without the need of intermittently asking their ways from passersby. This system can be easily extended to cover much larger communities.

(Keywords: electronic display, direction finder, route indicator, microcontroller, information kiosk)

INTRODUCTION

The electronic route indicator that has been developed in this project is a battery-powered portable system that can be used as a location finder. It has been designed for the author's university which has a size of over 200 hectares of land. The principal landmarks and buildings of the university are scattered all over this mass of land. This fact usually makes it difficult for first-time visitors, or those not well acquainted with the campus, and they have to resort to asking passersby series of questions in order to be able to get to their desired destinations, thus wasting valuable time.

The system described in this project has been designed to have a simple interface in order to eliminate usability problems. Its operation is also simple thus taking into cognizance the fact that not all visitors to the university need have a high level of literacy in order to interact with the system. Although this system has been designed for the university using only twelve locations, its firmware and hardware can easily be upgraded to cover other places such as large industrial layouts, wild life parks, large office complexes and towns where a maximum of sixty four locations may suffice to clearly indicate destinations to the user. In much larger cities with complex interconnections of streets and very many important locations, a GPS-based system may be more convenient [1], [2]. An algorithm of a system for finding the best route between two points in a city is discussed in [3].

MATERIALS AND METHODS

Twelve principal locations shown in Table 1 were identified; these are the locations most visited for various transactions by visitors to the university. These locations are then plotted on the site location map of the university as shown in Figure 1. Principal junctions on the site location map are illuminated with light emitting diodes (LED).

Table 1: Principal University Locations.

S/No	Location	Acronym
1	Administrative Block	ADM
2	Engineering Complex	ECM
3	Animal Production	ANP
4	Alfred Torkula Hall	ALF
5	University Clinic	UCL
6	Vice Chancellor's Lodge	VCL
7	College of Food Science and Technology	FST
8	Staff Quarters	STQ
9	University Gate	UGT
10	Academic Block	ACB
11	Students' Hostel	STH
12	University Water Works	UWW
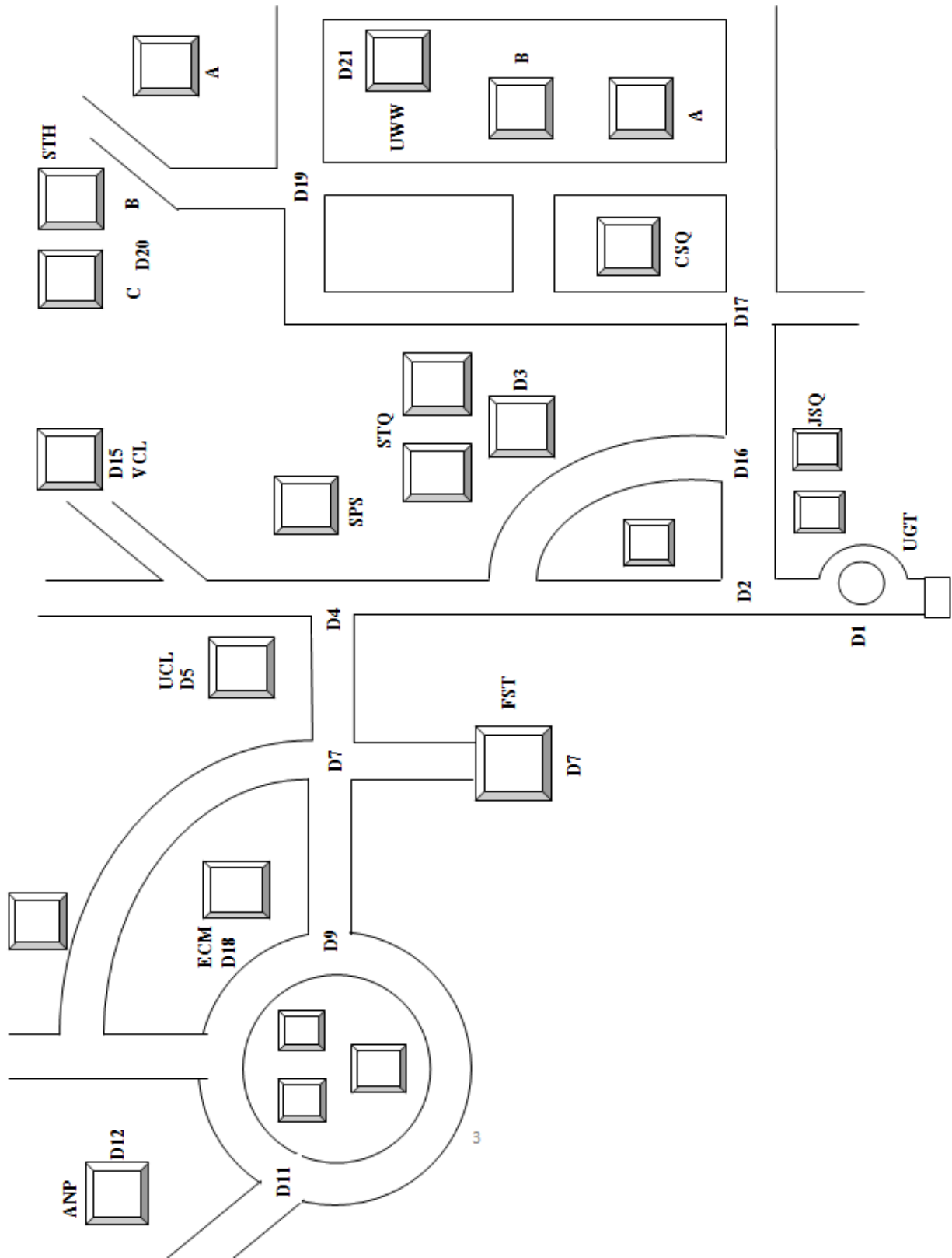
Figure 1: Site Location Map of the University of Agriculture Makurdi.

Block Diagram

The block diagram of the electronic route indicator is shown in Figure 2. It consists of Location/Destination switches, LEDs, and a microcontroller. The microcontroller used for the project is the PICI8F4680 [4] which has up to five Input/output ports. The microcontroller typically waits for the pressing of Location/Destination switches by the user and then, using the program in its memory, determines the sequence of LEDs that should be lit up for the user to get to his destination

The Location/Destination switches and the Location/Destination LEDs are each interconnected in a matrix form to the microcontroller through two 8-bit ports. This makes it possible for this route indicator to access a maximum of 64 Location/Destination switches and to drive up to 64 Location/Destination LEDs.
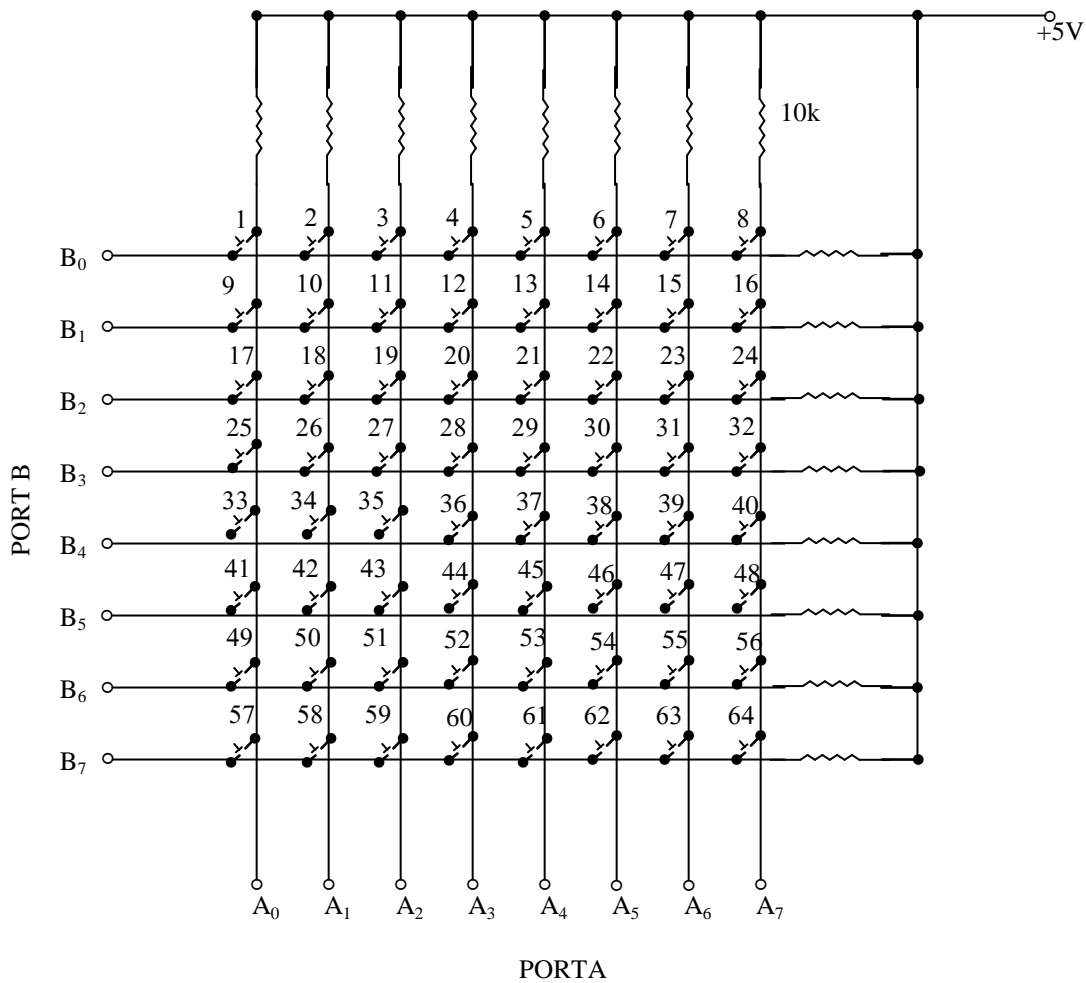
Location/Destination Switches

Although only 12 locations have been used in this project, the matrix connection of the Location/Destination switches to the two 8-bit ports of the microcontroller as shown in Figure 3 makes it possible for a total of 64 locations to be monitored. In the scheme depicted in Figure 3, the row lines of the Location/Destination switches are connected to PORTB of the microcontroller, which is configured as an output port while the column lines are connected to PORTA that is now configured as an input port. Zeros are output on all row lines. The column lines on PORTA are read and checked for zeros. A zero indicates a pressed switch. The program that scans the switches loops until it finds all switches open before accepting a pressed switch. When the switches are found all open, the program loops looking for a pressed switch. If a pressed switch is found, the program calls for a 20ms delay to give the switch time to stop bouncing.

The switch that was pressed is found by putting a zero on the first row and 1's on all the others; then the columns are read and checked for a zero. If no zero is found, the pressed switch must not be in that row, so the zero is rotated into the next row and the columns are rechecked. If a zero is found in a column then the position of the switch, which is determined by the combination of the row and column codes, is stored [5].
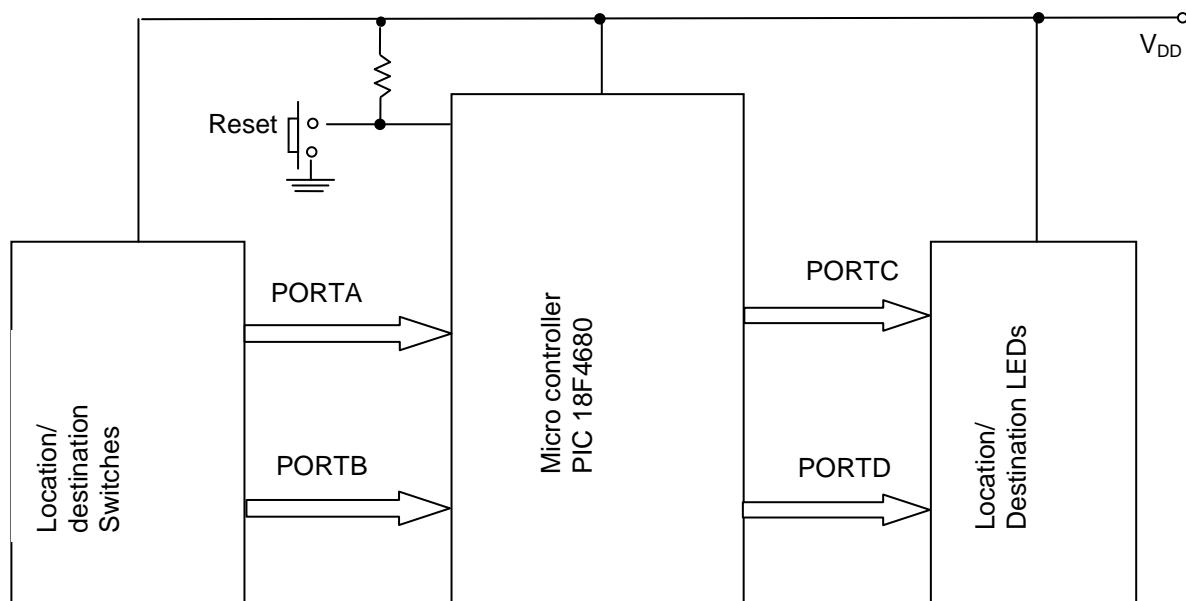
**Figure 2:** Block Diagram of Electronic Route Indicator.

Figure 3: Destination/Location Switches Connected in Matrix Form.

The first switch pressed by the user indicates his location. The user then presses the second switch which represents the destination to which he wants to go. If the location and destination switches are different then a set of LEDs along the path from the location to the destination are lit up showing the user the path to follow. If the same switch is pressed twice, in other words if the location and the destination switch is the same, the route indicator emits an audible sound to warn the user of an error. A flow chart that depicts the pressing of a location switch, and all possible destination switches, is shown in Figure 4. All the twelve locations have similar flow charts.

Location/Destination LEDs

The electronic route indicator uses 21 light emitting diodes (LEDs) which are placed at important junctions and locations on the map to show the user the path he must take to get from his location to the desired destination. The matrix connection of the Location/Destination LEDs to the two ports of the microcontroller is depicted in Figure 5.

Once any of the PORTC row lines (C0 – C7) is pulled low the LEDs (L1 – L8) can light up if any of the corresponding PORTD lines (D_0-D_7) is also pulled low. Any particular LED can be turned on or off since each line of PORTC or PORTD can be individually controlled.
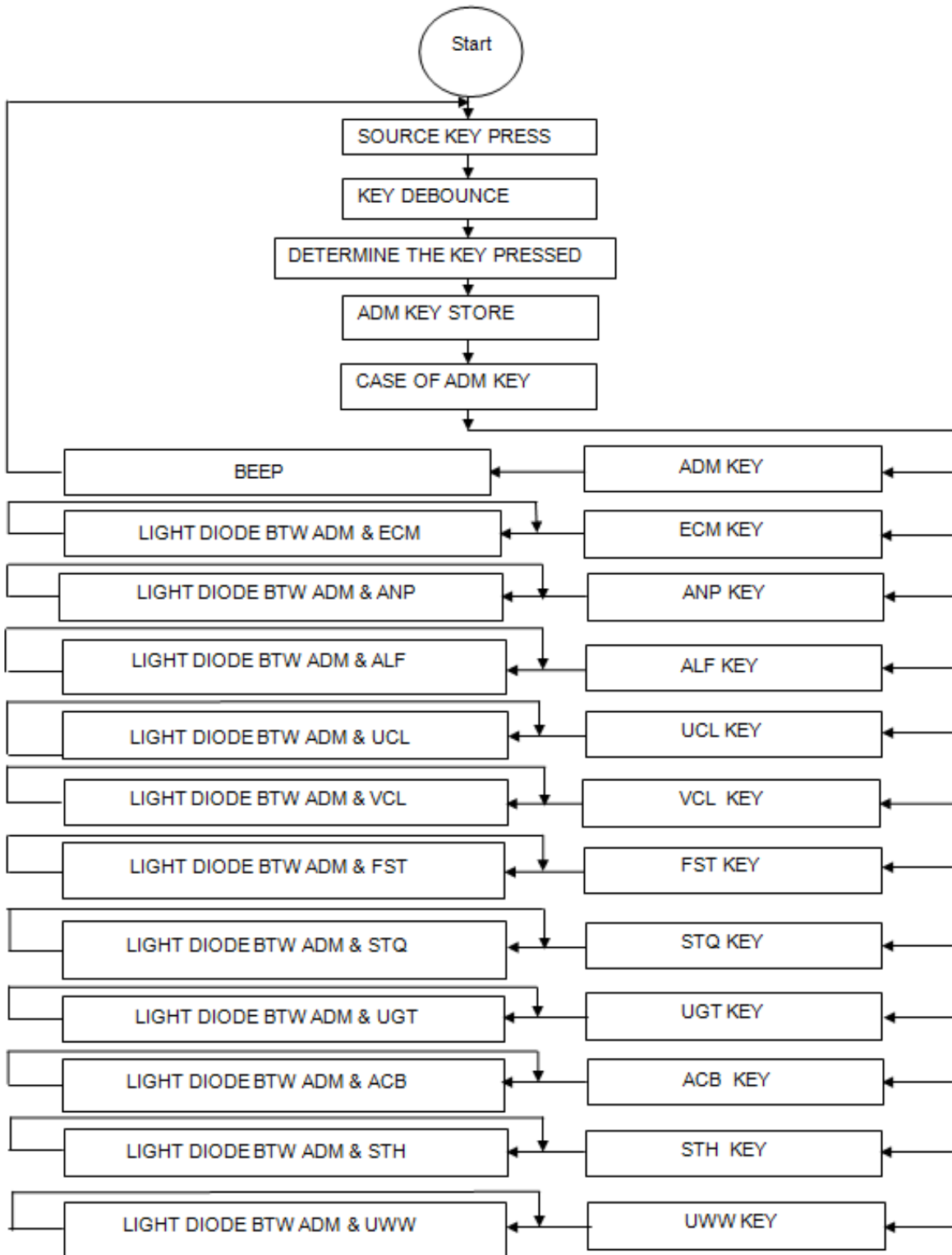
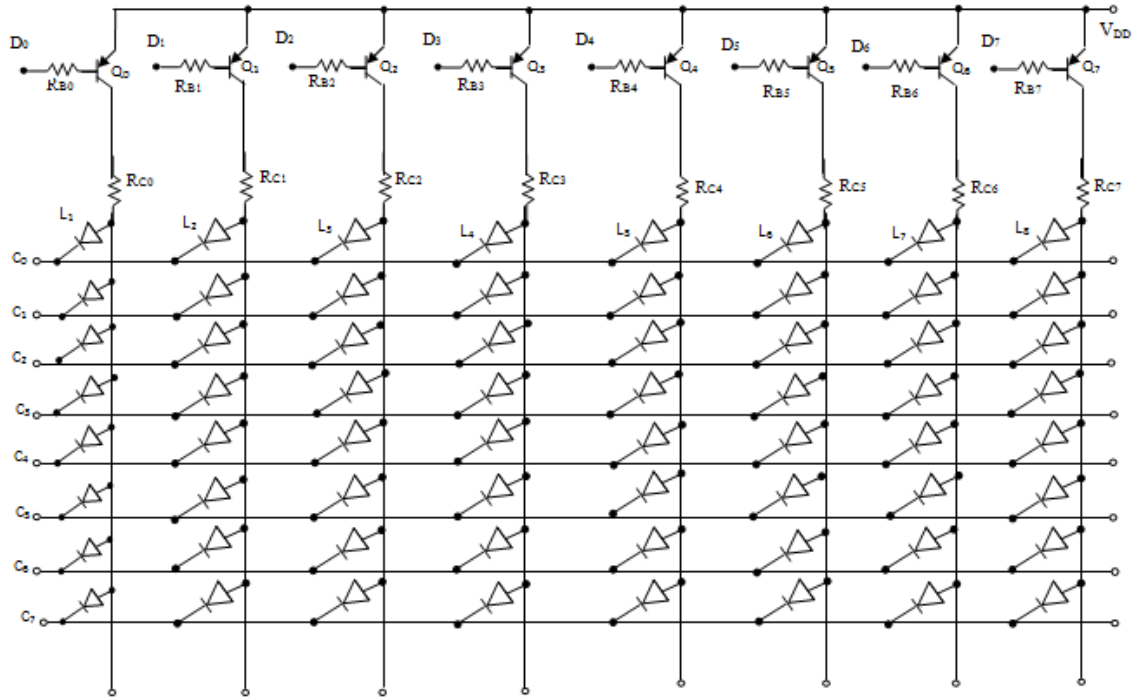**Figure 4:** Flow Chart for Selection of ADM Location Switch

Figure 5: LED Driver Matrix.

Table 2: States of LEDs When Location ADM BLK is Selected.

Location	Destination	LED Diodes States (0 = OFF, 1 = ON)																				
		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21
ADM																						
	ECM	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	ANP	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
	ALF	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
	UCL	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	VCL	0	0	0	1	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0
	FST	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	STQ	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	UGT	1	1	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	ACB	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0
	STH	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	1	1	0	1	1	0
	UWW	0	1	0	1	0	1	0	0	1	1	0	0	0	0	0	1	1	0	1	0	1

The pnp driver transistors are necessary in case all diodes connected to a column are simultaneously turned on which might exceed the drive requirement of a microcontroller port pin. The values of the base resistors and the collector resistors of the transistors must be chosen so that, for instance, [6, 7]:

$$R_{B0} < \frac{\beta_F R_{C0}(V_{DD} - |V_{BESat}|)}{V_{DD} - |V_{CESat}| - V_D} \quad .. \quad .. \quad ..(1)$$

In Equality (1) and Equation (2) β_F is the transistor's dc current gain, V_{BESat} and V_{CESat} are respective saturation values and V_D is the voltage drop across the LED When it is in the on state.

The current flowing in each LED is given in Equation (2) as I_D:

$$R_{C0} = \frac{V_{DD} - |V_{CESat}| - V_D}{8I_D} \quad . \quad . \quad . \quad (2)$$

States of the Diodes

When a destination switch that is different from a location switch has been pressed a combination of diodes, as shown on the site location map (Figure 1), is lit up. These combinations for each location and corresponding destinations must be determined before the firmware is written. Table 2 shows the states of diodes for the location ADM (Administrative Block) and for all possible destinations. Similar tables are obtained for all locations and all corresponding possible destinations.

Assembly Language Program

The program for the electronic route indicator monitors the Location/Destination switches when the microcontroller is powered on. The program uses the particular subroutine for a location switch pressed (such as Figure 4) to determine the combination of diodes to turn on (Table 2). The program was written in assembly language using the instruction set of the microcontroller PIC18F4680 [4] and the MPLAB IDE [8]. The program was software-debugged using the MPLAB SIM [8] that is integrated into the MPLAB IDE. Hardware debugging was carried out using the MPLAB ICD 2 [9] after the microcontroller had

been programmed. The development process is shown in the picture of Figure 6.

Figure 6: Testing the Circuit of the Electronic Route Indicator.

RESULTS

The operation of the electronic route indicator was first simulated in the software environment using the simulator of the MPLAB IDE. Before the construction of the hardware was undertaken a thorough simulation was done using the Proteus Virtual System Modeling (VSM) environment version 7.7 [10]. Following a satisfactory software performance, the hardware was built (Figure 6) and the lighting of the LEDs to indicate the paths of choice was observed to be correct.

CONCLUSION

A low-cost portable battery-powered electronic route indicator has been described. This electronic direction- indication system can have 64 locations and 64 LEDs to indicate the path that a user must take to find his way. It can be typically useful in a university campus, wildlife park, or in a town where the number of locations needed to properly navigate through the town is not excessive.

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