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A Directional Indicator with a Symbol based Interface for Improvised Safety-Enhanced Directional Indicators using Matrix LED

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***Abstract*— The system developed is an ideal replacement for the conventional directional indicators in automobiles. With conventional indicators a blink of light is used as a signal to indicate the turn taken by the vehicle, this is the case even if the vehicle takes a U-turn. The problem is that people tending to take a U-turn find it difficult as the vehicles approaching behind them get confused whether they are turning or taking a U-turn which creates havoc in rush hours. This problem is addressed by our system that uses a matrix LED to display an appropriate symbol by powering up the necessary bulbs to indicate whether the vehicle is taking a U-turn or just a regular turn.**

Keywords—Directional Indicator; automobile safety; Arduino;

I. INTRODUCTION

In automobiles from time immemorial, lights have played a significant role in representing the vehicles location, brakes applied, approach and so on. This is represented by the term Conspicuity. Conspicuity equipment are the lights and reflectors that make a vehicle discernible with respect to its presence, position, direction of travel, change in direction or deceleration. In olden days automobiles used gas lamps for lighting but with the advancement of technology gas lamps have been replaced by incandescent bulbs, the latest trend is the use of LED's for better visibility. The directional indicator play an essential role in vehicle's safety as they indicate a vehicle's turn in advance so that other vehicles may give way.

II. INCONSISTENCY OF CONVENTIONAL INDICATORS

The conventional indication system uses a blinking light that generally conveys the following vehicles and on-comers that the vehicle is going to take a turn this is good, but the real problem arises when the vehicle is taking a U-turn as the driver of the following vehicle cannot predict the directional turn of the forward vehicle tending to cause a collisions and traffic jams during rush hours. This seems to be a major problem in most populous countries where the smooth flow of traffic seems to be impossible. With narrow lanes and insensitivity of drivers making a U-turn can really be a nerve wracking experience.

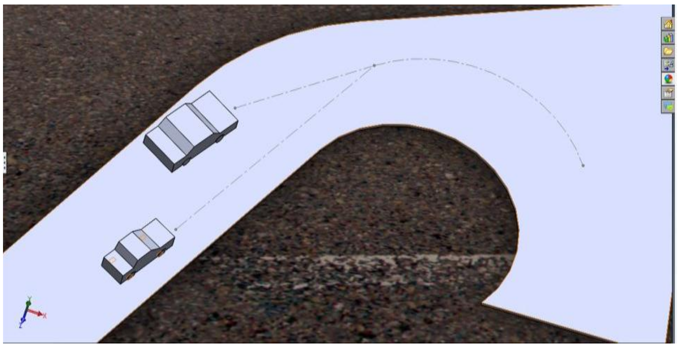

Fig 2.1 (Conventional System-screenshot from Solidworks)

The above picture clearly depicts the problem faced with the conventional directional indicators, as one can see that the vehicle following behind seems to take a right turn whereas the vehicle in front goes in for a U-turn, this is unpredictable by the succeeding driver therefore a collision takes place as indicated by the dotted lines.

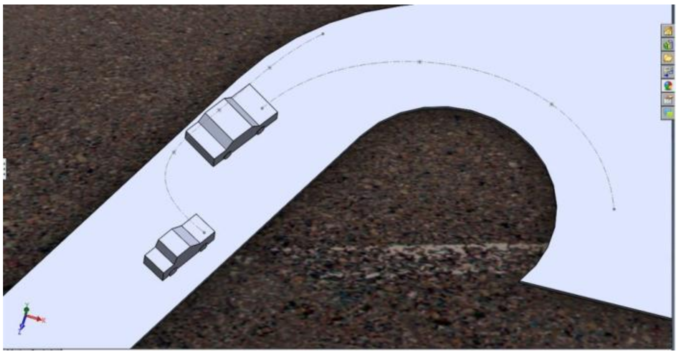

Fig 2.2 (System Proposed-screenshot from Solidworks)

With our newly developed directional indicator the succeeding vehicle is alerted well in advance that the vehicle in front is to take a U-turn so that it avoids the collision path and can move safely thereby the new system proves its consistency over existing indication systems.

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III. ARCHITECTURE OF THE SYSTEM DEVELOPED

The system which has been developed to address the issue faced with conventional indicators is essentially a matrix LED based system. The system comprises of an Arduino board for computing (program execution upon command), a microprocessor for circuit connections. The switch is developed in such a way that it fits into the existing housings fitted in automobiles. At the drivers input the indicator i.e. the matrix display lights up displaying a symbol to indicate whether the vehicle is taking a U-turn or a normal turn. Two sets of inputs are provided for each direction of switch to indicate the turning position.

A. Essential Circuitry and Components

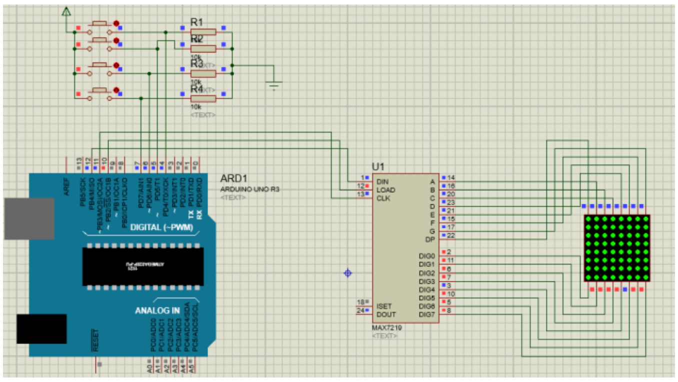

Fig 3.1 (Screenshot of simulated model from Proteus)

The above circuit diagram shows that the system is comprised of the following components that make up the entire system which is listed as follows

1. A switch with 4-Poles (two on either side of the OFF position).

2. An Arduino Uno R3 Board for computing (program execution).

3. A Max 7219 Dot matrix Driver Module to power up the LED's and provide essential linkage from Arduino.

4. Two pairs of 8x8 dot matrix LED.

B. Brief Description of Coding & Simulation

The coding was done in C-platform and the coded program was imported in PROTEUS for simulation. Initial setups were made and the simulation was run. The program is fine-tuned and deployed in the actual setup.

C. Circuit Connections

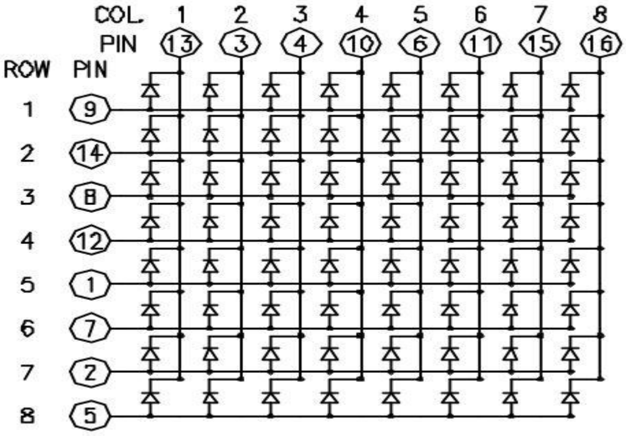

Fig 3.2 (Schematic Layout of the 8x8 matrix)

The above picture indicates the schematic layout of the 8x8 LED matrix which can be used as a reference for pin connections.

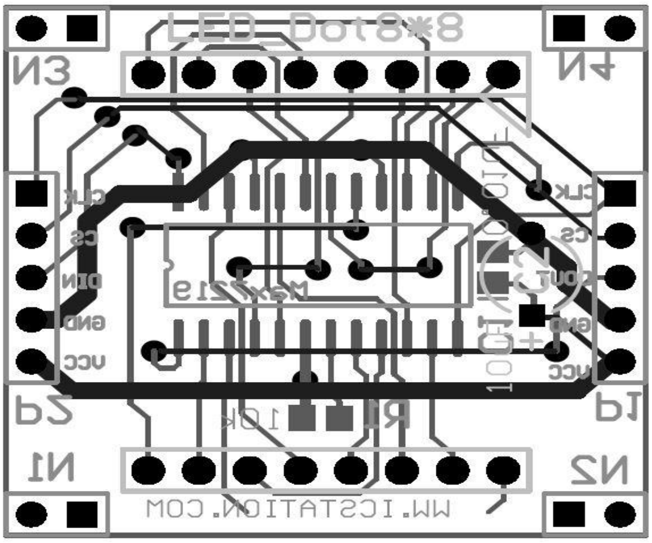

Fig 3.3 (PCB Layout of a 8x8 Matrix LED)

The PCB layout is given as an additional reference so that the circuit connections can be understood more clearly. The layout shows the necessary pins to which the Arduino is to be connected so that upon program execution the respective diode lights up.

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Matrix pin no.	Row	Column	Arduino pin number
1	5	-	13
2	7	-	12
3	-	2	11
4	-	3	10
5	8	-	16 (analog pin 2)
6	-	5	17 (analog pin 3)
7	6	-	18 (analog pin 4)
8	3	-	19 (analog pin 5)
9	1	-	2
10	-	4	3
11	-	6	4
12	4	-	5
13	-	1	6
14	2	-	7
15	-	7	8
16	-	8	9

Table.1. (Pin Connections form Arduino to LED matrix via Max 7219 Dot matrix Driver Module)

The above tabulation is a matrix of the pin connections based on the Fig 1.4, the pin connections from the microcontroller to the rows and columns need not be in the same order as described in the matrix as things are assigned in software.

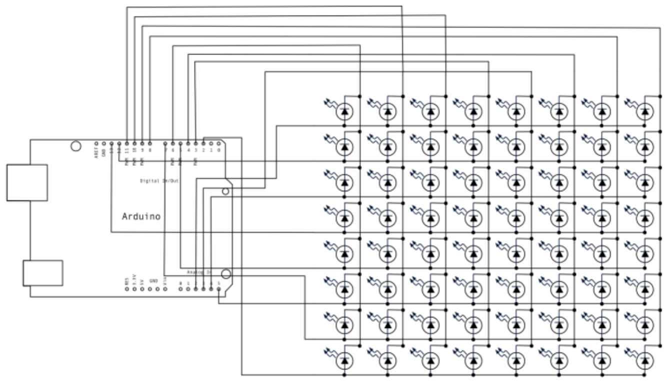

Fig 3.4 (Complete Layout of the system circuitry)

The above diagram shows the complete layout of the circuit after the circuit connections are made. This is the essential circuit connection for controlling the LED. The dot matrix module is not shown for simplified representation of the essential connections to be made. A dot matrix module can be introduced in between the Arduino and the LED for more sophisticated wiring and better control which is shown in the following figure.

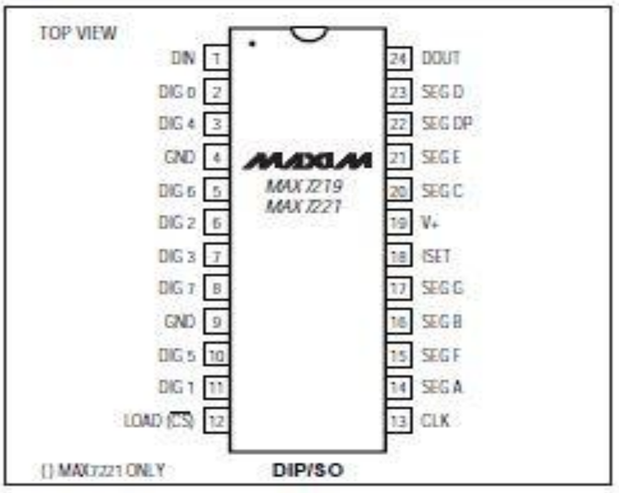

Fig 3.5 (Pin Configuration of the Max7219 Dot Matrix Controller)

The pin configuration layout diagram is used as a reference for making circuit connections while interfacing with Arduino as depicted in the figure below.

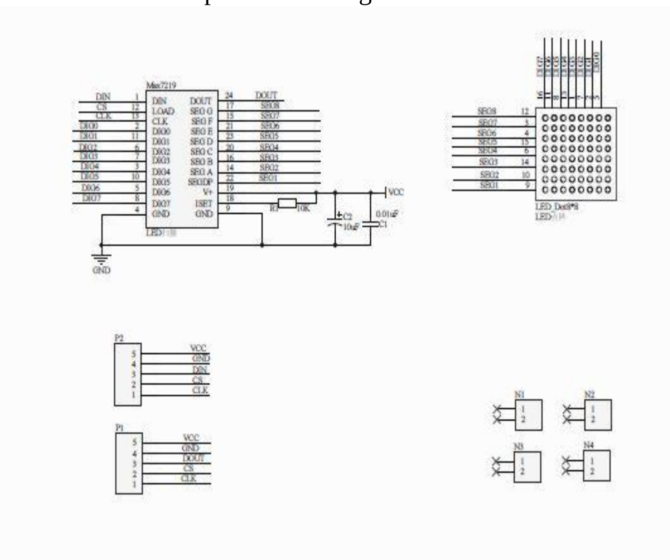

Fig 3.6 (Interfacing between LED matrix and DOT Matrix Controller)

The above image shows how dot matrix can be introduced for interfacing with the LED matrix. The dot matrix controller provides additional connectivity from Arduino and reduces load. Here, in this circuit Dot Matrix LED display is used for displaying information. The method of displaying message on dot matrix displays is same as seven segment multiplexing. Column of dot matrix is rotating very fast means greater then seventeen times in a second and same time changing in row data causes display some information on it. Due to the vision of our eye it looks like stable.

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D. Purpose and Desription of Max7219 Driver Module

The MAX7219/MAX7221 are compact, serial input/output Common-cathode display drivers that interface microprocessors (µPs) to 7-segment numeric LED displays of up to 8 digits, bar-graph displays, or 64 individual LEDs. Included on-chip are a BCD code-B decoder, multiplex scan circuitry, segment and digit drivers, and an 8x8 static RAM that stores each digit. Only one external resistor is required to set the segment current for all LEDs. The MAX7221 is compatible with SPI, QSPI and MICROWIRE. It has slew rate- limited segment drivers to reduce EMI. A convenient 4-wire serial interface connects to all common µPs. Individual digits may be addressed and updated without rewriting the entire display. The MAX7219/MAX7221 also allow the user to select code-B decoding or no-decode for each digit. The devices include a 150µA low-power shutdown mode, analog and digital brightness control, a scan limit register that allows the user to display from 1 to 8 digits, and a test mode that forces all LEDs on.

IV. WORKING OF THE SYSTEM

The working simulation of the direction indicator system for different switch positions as seen in Proteus is clearly conceptualized visually as seen in sec 5. Initially the switch is set to OFF position now all the LED's are in dead state i.e. they don't emit light. Now when the matrix is switched on the appropriate code corresponding to the switch position is executed and a series of rows and columns are lighted up to form a symbol. This is explained for the four cases with the help of a matrix tabulation.

A_{11}	**A_{12}**	**A_{13}**	**A_{14}**	**A_{15}**	**A_{16}**	A_{17}	A_{18}
A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	**A_{26}**	A_{27}	A_{28}
A_{31}	A_{32}	A_{33}	A_{34}	A_{35}	**A_{36}**	A_{37}	A_{38}
A_{41}	A_{42}	A_{43}	A_{44}	A_{45}	**A_{46}**	A_{47}	A_{48}
A_{51}	A_{52}	A_{53}	**A_{54}**	**A_{55}**	**A_{56}**	**A_{57}**	**A_{58}**
A_{61}	A_{62}	A_{63}	A_{64}	**A_{65}**	**A_{66}**	**A_{67}**	A_{68}
A_{71}	A_{72}	A_{73}	A_{74}	A_{75}	**A_{76}**	A_{77}	A_{78}
A_{81}	A_{82}	A_{83}	A_{84}	A_{85}	A_{86}	A_{87}	A_{88}

MATRIX 1: (LED light up sequence for Left U-turn)

A_{11}	A_{12}	**A_{13}**	**A_{14}**	**A_{15}**	**A_{16}**	**A_{17}**	**A_{18}**
A_{21}	A_{22}	**A_{23}**	A_{24}	A_{25}	A_{26}	A_{27}	**A_{28}**
A_{31}	A_{32}	**A_{33}**	A_{34}	A_{35}	A_{36}	A_{37}	**A_{38}**
A_{41}	A_{42}	**A_{43}**	A_{44}	A_{45}	A_{46}	A_{47}	**A_{48}**
A_{51}	**A_{52}**	**A_{53}**	**A_{54}**	**A_{55}**	A_{56}	A_{57}	**A_{58}**
A_{61}	**A_{62}**	**A_{63}**	**A_{64}**	A_{65}	A_{66}	A_{67}	**A_{68}**
A_{71}	A_{72}	**A_{73}**	A_{74}	A_{75}	A_{76}	A_{77}	**A_{78}**
A_{81}	A_{82}	A_{83}	A_{84}	A_{85}	A_{86}	A_{87}	**A_{88}**

MATRIX 2: (LED light up sequence for Right U-turn)

A_{11}	A_{12}	**A_{13}**	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}
A_{21}	**A_{22}**	**A_{23}**	A_{24}	A_{25}	A_{26}	A_{27}	A_{28}
A_{31}	**A_{32}**	**A_{33}**	**A_{34}**	**A_{35}**	**A_{36}**	**A_{37}**	**A_{38}**
A_{41}	**A_{42}**	**A_{43}**	A_{44}	A_{45}	A_{46}	A_{47}	**A_{48}**
A_{51}	A_{52}	**A_{53}**	A_{54}	A_{55}	A_{56}	A_{57}	**A_{58}**
A_{61}	A_{62}	A_{63}	A_{64}	A_{65}	A_{66}	A_{67}	**A_{68}**
A_{71}	A_{72}	A_{73}	A_{74}	A_{75}	A_{76}	A_{77}	**A_{78}**
A_{81}	A_{82}	A_{83}	A_{84}	A_{85}	A_{86}	A_{87}	**A_{88}**

MATRIX 3: (LED light up sequence for Left turn)

A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	**A_{16}**	A_{17}	A_{18}
A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	**A_{26}**	**A_{27}**	A_{28}
A_{31}	**A_{32}**	**A_{33}**	**A_{34}**	**A_{35}**	**A_{36}**	**A_{37}**	**A_{38}**
A_{41}	A_{42}	A_{43}	A_{44}	A_{45}	**A_{46}**	**A_{47}**	A_{48}
A_{51}	A_{52}	A_{53}	A_{54}	A_{55}	**A_{56}**	A_{57}	A_{58}
A_{61}	A_{62}	A_{63}	A_{64}	A_{65}	A_{66}	A_{67}	A_{68}
A_{71}	A_{72}	A_{73}	A_{74}	A_{75}	A_{76}	A_{77}	A_{78}
A_{81}	A_{82}	A_{83}	A_{84}	A_{85}	A_{86}	A_{87}	A_{88}

MATRIX 4: (LED light up sequence for Right turn)

The above matrices can be interpreted into a simple format by listing out which cells are to be powered up for the respective turn.

S.NO	TURN DIRECTION/ SWITCH POSITION	POWERED UP CELLS
1	LEFT U-TURN (EXTREME LEFT END)	A11;A21;A31;A41;A51;A61;A71;A81;A12;A13;A14;A15; A16;A26;A36;A46;A54;A55; A56;A57;A58;A65;A66;A67;A76
2	RIGHT U-TURN (EXTREME RIGHT END)	A88;A78;A68;A58;A48;38;A28;A18;A17;16;A15;A14;A13; A23;A33;A43;A53;A63;A73; A51;A52;A54;A55;A62;63;A63
3	LEFT TURN (IMMEDIATE LEFT END)	A34;A35;A36;A37;A38;A48;A58;A68;A78;A88;A13;A23; A33 A34;A43;A53;A22;A32;A42
4	RIGHT TURN (IMMEDIATE RIGHT END)	A31;A32;A33;A34;A35;A41;A51;A61;A71;A81;A16;A26;A36;A46;A56;A27;A37; A47;A38

Table 1: Tabulation of LED power-ups for each input.

V. SCHEMATIC FIGURES ILLUTRATING THE SIMULATION

The following images are results of screen capture from Proteus during Simulation.

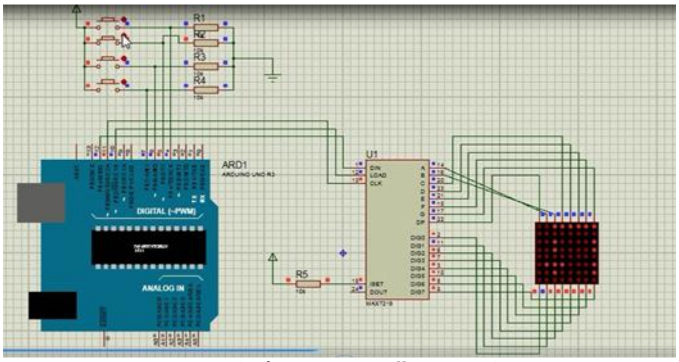

Fig 5.1 (Left U-turn LED illumination)

The left U-turn is represented by a left U-turn arrow this is done when the switch is moved to the extreme right end and the respective LEDs are lighted according to the powering sequence.

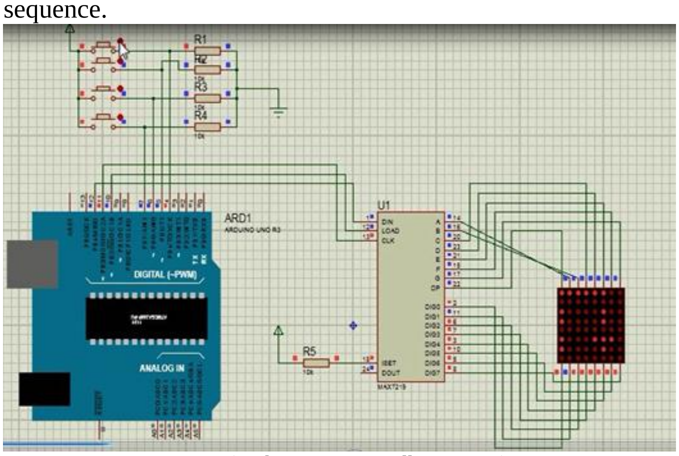

Fig 5.2 (Right U-turn LED illumination)

The right U-turn is represented by a right U-turn arrow this is done when the switch is moved to the extreme right end and the respective LEDs are lighted according to the powering sequence.

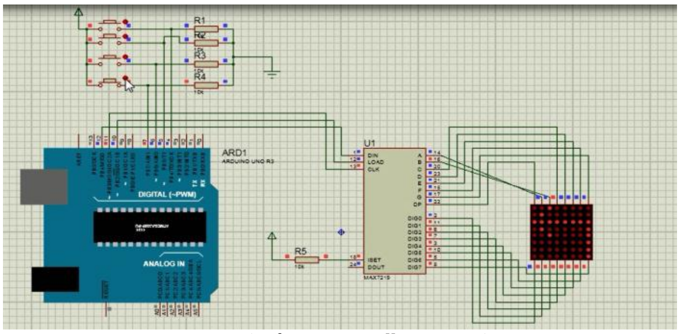

Fig 5.3 (Left turn LED illumination)

The Left turn is represented by a left arrow this is done when the switch is moved to the immediate left end and the respective LEDs are lighted according to the powering sequence.

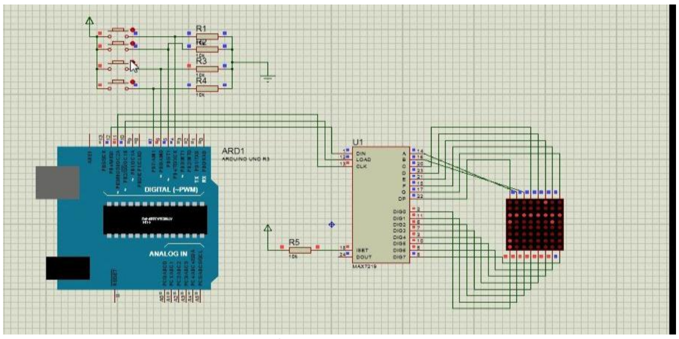

Fig 5.3 (Left turn LED illumination)

The Right turn is represented by a right arrow this is done when the switch is moved to the immediate right end and the respective LEDs are lighted according to the powering sequence.

VI. CONCLUSION

Thus the system proves to be an effective replacement for the conventional system of indication as it enhances safety as legible visualization of the vehicle's turn directions are precisely possible. This system is economically viable and can be implemented in the existing systems.

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