

Research Article

IDENTIFYING THE PROBLEMS IN MOTORCYCLE USING BOOLEAN FUNCTION

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ABSTRACT

This paper explains the use of Boolean function in relay and switching circuits and this can apply in various applications to detect the problems occurring in it. Here, we have taken the application as to be the motorcycle which is useful to control the pollution.

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INTRODUCTION

In 1930s, Claude Shannon used the Boolean algebra rules in switching algebra and design circuits by algebraic means in terms of logic gates. Thus, the difficult switching algebra can be constructed with two elements Boolean algebra. Now a day, Boolean functions are efficiently used to construct the logic circuits. Boolean function is useful in various fields and here we have use the relay and switch circuits to detect the problem in motorcycle which is essential in two ways. One the safety of human life and another to control the pollution. Likewise we can apply the below concept in various application.

Preliminaries

In this section we concentrate on Boolean function, Truth table, Relay circuits, Switch circuit which will be useful in later text.

Boolean function

If x_1, x_2, \dots, x_n are Boolean variables, $f: \{x_1, x_2, \dots, x_n\} \rightarrow \{0, 1\}$ is called Boolean function of degree n .

Boolean Expression

A Boolean expression in n Boolean variables x_1, x_2, \dots, x_n is a finite string of symbols formed recursively.

Boolean function

One variable

A Boolean expression in n Boolean variables x_1, x_2, \dots, x_n is a finite string of symbols formed recursively.
Assume,

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$$f(x) = ax + b(1 - x),$$

take $x = 1$, we have

$$f(1) = a.$$

Again, in the same equation making $x = 0$, we have

$$f(0) = b.$$

Hence, the values a and b are determined, and substituting them in the first equation can be rewritten as:

$$f(x) = f(1)x + f(0)(1 - x);$$

We denote x' for $1 - x$, so that above equation is rewritten as

$$f(x) = f(1)x + f(0)x';$$

Two variable

$$\chi(x, y) = \chi(1,1)x\lambda + \chi(1,0)x(\lambda - \lambda) + \chi(0,1)(1 - x)\lambda + \chi(0,0)(1 - x)(\lambda - \lambda)$$

We can use the above equation to verify that the following table of function values defines the function represented by

$$f(x, y) = xy + x'y$$

x	y	f(x, y)
0	0	0
0	1	1
1	0	0
1	1	1

Provided the output does not contain all '0' and all '1'.

Three variable

$$f(x, y, z) = xyzf(1,1,1) + xy'zf(1,0,1) + xyz'f(1,1,0) + xy'z'f(1,0,0) + x'yzf(0,1,1) + x'y'zf(0,0,1) + x'yz'f(0,1,0) + x'y'z'f(0,0,0)$$

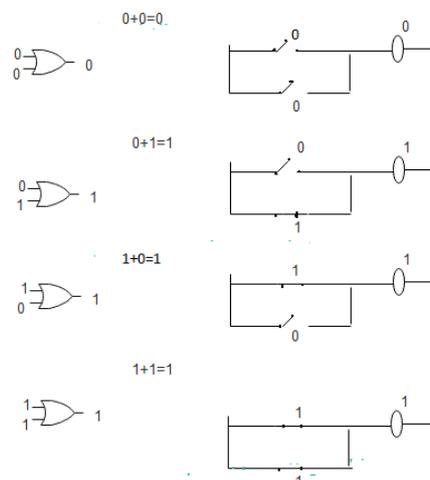
where $x' = 1 - x, y' = 1 - y, z' = 1 - z$

Truth Table

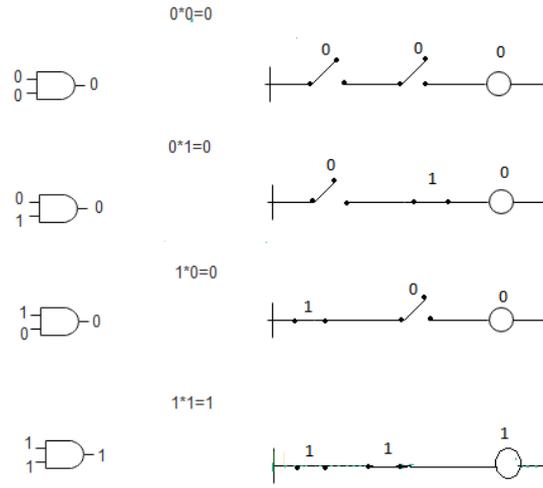
x	y	x + y	x * y
0	0	0	0
0	1	1	0
1	0	1	0
1	1	1	1

Logic Gates (Relay Circuits) and Switch circuit

The diagrammatic representation for OR gate [3] and its corresponding Switch circuit [2] is given below



The diagrammatic representation of AND gate [3] and its corresponding switch circuit is given below



Development of the problem

Here we have taken the example as motorcycle and we categories the problem in two ways, one safety of human life and another pollution control.

Safety of Human Life

Five major things

The five things play important role in motorcycle are break, smoke, engine-coolant, carburetor and air content of wheel.

First, we have to check the control of break in motorcycle. If it is not proper then it leads to the major accident. So, we are going to fix a sensor that if the break is not proper, the sensor will be on and the motorcycle will shut off. Therefore, if the control of the break is low, we denote it by 0 otherwise 1. Second, smoke level in motor cycle. If it is more then it leads to the environment gets polluted. So we fix a sensor for some level to the smoke so that it does not affect the environment. Therefore, if the smoke level is high, we denote it by 0 otherwise 1.

Third, engine coolant in a motorcycle. It keeps the engine from overheating. So we fix the sensor up to the particular temperature so that the engine is not overheated and we denote it by 0 otherwise 1. Fourth, carburetor in a motorcycle. It keeps the petrol and oil in appropriate liquid level and send it to the engine. If it is not in the good condition the engine get spoiled and economically it give the loss so we fix the sensor, for its good working condition and it is denoted by 1 otherwise 0. Last, the air content in wheel. If the air content is not good and we keep on riding the motorcycle then the wheel get burst. So we fix the sensor for appropriate level of air in the wheel and we denote it by 1 otherwise 0.

Finally,

- Proper control of the break “x” is 1
Otherwise 0
- Appropriate level of smoke “y” is 1
Otherwise 0
- Temperature of the engine “z” is 1
Otherwise 0
- Fluidity level of petrol “w” is 1
Otherwise 0
- Fixed air content of the wheel “s” is 1
Otherwise 0

Output 1

If all the above five things working properly then the following truth table gives the output.

Output 2

In the above five things smoke and engine- coolant does not affect much to drive a motor cycle. Up to some limit of defect in above two, we can drive a motor cycle. Therefore the following truth table gives the output of above condition,

Logic Gates

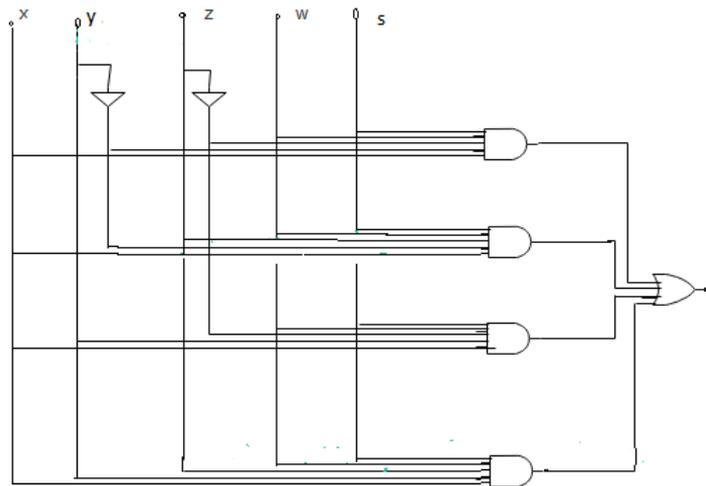
The above output 2 can be given below by logical circuit.

x	y	z	w	s	Output 1
0	0	0	0	0	0
0	0	0	0	1	0
0	0	0	1	0	0
0	0	0	1	1	0
0	0	1	0	0	0
0	0	1	0	1	0
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	0
0	1	0	0	1	0
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	0
0	1	1	1	0	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	0	0	1	0
1	0	0	1	0	0
1	0	0	1	1	0
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	0
1	1	0	0	0	0
1	1	0	0	1	0
1	1	0	1	0	0
1	1	0	1	1	0
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

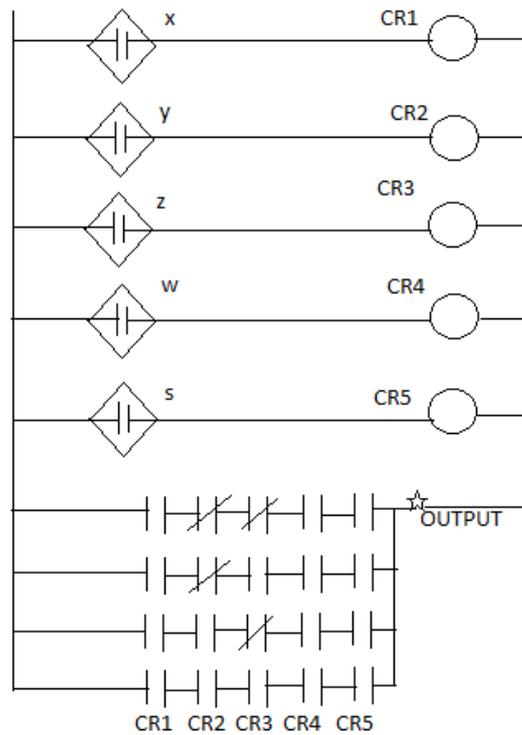
Output 1 = $xyzws$

x	y	z	w	s	Output 2
0	0	0	0	0	0
0	0	0	0	1	0
0	0	0	1	0	0
0	0	0	1	1	0
0	0	1	0	0	0
0	0	1	0	1	0
0	0	1	1	0	0
0	0	1	1	1	0
0	1	0	0	0	0
0	1	0	0	1	0
0	1	0	1	0	0
0	1	0	1	1	0
0	1	1	0	0	0
0	1	1	0	1	0
0	1	1	1	0	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	0	0	1	0
1	0	0	1	0	0
1	0	0	1	1	1
1	0	1	0	0	0
1	0	1	0	1	0
1	0	1	1	0	0
1	0	1	1	1	1
1	1	0	0	0	0
1	1	0	0	1	0
1	1	0	1	0	0
1	1	0	1	1	1
1	1	1	0	0	0
1	1	1	0	1	0
1	1	1	1	0	0
1	1	1	1	1	1

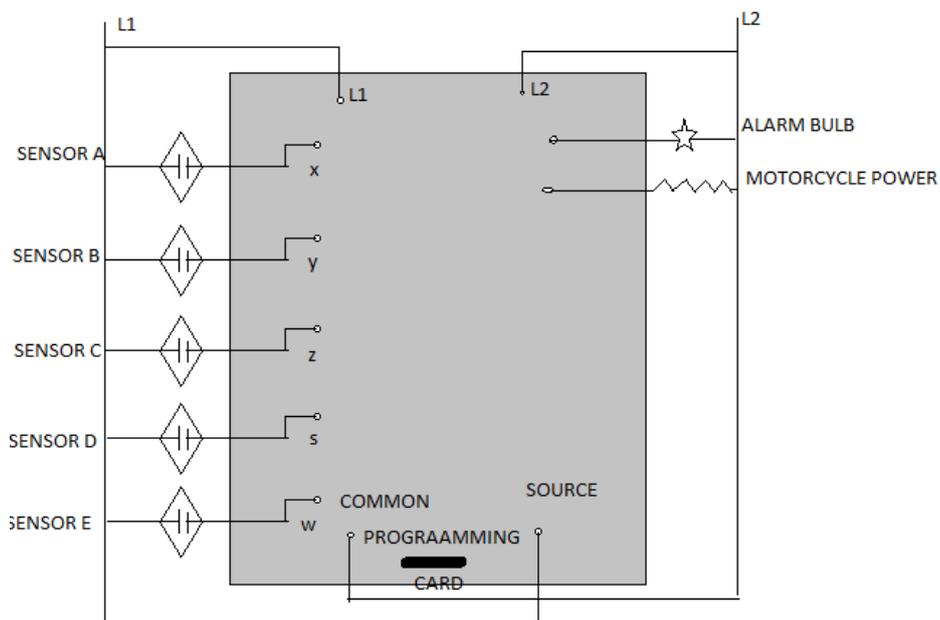
Output 2 = $x\bar{y}\bar{z}ws + x\bar{y}zws + xy\bar{z}ws + xyzws$



Switch circuit



PLC circuit



Pollution Control

Four major things

One of the major problems in now a day is excessive emission of smoke from motorcycle. It pollutes the environment, which affect the human life in several ways like illness, polluted surroundings etc. In this smoke, pollutants like hydrocarbons, carbon monoxide, sulphur oxides, nitrous compounds and volatile organic compounds. The above pollutant affects the human life also. The four major things that create excessive smoke is coolant leakage, poor lubrication, problem in chocking and sudden unintended acceleration.

First, we have to fix the sensor when the coolant starts to leak and we denote it by 0 otherwise 1. Second, Poor lubrication is occurred when engine get fault, so we fix the sensor when the engine is affected and we denote it by 0 otherwise 1. Third, we fix the sensor when there is a problem in chocking and we denote it by 0 otherwise 1. Last, sudden unintended acceleration. This happens because of high speed. So we fix the sensor if the speed is more than a limit and we denote it by 0 otherwise 1.

Finally,

Leakage in coolant “x” is 0

Otherwise 1

Defect in engine “y” is 0

Otherwise 1

Problem in chocking “z” is 0

Otherwise 1

Over speed “w” is 0

Otherwise 1

Output 3

If all the above four things are working properly then the following truth table gives the output.

x	y	z	w	Output 3
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

$$\text{Output 3} = x\bar{y}z\bar{w}$$

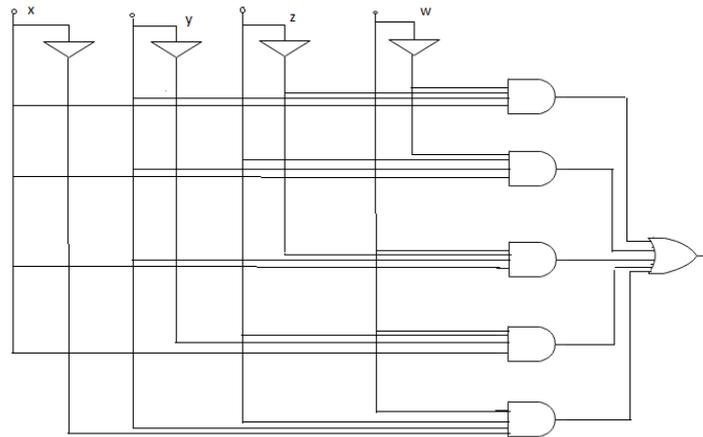
Output 4

In the above four things, if any one thing is happen the smoke will be excessively emitted from the motorcycle. Therefore the following truth table gives the output of above condition,

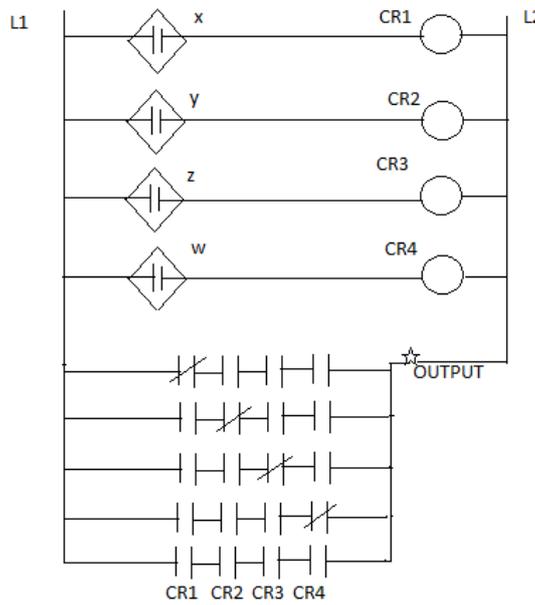
x	y	z	w	Output 4
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

$$\text{Output 4} = \bar{x}\bar{y}z\bar{w} + \bar{x}\bar{y}z\bar{w} + x\bar{y}\bar{z}\bar{w} + x\bar{y}z\bar{w} + x\bar{y}z\bar{w}$$

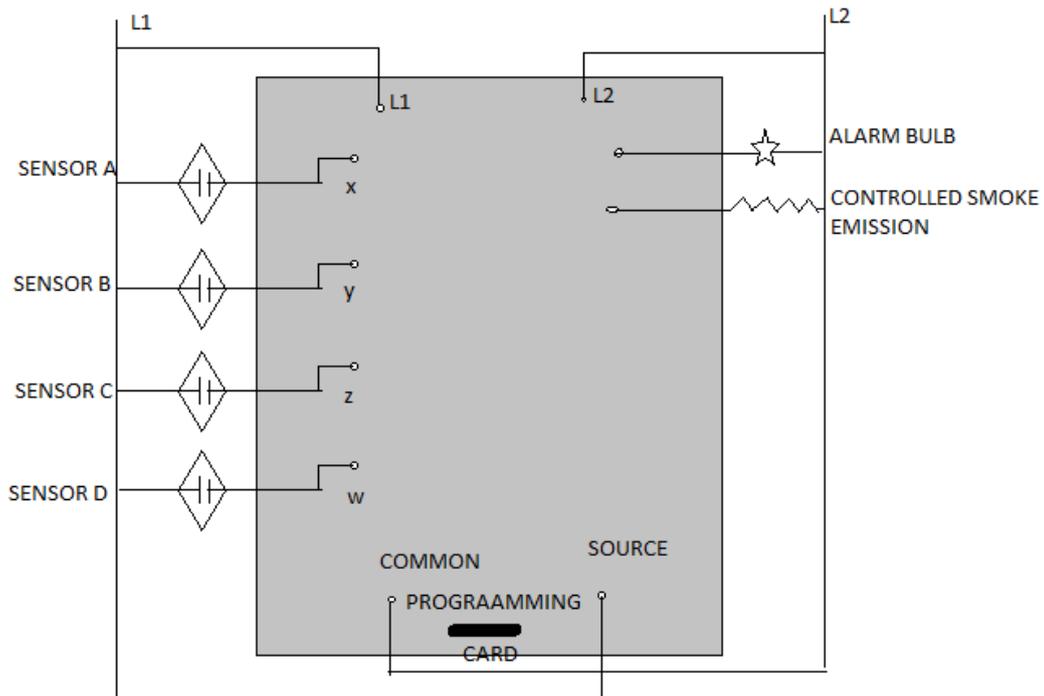
Logic Gates



Switch circuit



5.6 PLC circuit:



Conclusion

The above paper explains how the Boolean function helps to identify the problem in a motorcycle and excessive emission of smoke in a motorcycle using relay and switch circuit. Using PLC circuit we are connecting it with sensor and finding the defect earlier.

REFERENCES

- [1] Motorcycle, from Wikipedia, the free encyclopedia.
- [2] Holsworth, "Switching Circuit & Logic Design".
- [3] Kenneth H. Rosen, "Discrete Mathematics and its Applications", McGraw Hill.
