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Automated Counting of HMVs

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Abstract – *In this digital age, mining industries are still using conventional manual methods to register the count of HMVs (Heavy Motor Vehicles), leading to human errors even to corruptions in certain cases, by showing a less count of loaded HMVs entering the mine. This paper focuses on designing a cost efficient system to detect the presence of HMVs to avoid above problems and count the number of HMVs passing through a point of observation in a remote area with varying weather conditions, in absence of human intervention.*

Key Words: **Inductive Loop Metal Detector, OpenCV, Raspberry Pi, Python, Counting HMVs.**

1. INTRODUCTION

In industries like coal mine industry, counting of trucks, entering and leaving, is very important and traditional manual counting method does not ensure the required level of accuracy. Any fault or human error may lead up to a large loss, due to incorrect record of incoming and outgoing material of large costs, which is extremely adverse. Particularly, at remote places where human labour access is restricted, a reliable system that can be used by any such industry should be available, which can work in the worst of conditions all the while being accurate, proving it to be more effective than the manpower at disposal. The need of the industry to detect the presence of HMVs (Heavy Moving Vehicles), preferably trucks has urged us to design a new method for this purpose.

Methods like Inductive loop, Infrared Lasers, Load Cells, Ultrasonic sensors, image processing already exist and are used to detect the presence of vehicles (at vehicular traffic measurement). The combination of all these existing systems may lead to an optimized system for the above need. Further, the installation of such a system will greatly benefit the industry by keeping track of incoming and outgoing traffic, to keep the records of incoming amount of raw material inside an industry or counting the products going outside the company premises. As per the current scenario, there exists no such system in the market. So, building of such a system should certainly benefit the industry.

Primary purpose of the proposed design is that the whole system should not require any human involvement. It should be entirely automated and reliable.

2. PROPOSED WORK

The base circuit board design for this work was referred from literature available at Chemlec.com. [1] The basic circuit is shown in following fig. 1

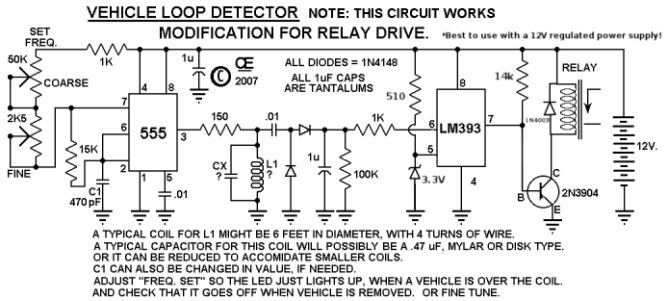

Fig -1: Original Inductive Loop Metal Detector Circuit

Discrete parameters of this circuit were varied, eliminated in some cases and a voltage regulatory structure was added in order to make the circuit compatible with Raspberry Pi system.

A python based program was written to detect large sized objects by utilizing a visual aid. The code detected outlines of mobile objects, and calculated the area enclosed. The calculated area is then analyzed against a set point threshold limit and detecting the areas exceeding the limit value, the outline is displayed on the LCD monitor while registering the count on record.

Threshold limit used for the code can be varied for the distance of object from the visual aid.

3. HARDWARE PART OF THE PROPOSED SYSTEM:

3.1 Inductive Loop Metal Detector: [2][3]

Inductive Loop Detector is the primary sensing part for this project. The major three parts associated with this circuit are:

3.1.1: The Input Part:

The input part of this circuit consists of aIC555 (Timer) working in astable mode of operation which means that output will have continuous rectangular pulses whose duty

cycle can be adjusted using the coarse and fine arrangement provided in the circuit through potentiometer.

3.1.2: The Resonating Tank Part:

The tank used is a LC (Inductor-Capacitor tank circuit). The inductor used in this circuit part is approximately 1 meter diameter wire loop made up of a single stranded copper wire. The inductance of the resulting loop mainly depends on the number of turns and diameter of the loop. The resonant frequency of the tank can be calculated by:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Where,

L-Inductance of the loop
C- Capacitance

3.1.3: The Comparator and Output Part:

This part uses a LM393 which is an open collector output comparator. It basically compares the output voltage of the tank circuit against a reference voltage and gives output accordingly. Finally a regulator is used to convert the level and forward it to the processing part.

3.1.4: Working:

When the power is turned on, the IC555 produces continuous pulses which are injected into the tank and oscillations are produced at the output and a fixed dc level at the output is received due to the rectifying diode.
When current passes through a conductor loop it produces magnetic field. So, whenever a large metal (ferrous) object comes in the proximity of the loop, eddy currents are produced resulting into a voltage drop at the output. This drop in voltage is sensed by the comparator, comparing the input voltage with a reference and finally it is forwarded through the regulator to the processing part.

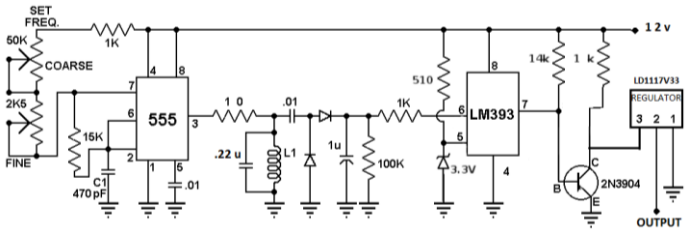

Fig -2: Modified Inductive Loop Metal Detector Circuit

4. SOFTWARE PART OF THE PROPOSED SYSTEM:

4.1 Image processing:

Normally, the industries keep track of vehicles entering the industry with the help of CCTV cameras installed on gates. Image processing systems can use one of these available cameras to use live feed for detecting and counting the vehicles. This is possible with image processing system as it deploys OpenCV library along with Python code, on a low cost well known processor, Raspberry Pi.

4.1.1. Raspberry Pi:

Raspberry Pi is a well-known SOC (System on chip) computers made by Raspberry Pi Foundation. It has different utilities already built on it like GPIO port, USB ports, SD card port etc. It incorporates the powerful ARM processor.[4]

4.1.2. OpenCV:

Open Source Computer Vision, named as OpenCV, is a free of cost library of different functions. It was developed by Intel. The main aim of this library is to bring a real-time computer vision and includes all the related functions for this purpose. This library can be used along with different computer languages like C, C++, Python, Java etc. It supports a variety of platforms such as Windows, Linux, Android, iOS making it more useful for users. It has been shaped by the users of OpenCV according to their requirements. This open source library is being used all worldwide for a variety of applications including robotics and robotic inspections etc.[5]

5. OPERATION & OBSERVATIONS:

The hardware part of proposed system provides a digital trigger signal to Raspberry Pi. As voltage level on the GPIO pin of raspberry should not exceed above 3.3 V, this circuit gives an output High-to-Low trigger, of around 2.30 V (when triggered), in the presence of a metal object of significant size around the inductive loop. This is shown in Fig-2.
The Raspberry Pi processes live input video frames with the help of python code & the OpenCV library. The count is shown on a monitor screen. Additionally it shows the ongoing processing on the image frame in the same window. So the triggering of hardware circuit and working on live video frames produces a combined output on the monitor screen, free from any errors.

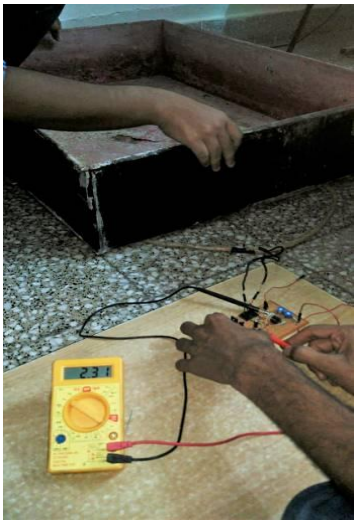

Fig -3: Inductive Loop Metal Detector Circuit Output Voltage

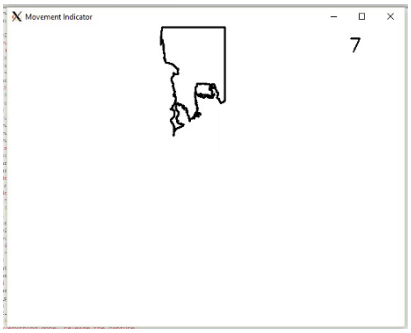

Fig -4: Python-OpenCV Program Output and Count on Top Right Corner

6. CONCLUSION

A completely independent, automated, reliable system is designed for the replacement of traditional methods. This system is free from any human intervention.
Scope of further modifications in the system includes incorporation of Load Cells for measuring the weight of loaded HMVs for the record, RFID systems for detection of unique identity assigned to a particular HMV entering or leaving the premises, and so on.

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9. BIOGRAPHIES

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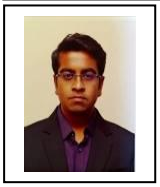

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