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Real Time Portable Vehicle Counting Using Roadside Sensors with Arm11 Processor

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ABSTRACT:

This paper focuses on the development of a portable roadside magnetic sensor system for vehicle counting, classification, and speed measurement. The sensor system consists of wireless anisotropic magnetic devices that do not require to be embedded in the roadway—the devices are placed next to the roadway and measure traffic in the immediately adjacent lane. An algorithm based on a magnetic field model is proposed to make the system robust to the errors created by larger vehicles driving in the nonadjacent lane. These false calls cause an 8% error if uncorrected. The use of the proposed algorithm reduces this error to only 1%. Speed measurement is based on the calculation of the cross correlation between longitudinally spaced sensors. Fast computation of the cross correlation is enabled by using frequency-domain signal processing techniques. An algorithm for Automatically correcting for any small misalignment of the sensors is utilized. A high-accuracy differential Global Positioning System is used as a reference to measure vehicle speeds to evaluate the accuracy of the speed measurement from the new sensor system. The results show that the maximum error of the speed estimates is less than 2.5% over the entire range of 5–27 m/s (11–60 mi/h). Vehicle classification is done based on the magnetic length and an estimate of the average vertical magnetic height of the vehicle. Vehicle length is estimated from the product of occupancy and estimated speed. The average vertical magnetic height is estimated using two magnetic sensors that are vertically spaced by 0.25 m. Finally, it is shown that the sensor system can be used to reliably count the number of right turns at an intersection, with an accuracy of 95%. The developed sensor system is compact, portable, wireless, and inexpensive. Data are presented from a large number of vehicles on a regular busy urban road in the Twin Cities, MN, USA.

Index-terms: ***Raspberry Pi Processor, vehicle counting, embedded systems, vehicle detection.***

I. INTRODUCTION:

A portable sensor system is designed that can be placed adjacent to the road and can be used for vehicle counting, speed measurements and vehicle classification. The sensor system consists of magneto resisitve devices that measure magnetic field and associated signal processing algorithms. The sensor system can make these traffic measurements reliably for traffic in the lane adjacent to the sensors. The vehicle detection rate accuracy is 99%. The developed signal processing algorithms enable the sensor to be robust to the presence of traffic in other lanes of the road. The velocity estimation has a max error of 2.5% over the entire speed range 5 – 60 mph. Vehicle classification is done based on the magnetic length and an estimate of the average vertical magnetic height of the vehicle. The sensor system can be used to reliably count the number of right-turns at an intersection. The developed sensor system is compact, portable, wireless and inexpensive. Magnetic readings of the Z axis of AMR-1 are used for detecting and counting the passing vehicles in the adjacent lane. A threshold of 30 counts was used as the vehicle detection threshold. Signals from 188 vehicles driving in the adjacent lane were recorded, 186 vehicles created a large enough signal to be detected resulting in a detection rate of 99%. Signals from 216 vehicles driving in the non-adjacent lane were also recorded. Passenger's vehicles driving in the non-adjacent lane typically do not create detection errors. However, larger vehicles (trucks, buses, etc.) in the non-adjacent lane may create large enough signals to cause over-detection and affect accuracy of the system. 15 vehicles out of 216 vehicles created a large enough signal to be miscounted as vehicles passing in the adjacent lane. If uncorrected, this will cause an over-detection error of 8%. Similar error rates (7-15%) have been reported in literature even for magnetic sensors placed in the middle of the lane.

II. SYSTEM ARCHITECTURE:

2.1 BLOCK DIAGRAM:

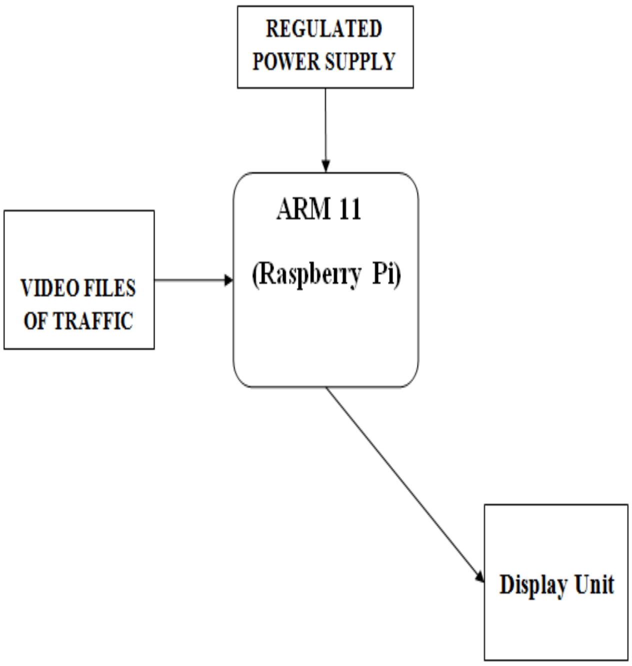

Figure-1: Block diagram of project

2.2. EXISTING METHOD:

Over the years, the need for electricity has grown in rapid proportions. Electric meters are devices responsible for determining these billing charges, usually on a monthly basis and are computed in kilowatt-hours (kWh). From manual meters employing electromechanical principles, technological advancements have prompted the advent of automatic meter reading systems.

2.3 PROPOSED METHOD:

This project focuses on the development of a portable roadside magnetic sensor system for vehicle counting, classification, and speed measurement. The sensor system consists of wireless anisotropic magnetic devices that do not require to be embedded in the roadway—the devices are placed next to the roadway and measure traffic in the immediately adjacent lane. An algorithm based on a magnetic field model is proposed to make the system robust to the errors created by larger vehicles driving in the nonadjacent lane. These false calls cause an 8% error if uncorrected. The use of the proposed algorithm reduces this error to only 1%. Speed measurement is based on the calculation of the cross correlation between longitudinally spaced sensors.

Fast computation of the cross correlation is enabled by using frequency-domain signal processing techniques. When the sensors are placed on the side of the road, the signals are more uniform compared to the case that the sensors are on the road. Magnetic field readings for a Ford Ranger from a magnetic sensor adjacent to the road. Sensor configuration for data collection. Reason is that, with the sensors on the road, many different ferromagnetic parts underneath the vehicle will pass over the sensors at close proximity and create extra fluctuations in the signal. Because the original signal levels are low when the sensors are placed on the side of the road, it is necessary to use higher amplification to get a better signal-to-noise ratio (SNR). Hence, the sensor signals were amplified using instrumentation amplifiers, with cutoff frequencies set to 100 Hz to reduce the noise level. Our system is designed by

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using BSC2836 micro processor developed by BROADCOM which was called as Raspberry Pi.

III. HARDWARE IMPLEMENTATION:

3.1 RASPBERRY PI PROCESSOR:

Figure-2: Raspberry Pi processor

Your Raspberry Pi board is a miniature marvel, packing considerable computing power into a footprint no larger than accredit card. It's capable of some amazing things, but there are a few things you're going to need to know before you plunge head-first into the bramble patch. The processor at the heart of the Raspberry Pi system is a Broadcom BCM2836 system-on-chip (SoC) multimedia processor. This means that the vast majority of the system's components, including its central and graphics processing units along with the audio and communications hardware, are built onto that single component hidden beneath the 256 MB memory chip at the centre of the board. It's not just this SoC design that makes the BCM2836 different to the processor found in your desktop or laptop, however. It also uses a different instruction set architecture (ISA), known as ARM. A better-quality picture can be obtained using the HDMI (High Definition Multimedia Interface) connector, the only port found on the bottom of the Pi. Unlike the analogue composite connection, the HDMI port provides a high-speed digital connection for pixel-perfect pictures on both computer monitors and high-definition TV sets. Using the HDMI port, a Pi can display images at the Full HD 1920x1080 resolution of most modern HDTV sets.

3.2. GCC COMPILER:

The original GNU C Compiler (GCC) is developed by Richard Stallman, the founder of the GNU Project. Richard Stallman founded the GNU project in 1984 to create a complete Unix-like operating system as free software, to promote freedom and cooperation among computer users and programmers. GCC, formerly for "GNU C Compiler", has grown over times to support many languages such as C++, Objective-C, Java, Fortran and Ada. It is now referred to as "GNU Compiler Collection". The mother site for GCC is http://gcc.gnu.org/. GCC is a key component of "GNU Toolchain", for developing applications, as well as operating systems.

3.3 OPEN CV:

OpenCV [OpenCV] is an open source computer vision library available from http://SourceForge.net/projects /opencvlibrary. The library is written in C and C++ and runs under Linux, Windows and Mac OS X. There is active development on interfaces for Python, Ruby, Matlab, and other languages. OpenCV was designed for computational efficiency and with a strong focus on real- time applications. OpenCV is written in optimized C and can take advantage of multi core processors. If you desire further automatic optimization on Intel architectures [Intel], you can buy Intel's Integrated Performance Primitives (IPP) libraries [IPP], which consist of low-level optimized routines in many different algorithmic areas. OpenCV automatically uses the appropriate IPP library at runtime if that library is installed. One of OpenCV's goals is to provide a simple-to-use computer vision infrastructure that helps people build fairly sophisticated vision applications quickly.

3.4. DESCRIPTION OF PROJECT:

In this section, we give an overview on the proposed system architecture. Here we are using Raspberry Pi board as our platform. It has an ARM-11 SOC with integrated peripherals like USB, Ethernet and serial etc. On this board we are installing Linux operating system with necessary drivers for all peripheral devices and user level software stack which includes a light weight GUI based on XServer, XOrg middle-ware for interacting with display devices like monitors and display drivers, TCP/IP stack to communicate with

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network devices and some standard system libraries for system level general IO operations. By using USB type camera that is interfaced to the embedded board we can capture the live video of the particular location. The camera will continuously capture the images and send it to ARM board. After that the controller will undergo with image processing based on the Background Subtraction algorithm to detect the object like car and calculate the object travelling in the image to find out the speed measurement in the input frame captured from the video file. On detecting Using the image processing function in opencv, rectangle will be drawn around the vehicle to identify. So we can also track the vehicle on continuous image capturing from the video file/device. In this way we can design vehicle detection and tracking with speed measurement by using **Raspberry Pi** board and **Embedded Linux**.

IV. RESULTS:

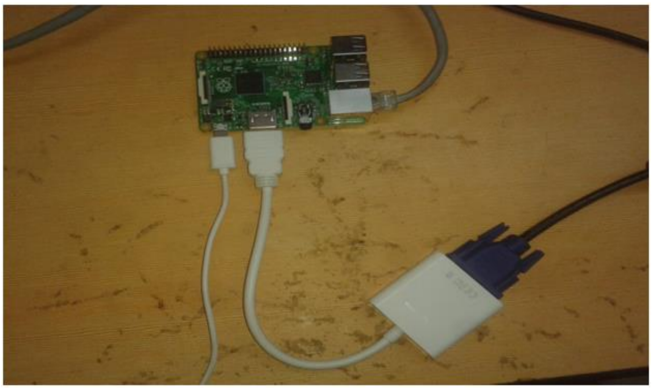

Figure-3: Hardware Implementation

Figure-4: Vehicles speed measurement

Figure-5: Vehicles Passing

V.FUTURE SCOPE

Currently in our system we are just accessing the system from local PC system. So in future we can implement a system with video database storage for reference even which we can use single RAM for different system like servers in companies.

VI. CONCLUSION

This paper has proposed a portable and low-cost sensing system based on magnetic sensors that can be placed adjacent to the road and be used for traffic counting, speed measurement, and vehicle classification in the lane adjacent. The vehicle classification and speed measurement in this paper are enabled using multiple spatially separated sensors. The project "Real time portable vehicle counting using roadside sensors with arm11 processor" has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM board and with the help of growing technology the project has been successfully implemented.

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