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Vehicular Automatic Speed Control, Monitoring and Tracking in ARM Platform

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Abstract — This paper presents the development of a methodology to manage and trace the vehicle velocity, temperature and position of the vehicle from the vehicular system .We proposed a automatic speed control system through analysis and monitoring through digitalized image sensing of the vehicle ahead and use color segmentation algorithms to have a position of the vehicle ahead , aiming predict a need of preventive maintenance and mostly avoids collision between the vehicles. In this proposed system, accelerometer which will identify vibration, temperature sensor to identify the temperatures at critical points of vehicle, a microcontroller hardware which will make acquisition and processing of signals from sensors. The acquired parameters such as, Vehicular speed, position and temperature are stored in a SD card and finally The vehicles sends information to the Emergency services, respective mobile numbers. The post processing is performed remotely through a computer that receives the data submitted via GSM presenting them to the user via graphical interface. This leads to minimize collision in highways

Keyword: ARM7, MEMS Accelerometer, Collision avoidance, Speed Control.

I. INTRODUCTION

A lot of accidents in the road highways are due to the carelessness of the driver. In this project, we have tried to provide a solution for the collision avoidance. The ARM based GSM and GPS is used to monitor and tracking of the vehicle and the automatic speed control of the vehicle using artificial vision implemented in those vehicles used to process the image traced by it using algorithms for obstacle detection and pedestrian detection. Then perform color segmentation algorithms on those images to know about the position of the vehicles and indicate the driver about the danger ahead. In the absence of the response from the driver, digitally control the speed and the steering action of the vehicle. Automated control systems must be incorporated which will not Only take care of adjusting sensors and signal conditioner but also be able to take necessary action at the proper time to avoid collision.

Key feature of this design include:

a. Vehicle real-time monitoring achieved by sending "its" information regarding velocity, Position (longitude, latitude) to the monitoring station and to the user/owners mobile that should help them to get an immediate medical help if accident or the theft.

b. Display that information on GUI(graphical user interface) and also at the same time these information are stored in the database.

c. User/owner has an access to get real-time position of a vehicle in real time.

d. Also in case of theft vehicle should be stop at the same time where this system is ported on the mobile vehicle.

e. Temperature sensor that gives temperature in degree Celsius for monitoring the environmental condition around the goods or other stuff in the transport vehicle.

f. the cmos image sensors provide a direct digital signal and consume low power.

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II. HARDWARE OF THE VEHICULAR SYSTEM

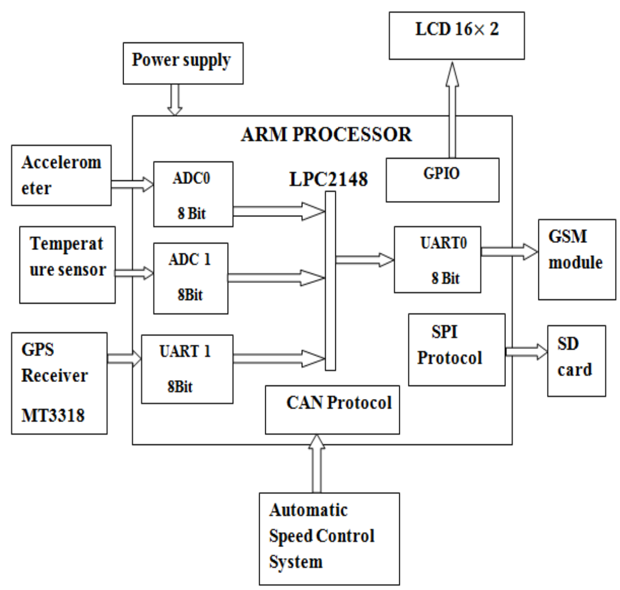

Figure 1:vehicular system block diagram

The vehicular system [VS] includes hardware that consists of an ARM 7 TDMI core processor, Accelerometer, GPS module, GSM module, SD memory card, l6x2 LCD, temperature sensor and automatic speed control system. The whole vehicular system works on a 5V or 9V dc regulated power supply. The GPS receiver module interfaced with UART1 of ARM processor provides speed and location information. The identity of a vehicle is fixed that is saved in a flash memory of a processor. The temperature sensor provides temperature per degree Celsius to an ARM processor. The temperature sensor is interfaced to an ADC1 of ARM processor. Vehicular speed, position and temperature are stored in a SD card. The SD card is interfaced to an ARM processor using SPI (Serial Peripheral Interface). All this information are shown on LCD that is interfaced with a GPIO0 and send it to a monitoring station (receiver side) by GSM module wirelessly that is interfaced with UART0 of ARM processor. Also the same information is given to a concern person to get that information anywhere anytime. The module requires GSM SIM (Subscriber Identity Module). As per the definite event stored in a program and when collision/accident occurs that is sense by an Accelerometer which is interfaced to ADC0 of ARM processor. The automatic speed control system is interfaced to an ARM processor using CAN(controlled area network). The detail descriptions of all modules are as follows.

Gsm Module:

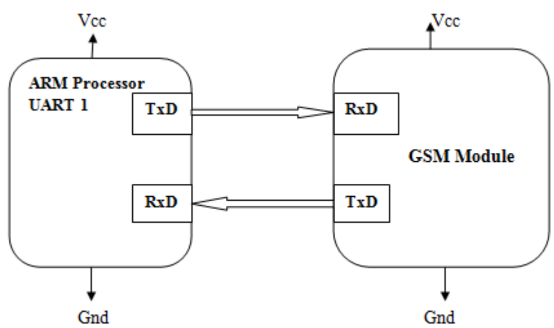

Figure 2: Interfacing of GSM module with ARM processor on UART1

Global System for Mobile communications (GSM) is the almost popular wireless standard for mobile phones in the world. GSM module allows transmission of Short message service (SMS) in TEXT mode and PDU mode. The proposed design uses SIM 300 GSM module in text mode. This design uses SIM300 GSM module that provide 900/1800/1900MHz Tri-band for VOICE, SMS, DATA, and FAX. This module operates on AT command over TTL interface. AT command is an abbreviation for Attention command that is recognized by GSM Module. This abbreviation is always used to start a command line to be send from TE (Terminal Equipment) to TA (Terminal Adaptor).The information contains information speed position (longitude, latitude), identity and temperature of a vehicle that is transmitted to the monitoring station by the SMS through the GSM network.. SIM 300 Module works on 12V, 2A power supply. The module is configured at 9600 baud rate. Figure 2 shows interfacing of GSM module with ARM Processor on UART1where TxD pin of ARM processor is connected to RxD pin of GSM module and vice versa. The transmitted data from ARM processor using UART1 module contains information about Vehicle Identity that may be checked and displayed on Hyper-Terminal and as per the connection shown in fig 2 .

Gps Module:

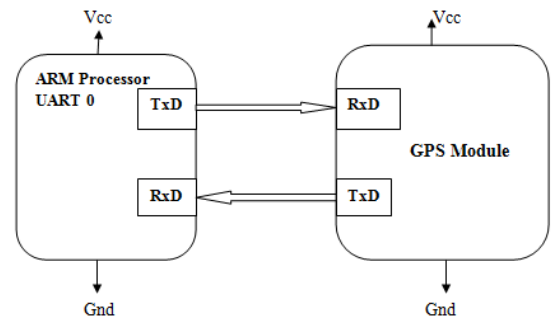

Figure 3: Interfacing of GPS module with ARM Processor on UART0

Global Position System (GPS) is a space-based satellite navigation that provides location and time information in all weather conditions, anywhere on or near the Earth. GPS Receiver MT3318 Module is used that have a active patch antenna from Cirocomm. The GPS receiver tracks 51 satellites simultaneously. The module is mounted on the PCB along with the 3.3V low drop voltage regulator, transmit, receive and power indication LEDs, Schmitt trigger based buffer for 5V to 3.3V logic level conversion. This GPS receiver gives data output in standard National marine electronics association (NMEA) format. The GPS receiver gives -157dBm tracking sensitivity. The module is configured at 9600 baud rate. Module requires a 5V supply and can be interfaced with the 5V TTL / CMOS logic.

The detail NMEA protocol:

1: GPGGA - Global Positioning System Fix Data
2: GPGSA - GPS DOP and active satellites
3: GPGSV - GPS Satellites in view
4: GPRMC- Recommended minimum specific GPS/Transmit data Speed.
5: GPVTG- Track Made Good and Ground

Figure 3 shows interfacing of GPS module with ARM Processor on UART1 where TxD pin of ARM processor is connected to RxD pin of GPS module and vice versa. The data from GPS receiver in NMEA format is received on ARM processor using UART1 protocol which contains information about Vehicle position (longitude, latitude) and speed. This information can be check on HyperTerminal of a computer using USB to serial convertor.

III. AUTOMATIC SPEED CONTROL SECTION

A. Introduction:

Automatic speed control system concerned with the digitalized image sensing of the vehicle ahead and use color segmentation algorithms to have a view of the vehicle ahead. Depending on the results, the system provides an alarm signal to the driver, who carelessly leads to a lot of accident. It also automatically controls the brakes and steering action in the absence of the response from the driver. When the same system is kept at the rear side of the vehicle, the same technique can be implemented for safe parking. This safe parking is done when the driver does not respond to the alarm.

B. The way it works :

When we take the picture of a moving object from a moving point, the area occupied by the picture on the image keeps on changing. When the object is closer to the point of observation the area occupied by the object is greater than the area occupied when it is far away. When the area occupied goes beyond a maximum limit, an alarming system is activated.

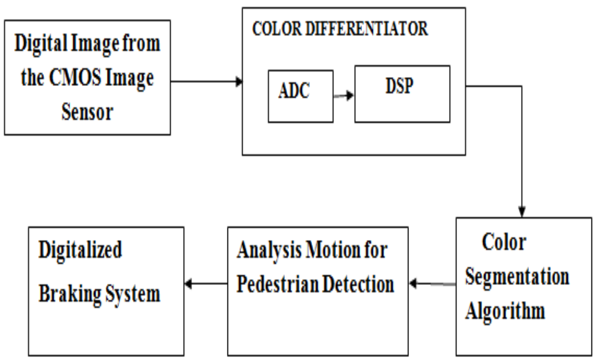

Figure 4: Automatic speed control system

C. Image Sensing :

The image sensing elements used are CMOS image Sensors. Most of the cameras will shoot and capture a full image of 20486 x 1548 and then down sample them to the required 640 x 480 pixel which will be the resolution of the normal display devices. But CMOS image sensors can selectively turn off pixels thereby setting lower or higher resolutions at the time of the initial capture.

D. CMOS Image Sensor:

CMOS image sensors produce digital output representing each pixel. Its support circuitry includes a crystal oscillator and power supply decoding. Some sensors need a resistive bias network of some type. All of these components are surface mounted on the back of the PCB and occupies little space. Connecting a camera directly to the image sensors can cause problems. Trying to clock this raw data in will use up great amounts of CPU time if the microcontroller could do it in the first place. If you drop a pixel because an ISR is doing something more privileged, then you have no ability to sample that location and thus no method of error correction.

Advantages Of CMOS Image Sensors are

No Blooming, Low Power Consumptions (Ideal For Battery Operated Devices), Direct Digital Output, Small Size And Little Support Circuitry (Often Just A Crystal And Some Decoupling), Simple To Design etc..

While the frame rate on many devices can be slowed down by using internal divisors, it still doesn't reach an acceptable speed nor allow random access to pixels. Reducing the master clock rate of the devices will effect exposure times and other time dependent settings thus leading to a different solution. Clearly some additional circuitry is necessary and it is as follows.

E. Digital Image Capture :

Image sensors are inherently gray scale devices and have no color to them, sensors used in cameras typically employ a color filter array(CFA) wedged between microlens and the pixel well. The CFA is constructed to design a single color to each pixel. CFA architecture is based on different combinations of primary colors and complementary colors. The idea behind it is to transfer only the color of interest, so each pixel sees only one color wavelength. CFAs also attempt to reduce color artifacts and interference between neighboring pixels.

F. Color Differentiator:

The Analog to Digital Converter (ADC) passes the digital data stream to a DSP (Digital Signal Processor) chip or chips. In the DSP, the many points of data are assembled into an actual image based on a set of built in instructions. Such instructions include mapping the image sensor data and identifying the color and the gray scale value for each pixel. In a single sensor camera using a color filter array, demosaicing algorithms are used to derive color data per pixel. Think of the color filter array's checkerboard of color pixels as a mosaic or a tiled representation of a captured picture made up of only three or four primary or complementary colors. From this other colors can be created. Demos icing algorithms analyze neighboring pixel color values to determine the resulting color value for a particular pixel. The assembled image exhibits natural gradations and realistic color relationships.

G. Vision At Night:

All colors in the camera are created by combining the light or signals of the three primary colors-red, green & blue. These three primary colors are called channels. Bit depth of color may state for each of the three channels or for the entire channel by multiplying the channel value by 3. We normally use greater bit depths because the greater the bit depths, the more details or tonal ranges you'll capture especially in the shadows and the lights. Once the camera has all these data, it can analyze all the bits and when it converts the image down to 24-bit, it will attempt to retain the most critical image data. If the algorithms are programmed well, the result will be more toned ranges and detail in the lights and shadows than what you get from a simple 24-bit capture.

H. Color Segmentation Algorithm:

A problem faced during lane detection is the partial blocking the visibility of the road. To cope with this problem we may use color segmentation algorithm or we can design systems such that they investigate a small portion of the road where the absence of other vehicles can be assumed. Since lane detection is generally based on the localizations of the specific patterns, it can even be done on a still image whereby we can assume the lane area and thereby reduce the area to be searched, helping in speeding up the detection process.

I. Obstacle Detection:

The first thing required for obstacle detection is to define what an obstacle is. Determining vehicles is alone considered as obstacle detection to simplify things. For when our search ends with identifying vehicles, it is relatively easily done with searches based on specific patterns (like shape, symmetry etc).

The variables associated with obstacle detection and which will need to be updated continuously in real time situations are distance, direction, relative speed, relative acceleration, lateral position, lateral speed and size. The search for possible vehicles can be made in two steps. By exploiting characteristics such as symmetry, shadow underneath the vehicle and differences in the gray level average intensities.

When obstacle detection is limited to the localization of specific patterns, processing can be based on single still images and therefore faster and requiring less processing. A more general definition of an obstacle defines it as anything that obstructs or tends to obstruct the vehicle's driving path. In other words we can say that an obstacle is something that rises significantly out of the road surface. By using this concept obstacle detection is reduced to find free-space instead of analyzing the various obstacles possible and their patterns.

J. 2D Vision (Optic Flow Field):

Here we can use the technique of analyzing of the optical flow field. This technique requires the analysis of a sequence of two or more images. We can compute a two dimensional vector in the image domain, encoding the horizontal and vertical component of the velocity of each pixel. Obstacles can be detected by analyzing the difference between the expected and real velocity fields. We can build up a real time vision system for segmentation and tracking of independently moving objects which can track down objects and be able to correctly handle occlusions among obstacles and automatically track down objects and be able to correctly handle occlusions among obstacles and automatically track down each object that enters the scene.

K. 3D Vision (Trinocular Vision):

A still better method for obstacle detection will be to use a binocular or trinocular vision, whereby we have the advantage of directly detecting the presence of an obstacle. This method also allows 3D reconstruction of the obstacles. The problem is that this method is more sensitive to vehicle movements and drifts in calibration.

L. Pedestrian Detection:

The most challenging task still ahead is vision based pedestrian detection. People dress in very different colors that sometimes blend with the background. They wear hats, carry bags, stand, walk and change directions in the most unpredictable way possible. The backgrounds are also various, containing building, moving or parked cars, autos, cycles, street signs, signals etc. A fusion of pattern detection, stereo analysis, shape detection and tracking must be fused in more than one combination to achieve pedestrian detection successfully.

Pedestrian detection can be split into two steps. The first being to segment the image into foreground and background regions. Then in the second step we determine if the foreground is a pedestrian or not. Pedestrian detection can be achieved by involving the analysis of more than one image, such as:

- The analysis of motion
- The processing of stereo images

M. Analysis Of Motion:

Motion can be used to find interesting regions in the scene. It is quite reliable method when we need to find only the moving object and not its precise velocity. But this cannot be used in case of standing pedestrians. Stereo analysis can be used to build a disparity map of the background for use with background subtraction.

Another important method for human detection is

- Detection of the typical periodicity of the human gait in the movement of foreground regions.
- Shape analysis of foreground regions

For gait recognition we require the analysis of multiple frames and can be easily applied only to pedestrians crossing the vehicle, where the alternating movement of legs is more evident. We can use shape based approaches for recognition of even standing people. Periodicity of the human gait is often recognized with Fourier transform itself. Thus we can use a two phase approach where both phases rely on shape and pattern analysis combined with segmentation. We can use a multiple classifier for arms, heads and legs in a hierarchical organization, in order to cope with occlusions.

N. Digitalised Braking System

On receiving the control signal from the processing unit, electric current passes through the solenoid and as a result, the soft iron core gets magnetized and moves inside the solenoid to the required position. This causes the compressed air to flow into the actuator resulting in expansion of the diaphragm, pulling the piston type valve to move up allowing the circulation of air in the circuit. Consequently the brakes are applied.

IV. Receiver / Monitoring Section

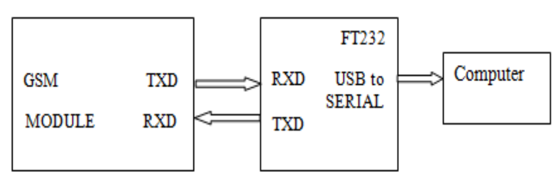

Figure5 :Interfacing of GSM module with PC

GSM module provides information in text mode. The information is given to a computer by interfacing of GSM module to computer by use of USB to SERIAL convertor. Most of the laptops are not having serial port and also in serial port are removed. The Location, Velocity and Identity of a vehicle can be display to the GUI and stored in a database. Figure 6 shows interfacing of GSM module with the PC using

USB to serial convertor. The data received from GSM module is stored in data base and also it can be show on GUI. In case of accident occur the position of vehicle can be easily track use of Google map software. The monitoring station uses a single GSM module which can communicate with number of modules at run time which is a high real time need. This information can also be sending to the nearest hospital/police station to get help easily .This will certainly save the lives.

V. Conclusion

The Vehicular System provides information of a vehicle like velocity, position, through a GPS module and identity of a vehicle to a monitoring station and to a mobile phone according to a definite event stored in a program or a query from a monitoring station and also automatically controls the brakes and steering action in the absence of the response from the driver to provide a safe driving.. This safe driving is done when the driver does not respond to the alarm. Accelerometer senses the collision of the vehicle and sends this information in real time to a hospital/police station. The monitoring station display these information on GUI also stored these information in database for further process according to a program. The system is useful in much application such as surveillance, security, tracking, which may be installed in cargo trucks, cars, motorcycle, and boat. The system can be used in many applications.

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