Catching Moving Violations using Serial Communication

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ABSTRACT
In this paper, the aim is to design a system which will efficiently assist in capturing motorists who break signals at a monitored traffic junction. Signal breaking is a big menace in India currently, and such a system is not in place in any Indian city.. It is a major violation, accounting for 13,244 cases in the first 6 months of this year in the Indian City of Navi Mumbai, 65% more than the number of cases registered in the whole of 2013[1], causing traffic jams and a deadly threat, both for pedestrians and other motorists caught unaware by signal-jumpers. Hence this system of documenting traffic violations has much potential. The design of a prototypical system using components like a Passive Infrared (PIR) sensor, a digital camera module and an mbed FRDM-KL25Z platform is outlined in the paper. The system designed will enable the penalization of those who violate traffic laws.

General Terms
Serial Communication, Moving Violations.

Keywords
Moving Violations, PIR sensors, Digital Camera Module, SD Card Breakout, FRDM-KL25Z platform

1. INTRODUCTION
A moving violation is a violation of the law committed by drivers of moving vehicles. The term 'motion' differentiates it from other violations such as a parking violation, carrying improper documents, etc. Signal-jumping, also known as red light running, is a traffic violation where a motorist ignores a stop sign and "jumps" a signal anyways, i.e. they cross the signal even though they are supposed to stop. In the United States as well, accidents at intersections with traffic lights account for up to 40% of all accidents and a major portion of these accidents could be attributed to motorists running a red light. In this project, the aim is to design a system to detect incidences of signal-jumping [2]. A PIR motion sensor is used to detect the motion of vehicles after the signal has turned red. On detecting motion, it sends a signal to the mbed platform. The mbed, in turn initializes and obtains the picture data from the camera module. The picture data is then stored on the computer and, if necessary, on online storage services such as Google Drive.The form of data communication in between the various components used is serial communication, in which only one bit is sent at a time. The computer/microcontroller reassembles these bits, using the appropriate hardware such as UART (Universal Asynchronous Receiver-Transmitter), to convert the data to parallel form in order to facilitate storage.

2. COMPONENTS EXTERNAL TO THE MBED

2.1 Camera Module
The uCAM-II is a serial camera module which gets attached to another system that may require a video or JPEG still camera[3]. The module can produce both RAW format as well as JPEG format images.The CMOS VGA color sensor and JPEG compression chip enables the module to operate on the low power supply. The serial interface is TTL compatible and is used for connections with any host microcontroller UART or a PC COM port.

2.1.1 Features:
It requires a nominal supply of 5V DC. The on-board serial interface is capable of transmitting JPEG still pictures or raw images up to a speed of 3.68Mbps. Itcommunicates with the help of a serial port. It is done with the help of a serial interface which is used by the host for communication with the MATLAB serial port interface. It consists of built-in color conversion circuits for 16-bit RGB or standard JPEG images. A VGA color sensor along with a RAW/JPEG CODEC is utilized for different image resolutions.

2.1.2 Pin description:

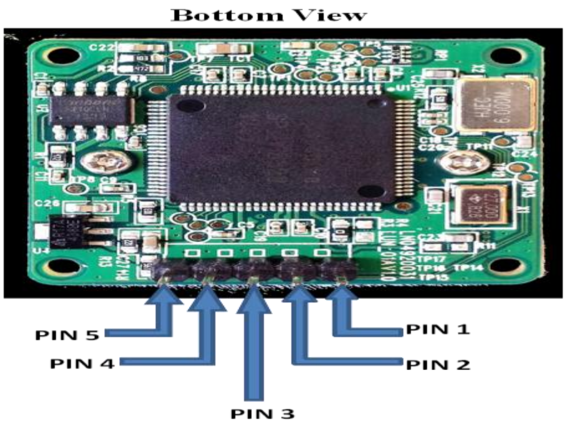

Fig 1: Pins of the uCAM-II module

PIN 1 (+VCC): Supply input pin. This pin must be connected to a regulated supply voltage within a range of 4.5V to 9.0V DC.

PIN 2 (TX/Serial Transmit): It is an asynchronous serial pin. This pin must be connected to the serial receive (Rx) pin of the USB to TTL converter. This pin works on a 3.3V logic.

PIN 3 (RX/Serial Receive): It is an asynchronous serial pin. This pin must be connected to the serial transmit (Tx) pin of the USB to TTL converter. This pin works on a 3.3V logic, but is 5V tolerant.

PIN 4 (GND/Ground): This pin must be connected to ground.

PIN 5: Not connected

2.2 PIR Sensor

The HC-SR501 PIR sensor is an electronic sensor which measures infrared light radiating from objects in the field of view[4]. It does not generate any energy itself but works on the principle of detection of the infrared radiation emitted by objects. Hence, the name consists of the word "passive". It detects motion due to the change in the amount of infrared energy incident upon the sensor, in response to which the sensor sets its output pin to a logic HIGH (3.3 V) voltage. This property makes it useful for intruder detection[5].

2.2.1 Features:

Operating voltage range: 3.6V-20V DCTemperature sensitivity: Temperature compensation might be required depending upon the temperature of the body to be detected as compared to the ambient temperature. If the body is at a warmer temperature, then it becomes difficult to detect at a greater distance when the ambient temperature rises, i.e. the temperature difference becomes smaller. It provides a high output signal of 3.3V when triggered.The quiescent current is in the microampere range (<50 μA), which ensures lower power consumption when idle. This makes the sensor ideal when operated using battery power, where power conservation becomes important.

2.2.2 Pin Description:

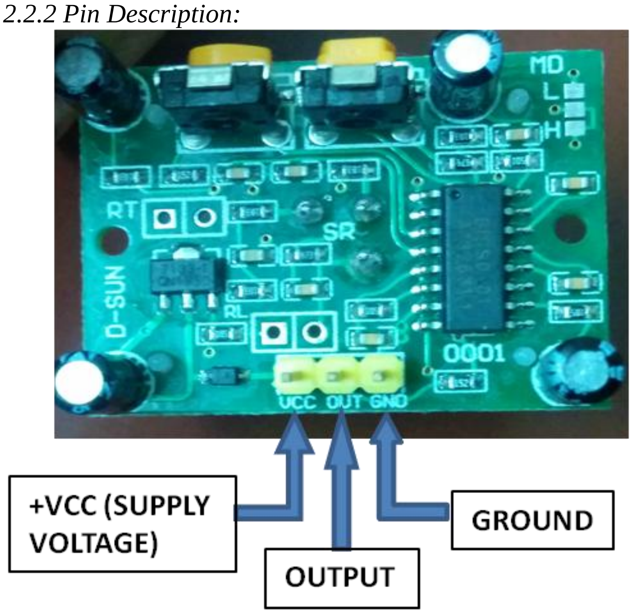

Fig 2: Pins of the PIR Sensor

VCC: This is connected to the DC supply voltage.
OUT: The output of the sensor is obtained using this pin.
GND: This pin is grounded (connected to 0V)

2.3 SD Card Breakout

The SD card breakout socket is used to enable the access to pins on the SD card easily. The pins are described as follows:

2.3.1 Pin Description:

Fig 3: Pins of the SD Card Breakout

CS (Card Select): This pin allows the selection and enabling of the card.

DI (Data Input): This pin receives data from the PSoC.

VCC: This is connected to the positive supply voltage.

CLK (Clock): This is the serial clock input.

GND (Ground): This is connected to the ground

DO (Data Output): This pin sends data from the SD card to the PSoC.

IRQ & P9: These pins are not used.

CD & WP: Neither of these pins are connected.

COM: This pin is not used; it is connected to the ground.

3. PLATFORM USED

The FRDM-KL25Z development platform which is ultra low-cost[6]. Features include an easy access to MCU I/O pins, battery-ready with low-power operation, along with the facilities to make an expansion board as well as a built-in debugging interface which enables flash programming and facilities to implement run-control. The FRDM-KL25Z finds support in a range of Freescale and third-party development software.

3.1 Features:

- 128 KB of flash memory, 16 KB of SRAM, USB OTG (FS).
- Capacitive touch "slider" allows one to detect touch inputs. MMA8451Q accelerometer, RGB LED also present.No software installation required to evaluate compile programs due to the presence of an online compiler.
- mbed enabled, hence one can program it using the mbed compiler.

3.2 Serial Communication in FRDM-KL25z:

The Serial Interface on the platform can be used with supported pins and USBTX/USBRX. USBTX and USBRX are not DIP pins, but represent the pins that route to the interface USB Serial port on order to facilitate communication with a host PC. A picture of the FRDM-KL25z pin configuration is shown below, with the Serial Communication enabled pins highlighted.

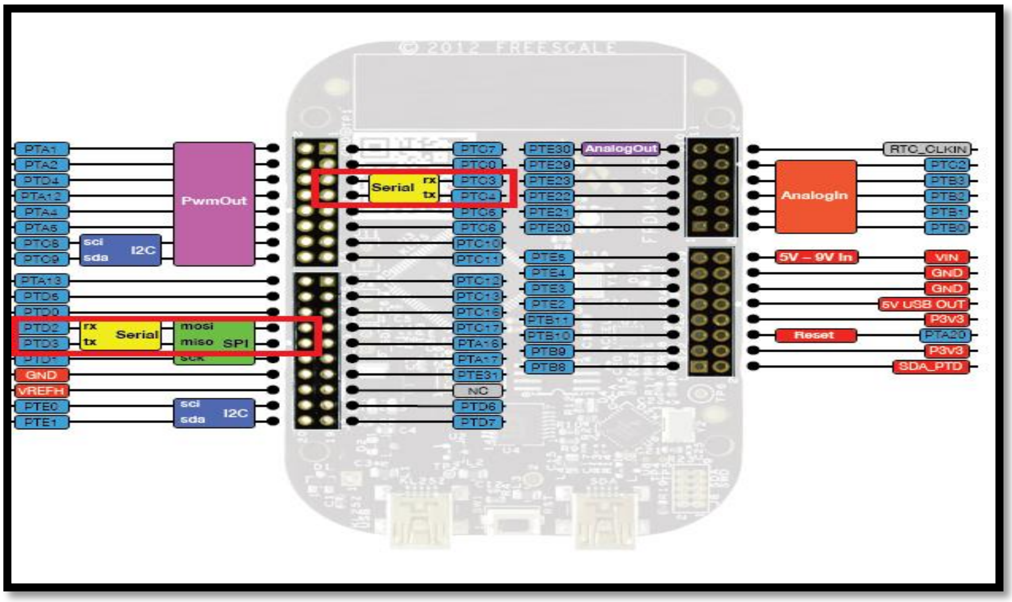

Fig. 4: FRDM KL25z Pinout showing Serial-enabled pins

4. BLOCK DIAGRAM

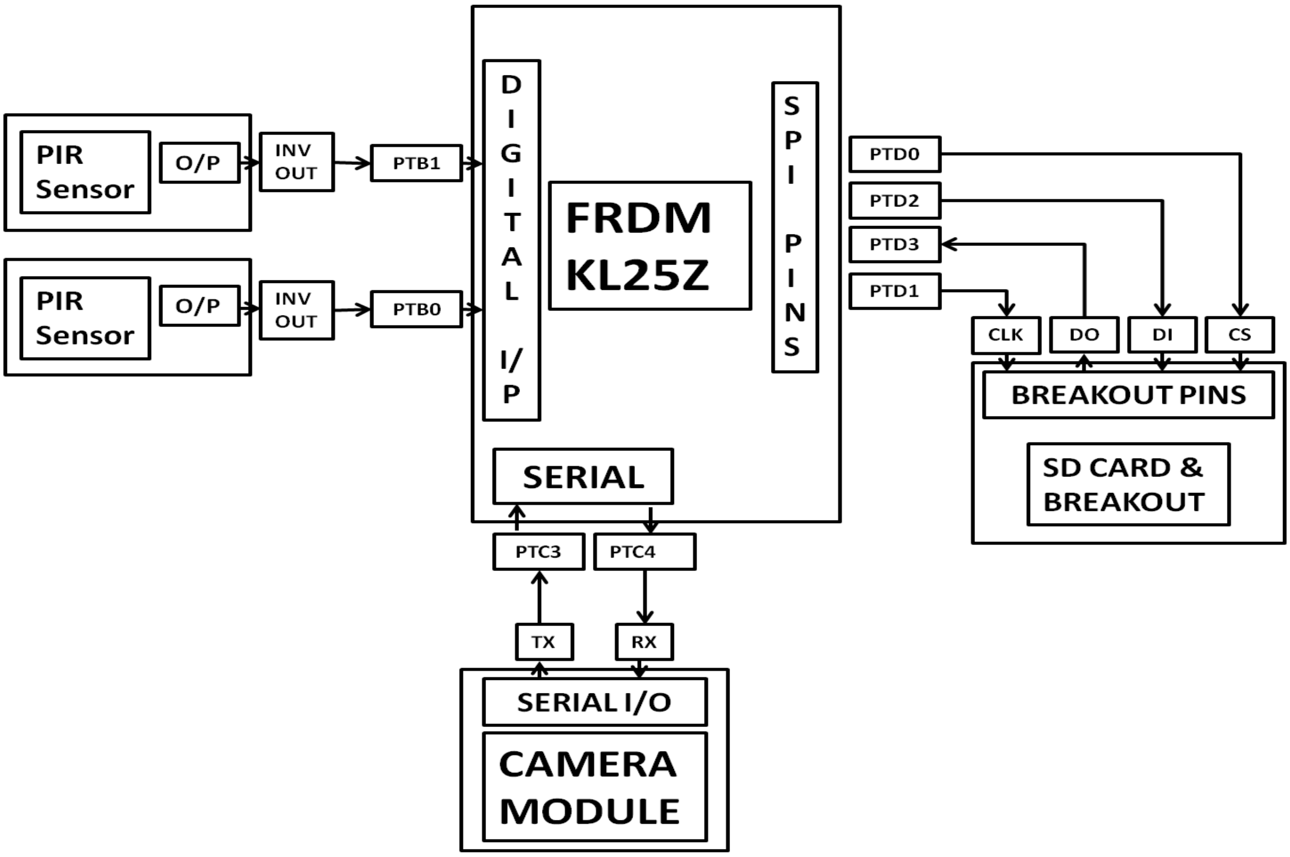

Fig 5: Block diagram showing the system functioning.

5. ALGORITHM TO DETECT SIGNAL JUMPING

Step 1: Initialize suitable variables.

Step 2: Wait for the first PIR to be triggered.

Step 3: Turn on the red led, wait for the second PIR to be triggered.

Step 4: The moment the second PIR is triggered, bring the barrier down.

Step 5: Start communicating with the camera to take the picture.

Step 7: Synchronize the camera module.

Step 8: Set the baud rate to 115200 baud.

Step 9: Initialize the camera module to store a JPEG image of resolution 640 x 480 pixels.

Step 10: Set the package size.

Step 11: Program the Camera to take a JPEG snapshot and store it in the module's RAM.

Step 12: Send a command to the camera module to retrieve the image data from it. Calculate the length of data based on the acknowledgement received.

Step 13: mbed will receive data in the form of several packages from the camera module; each assigned a package ID that varies from 0x0000 to the maximum package ID no.

Step 14: The image data is stored in the SD Card module.

Step 15: Reset the camera module so that it can be used to take another picture, whenever required.

Step 16: Go back to step 2.

6. RESULTS AND DISCUSSION

Fig. 9: A sample picture taken by the uCam-II module

A few noteworthy points we feel necessary to mention regarding our project:

- The optimum baud rate for the camera and mbed to function properly is 115200 bps.
- Although the camera module can store image in various uncompressed formats (such as RAW and 16-bit colour) in addition to the compressed JPEG format, JPEG images are of the best resolution (640x480 pixels) and quality and consume the least amount of data space for their resolution.
- In addition, JPEG images are more likely to be error-free due to the presence of parity data.
- If one chooses not to use the reset functionality, one must turn off the power supply to the camera to take another picture. However, this requires unnecessary manual intervention and is hence not preferred owing to the simplicity of the former method.
- The PIR sensors require that there be a change in the amount of ambient temperature in order to detect any motion.

7. APPLICATIONS AND USEFULNESS

- As discussed earlier, the project can be used to catch signal-jumping motorists.
- It can hence be used to enforce stricter traffic laws and serve as an effective deterrent to other motorists. The benefits could be seen as fewer traffic jams and better safety for pedestrians and other motorists.
- It can also be used to capture pictures of intruders who trigger the PIR sensor, as evidence against them in a court of law.
- The SD card output ensures that the evidence captured can be stored accessed with ease at a later time, either by using an SD card reader or a device which accepts SD cards, such as a mobile phone or PC.
- The market potential of this system can be fully appreciated once we consider the costs involved, as compared to traditional surveillance systems.

8. LIMITATIONS

- This project can, as of now, only deal with one vehicle at a time, since the algorithm is unable to differentiate between various vehicles.
- The system is not fully automated, as we require manual intervention at the last stage to view the image and issue the photo traffic ticket.
- The PIR sensor requires the vehicle to have a temperature different from that of its surroundings. This might not be detectable in cold climates.

9. CONCLUSION

This project described, has thus implemented an embedded system which can be, with a few modifications, successfully implemented in real time at traffic signals to catch motorists.The external components used for the embedded system were studied. The algorithms, limitations and applications of the project were described at length.While still in its infancy, the project has various potential applications even outside the field of traffic law enforcement. The low power requirements enable it to be used with a battery power supply. The aforementioned advantages allow the usage of the project for purposes ranging from wildlife conservation to intruder detection. Variations in the design of this project enable it to detect over-speeding by using two PIR sensors instead of one. This variation can implement an up-counter, based on which the time taken by the vehicle to travel the distance between the limits of the areas under observation of the two PIR sensors can be determined. If the value of the counter is less than a predetermined threshold value, it can be concluded that the vehicle is over-speeding, and therefore the trigger the motion sensor. Taking pictures of endangered animals in this way is vital to monitoring species population [7].The implementation of this system will thus reduce road accidents overall, leading to better safety on roads for bothmotorists and pedestrians[8]Instead of using PIR sensors, ultrasound sensors can be used to trigger the output. This eliminates the need for a temperature difference to be present

10. REFERENCES

[1] Sanjay Banerjee. “Traffic signal jumping soars to a new high”, The Times of India, July 26, 2014.

[2] Retting, Richard A., Robert G. Ulmer, and Allan F. Williams. "Prevalence and characteristics of red light running crashes in the United States." Accident Analysis & Prevention 31.6 (1999): 687-694.

[3] 4D Systems. “Serial Camera Module uCAM-II datasheet.”

[4] Marlin P. Jones & Association. “HC-SR501 PIR MOTION DETECTOR”

[5] Moghavvemi, M.; Lu Chin Seng, "Pyroelectric infrared sensor for intruder detection," TENCON 2004. 2004 IEEE Region 10 Conference , Vol. D, No., pp.656,659, Vol. 4, 21-24 Nov. 2004, DOI: 10.1109/TENCON.2004.1415018

[6] Freescale Semiconductor, Inc. “Kinetis KL25 Sub-Family.”

[7] Brown, Justin, and Stanley D. Gehrt. "The basics of using remote cameras to monitor wildlife." Ohio State University Extension Agriculture and Natural Resources Fact Sheet W-21-09. Ohio State University, Columbus, OH (2009).

[8] Shivani Bhattacharjee, NiramaySanghvi, VarunVaradan, Avi Shah, Aman Shah.” Catching Moving Violations using an Embedded System”,IJCA Vol. 104,No. 16, October 2014

[9] PSoC® Creator™ Component Datasheet. “SDCard 1.0.”

[10] Ashby, Robert. “Designer's guide to the Cypress PSoC.” Vol. 10. Newnes, 2005.

[11] Programmable System-on-Chip (PSoC®) datasheet. “PSoC® 4: PSoC 4200 Family.”

[12] PSoC® Creator™ Component Datasheet. “Pins 1.90” [10]