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Smart Speed Bumps

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ABSTRACT

Speed bumps are the common name for a family of traffic calming devices that use vertical deflection to slow vehicle traffic in order to improve safety conditions. Although speed bumps are very effective in keeping vehicle speed down, they have several disadvantages. Smart speed bumps treat drivers differently depending on their speed and the type of their vehicles. The smart speed bumps only activate if a vehicle is moving above a certain speed. Vehicles moving below this speed will not encounter the discomfort of a conventional speed bump. Another task can be achieved where the speed bump can also be deflated to allow emergency vehicles and heavy vehicles to cross at higher speeds. A prototype model of smart speed bumps system has been built successfully. The Arduino Uno is used as microcontroller board based on the ATmega328.

1. INTRODUCTION

Speed bumps are the common name for a family of traffic calming devices that use vertical deflection to slow vehicle traffic in order to improve safety conditions. Variations include the speed hump (or speed ramp), speed cushion, and speed table.
The use of vertical deflection devices is widespread around the world, and they are most commonly found where vehicle speeds are required to be mandated to be low, usually 40 km/h, or 8 to 16 km/h in car parks. The height of a speed bump in a roadway is typically ranging between 3 and 4 inches (7.6 and 10.2 cm), and its depth is typically less than or near to 1 foot (30 cm). [1][2][3]

Although speed bumps are very effective in keeping vehicle speed down, their use has sometimes public disagreement as they have the following as disadvantages:[3][4][5]

-can cause problems for emergency services and buses;
-can increase traffic noise, especially when large goods vehicles pass by;
-can cause discomfort for drivers and passengers;
-can cause damage to some vehicles; and
-there is a possibility of increased noise and pollution for residents living immediately adjacent to the speed bumps.

2. SUGGESTED PRACTICAL IDEA

Dynamic speed bumps differ from conventional speed bumps in that they only activate if a vehicle is moving above a certain speed. Vehicles moving below this speed will not encounter the discomfort of a conventional speed bump.

To achieve this task, a rubber housing of speed bumps is fitted with a electromechanical valve or pump which works according to the speed of a vehicle. If the vehicle is traveling below the set speed, the electromechanical valve opens allowing the bump to deflate as the vehicle drives over it, but it remains closed if the vehicle is moving too fast.

Another task can be achieved where the valve can also be set to allow emergency vehicles and heavy vehicles, such as fire trucks, ambulances, and buses to cross at higher speeds [6][7]. These dynamic speed bumps with more than one function could be called smart speed bumps, because they treat drivers differently depending on their speed and the type of the vehicles.

3. SYSTEM WORKING

Figure 1 shows the block diagram of the proposed smart speed bumps. The first block represents a speed sensor or a radar, which measures the speed of vehicle and provides the value of the speed to the microcontroller. If the vehicle is traveling below the set speed, the microcontroller activates the electromechanical valve to open allowing the speed bump to deflate as the vehicle drives over it, but it remains closed if the vehicle is traveling too fast. In the same time the microcontroller activates the big indicating screen to warn the drivers about their cars speed and the position of the bump and its condition (closed or deflate).

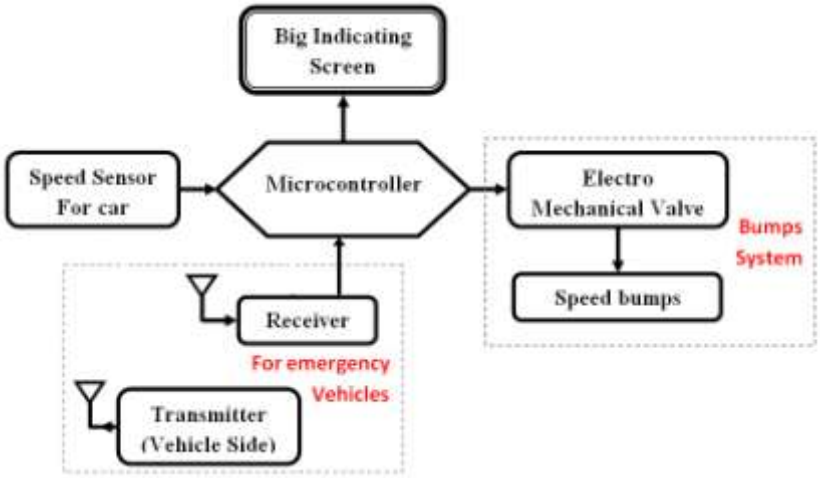

Figure1. Block diagram of the proposed system

Now, the second task of the smart speed bump is to control the electromechanical valve to deflate the bump allowing emergency vehicles and heavy vehicles, such as fire trucks, ambulances, and buses to cross at higher speeds. The arrangement at vehicle side (emergency vehicles and heavy vehicles) is a RF transmitter as shown in Figure1, while at bump side is a receiver which receives the RF signal when the transmitter signal is interacting. The signal available from the receiver is fed to microcontroller and the microcontroller is so programmed that it now the driving system drives the signal to a suitable level that which controls the action of electromechanical valve. The valve deflates the speed bump when the RF signal is interacting with receiver, and hence the emergency and heavy vehicles can cross the bump at higher speeds.

4. PRACTICAL ARRANGEMENT

A prototype system of the smart speed bumps has been constructed as shown in Figure 2:-

(I) The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as pulse width modulated PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead () functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, it have other pins for specialized functions. The Arduino Uno can be programmed with the Arduino software. Select "Arduino Uno w/ ATmega328" from the Tools Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP) [8]. The Arduino UNO is a popular microcontroller which comes on a development board to accelerate programming, provides simple interfacing with peripheral devices and connection with computers. The Arduino UNO chip is programmed with the Arduino programming language and Arduinio 1.0 software through a USB port on the board which plugs into a computer's USB port. The Arduino 1.0 software writes code from the software to the chip by uploading the file containing the desired code to the board. Once the chip has been programmed with the desired code, the chip can be removed from the development board and connected to any circuit.

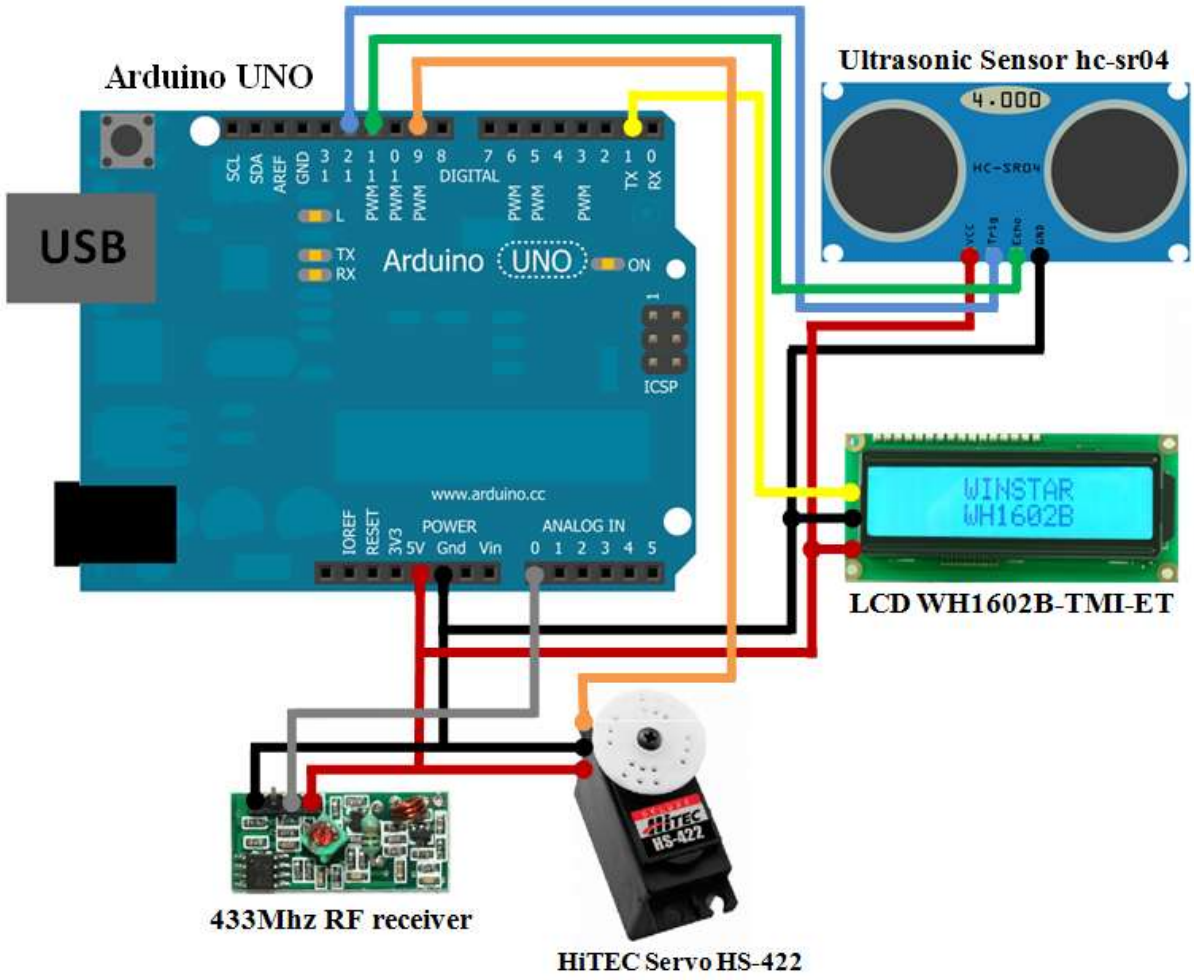

Figure 2: A practical prototype system of the smart speed bumps

(II) The ultrasonic sensor hc-sr04, which shown in Figure 2, is used as speed sensor to measure the vehicles speed. Basically, hc–sr04 is an ultrasonic ranging module provides a non-contact measurement function. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work: (1) Using IO trigger for at least 10μs high level signal, (2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. (3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340m/s) / 2 [9].This sensor is adapted through the microcontroller to be used as speed sensor to measure the vehicles speed.

(III) As prototype model, a servomotor HiTEC Servo HS-422 is used instead of the electromechanical valve or pump mentioned before. It is connected as shown in Figure 2. Servo's receive pulse width modulated (PWM) signals to determine in which manner to move. When the Pulse Width is less than 1.5ms the motor will move to the 0 position and hold. When the Pulse Width is 1.5ms the motor will rotate to the 90° degree position and if the Pulse Width is greater than 1.5 ms the motor will rotate to the 180° position. When the motor reaches the desired position it will hold there until a signal is sent to move. This is done in this application using the Arduino 1.0 coding software to write to one of the Arduino UNO's 5 PWM output pins. The PWM output pins on the development board can be written to with different pulse widths which are used to control the motor. A servo motor can be controlled with an Arduino UNO development board using the hardware and the software approach outlined above. With the program described running, and connections properly made, the servo motor will continuously rotate between 0 and 90° . The servo motor can be coupled to the shaft of the speed bumper which can be used to deflate or remain it closed. [10]

(IV) LCD WH1602B-TMI-ET, shown in Figure 2, is used as indicating screen. The Arduino board is easily used to control the LCD WH1602B-TMI-ET using the proper hardware and software.[11]

(V) 433MHz RF transmitter and receiver link kit for Arduino, shown in Figure 3 and Figure2 respectively, are used. Their specifications are given in [12].

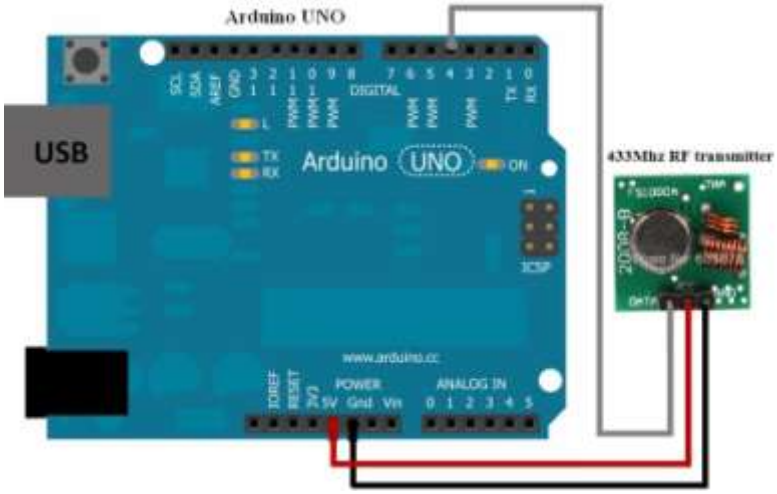

Figure 3. 433MHz RF transmitter kit for Arduino

(VI) Software used is available in components references. Using nothing more than the provided simulation support and debug scripts, researchers can create a high-fidelity simulation of their actual target hardware and environment.

5. RESULTS AND CONCLUSIONS

A prototype model of smart speed bumps system is built. The Arduino Uno is used as microcontroller board based on the ATmega328. This design successfully utilizes a new idea of smart speed car bumps, where they only activate if a vehicle is traveling above a certain speed. Vehicles traveling below this speed will not experience the discomfort of a conventional speed bump. Also the speed bump is set to be deflated to allow emergency vehicles and heavy vehicles, such as fire trucks, ambulances, and buses to cross at higher speeds. The indicating screen can be used to warn the drivers and pedestrians about the cars speed and the position of the bumper and its condition (closed or deflate). The actual model can be performed practically in future.

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