RFID Based Virtual Speed Breakers: Perspective Bangladesh

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Abstract—**The point view of the research offers regulating the road and transportation system of Bangladesh digitally. According to BRTA's annual accident report of five years, it can be said that speed breakers have a great impact on the road accidents. The road authority tries to control the accidental facts by placing speed breakers on the road. This paper offers RFID based virtual speed breaker instead of the traditional speed breaker. That will decrease the construction cost as well as vehicle maintenance cost. It is a smart vehicle controlling system that will ensure the safety of the passengers whither the driver is conscious or not.**

Keywords-RFID, speed braker, microcontroller, ECU (Electronic control unit), fuel injection sysytem, LCD display, road and transpotration system.

I. INTRODUCTION

Speed control is needed of the hour due to increased rate of accidents reported in our day to day life. Bangladesh is a country having about 1.5 million motorized and over 3 million non-motorized vehicles. In recent years good roads are being constructed adding speed to transportation and frequency of movement of people. Simultaneously, the number of road accidents is also soaring high. Road accidents in Bangladesh claim, on an average, about 4000 lives and injure about 5000 people every year. The national loss due to road accident is estimated around 5000crores every year [1]. Under the guidance of the National Road Safety Council there are some organizations those are researching on the Reduction of Road Accidents and Casualties. The mentionable organizations are BRTA, RHD, LGED, MOC and ARI (BUET). According to the research the mentioned organizations play a vital role to reduce road accidents. They have suggested removing the unauthorized speed breakers from the highways. This does not mean that the authorized speed breakers do not cause road accidents. Normally we know speed breakers are raised sections of pavement across the travel way on the road and are approximately 3 to 4 inches high [2]. They are an elongating shape. The intended purpose of these traditional speed breakers is an attempt to reduce speeds by vertically deflecting the wheel and frame of a vehicle. These speed breakers not only cause the road accidents but also have a negative impact on the response time of emergency vehicles. They cause an increase in gasoline consumption and emissions of excessive smoke. Motorists may drive on sidewalks or through yards to avoid the speed breakers, decreasing the effectiveness of the parts of vehicles. The key idea offered by this paper is to use radio frequency identification technology to locate a speed breaker removed physically from the roads. Radio frequency identification (RFID) is an emerging technology, radio wave communication between a microchip and an electronic reader, consisting of data gathering, distribution, and management systems that has the ability to identify or scan information for remote recognition of objects with increased speed and accuracy. RFID based system can be used instead of the traditional speed breaker system. Here the system is named as RFID Based Virtual Speed Breakers. This system will be implemented by placement of RFID tags on the roadside signboards in order to omit the traditional speed breakers from the roads and highways. The proposed Virtual speed breakers consists three units. One is transmitting unit, receiving unit and Electronic Control Unit (ECU). The transmitting unit will be placed on the roadside signboard and the receiving unit will be placed on the dash board of the vehicle. An RFID tag will be used in the transmitting unit. That will leave an electromagnetic signal by an antenna. And the receiving unit will be consisting of a sensor, microcontroller and LCD display. RFID sensor collects information and microcontroller sends signal to ECU and controls the vehicle's fuel supply system and break to maintain a given target speed.

II. PREVIOUS WORKS

RFID tags are mainly tracking and tracing devices. Some works on road and transportation system and vehicle controlling system have already been done using RFID technology. Japan has set-up of the "Free Mobility Assistance System" based on ubiquitous network technology including RFID tags, to provide information for seamless movement [3]. Netherlands has introduced payment cards for public transport [4]. Singapore establishes Nationwide Electronic Road Pricing (ERP) system to control and manage traffic volume; payment of road usage charges. The ERP is applied to all of Singapore's 840,000 vehicles [4]. RFID based highway toll deduction systems which are now routinely employed in many countries, like the Tele-pass system in Italy and the Auto-pass system in Norway. Other uses include monitoring systems to avoid vehicle theft [5], access control to car parking or private areas [6], and embedding of RFID tags in license plates with specially coded IDs for automatic vehicle detection and identification [7]. Placement of RFID tags on the road lanes has been proposed in order to provide accurate vehicle

localization in tunnels or downtown areas where GPS positioning might be unreliable [8]. RFID tagging of cars is offered as an alternative to traffic data collection by inductive loops placed under the road surface [9]. The information about the traffic collected by a network of RF readers is then used to regulate traffic at intersection or critical points in the city [10].

III. WORKING PROCEDURE

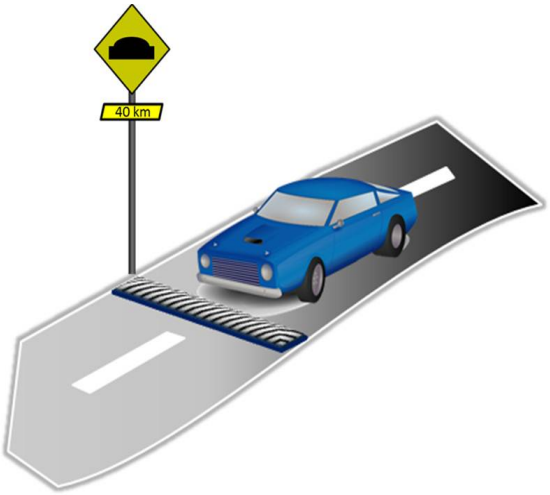

Figure 1. Road with traditional speed braker.

The RFID based virtual speed breaker will have three units (i) transmitting unit and (ii) receiver unit and (iii) electronic control unit (ECU). The transmitter unit will be attached with a roadside signboard. The transmitter unit will be consisting of an active RFID tag. That will consume power from the solar rechargeable battery. A small solar panel will be attached to the roadside signboard. The receiver unit will be on the vehicles dash board. When the vehicle comes into the range of the RFID tag the reader will get specific signal from the tag. The microcontroller in the receiver unit will supply a particular signal to the ECU. The ECU will control the electronic fuel injection system and reduce the flow of fuel in the engine. There would also be an electro-hydraulic Braking system in the vehicle that would also be controlled by ECU. That will reduce the speed of the vehicle as per requisite. When the vehicle will pass out the range of the RFID tag microcontroller would be reset. For emergency or other condition there remains a reset button in the device that resets the whole system. When the road is empty or the less speed is not required then the driver would puss the reset button, and the speed won't be reduced and the driver will be able to pass the area with his desired speed.

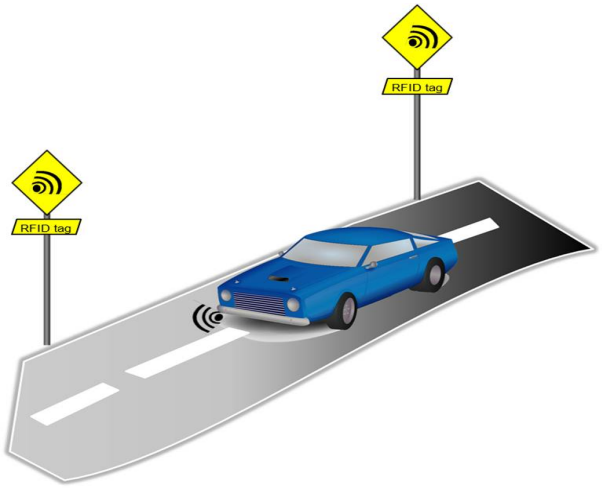

Figure 2. Road with virtual speed breaker.

IV. SYSTEM ARCHITECTURE

This RFID based virtual speed breaker consists of three units. Transmitting, receiving & ECU (electronic control unit). The main parts of the entire system are - an RFID tag that is combined by a chip and an antenna, a reader or RFID sensor along with a microcontroller and another important section is the database where the information about the tagged object is stored. The fuel system of the engine is operated by a fuel injector. Here remains the ECU (electronic control unit). The ECU controls timing and quantity of the fuel entering into the injector. The ECU takes input from the microcontroller and analyzes it. A much explanation of the units are given below.

A. Transmitting Unit

A RFID tag is the main part of the transmitting unit. A chip and an antenna are the components of the tag. The chip contains information about the speed limit and the antenna attached to the chip is responsible for transmitting information. RFID tag of different transmitting range is available. The transmitting range can be determined by the following equation.

$$d_T = \frac{2\pi h_T h_R}{\lambda} \tag{1}$$

Where λ is the wave length of the RF signal and are respectively the heights of the transmitter and the receiver. The RFID tag of certain range should be chosen as per requisite. Using active RFID tags will be better for this system.

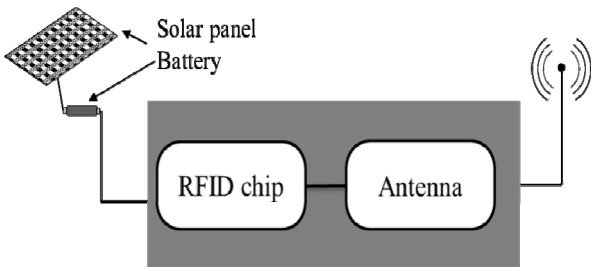

Figure 3. Block diagram of Transmitting unit.

The active RFID tag needs an external power source. Here we will use a solar panel and a rechargeable battery that will be charged from the solar energy. The active tag always sends signals. When a receiver comes into its range it absorbs the signal.

B. Receving Unit

The receiving unit consists of a RFID sensor and a microcontroller. It is mainly attached in the corresponding vehicle. The signal received from the RFID tag used as the microcontroller input. The microcontroller decodes the signal. Here the signal is processed by the microcontroller that goes to the ECU as input. An LCD display is attached on the dash board of the vehicle that displays the corresponding information. There also remains a reset button on the dashboard of the vehicle. By which the driver can distil the whole system when needed.

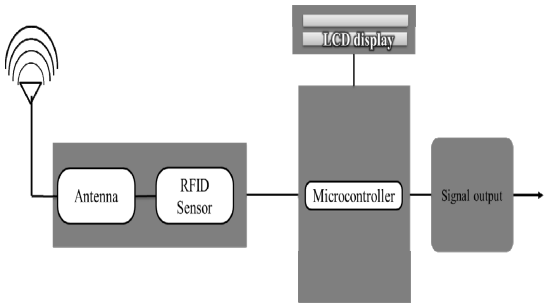

Figure 4. Block diagram of Reciving unit.

C. Electronic Control Unit

In this unit there will be two parts. One part will control fuel flow of the engine and another part will control the braking system. There would be a microcontroller in the ECU. The input data is analysed according to the microcontroller program fed and the output is produced to operate the electronic fuel control system and the Electro-Hydraulic Braking System.

1) Electronic fuel control system:

The fuel system provides the injector with the fuel at constant rate and quantity with certain optimum pressure. The ECU we use here controls the timing and quantity of the fuel entering into the injector. The ECU get the input, analyses it and based on the requirement it provides the output. The fuel flow is being controlled by this. When the signal for reducing the fuel comes the injector reduces the flow. The fuel pump is controlled by varying the pulse width according to the output of the ECU. From the fuel pump after passing through the filter it enters the injector which supplies the fuel to the engine. The fuel supply directly controls the engine speed as well as the vehicle speed.

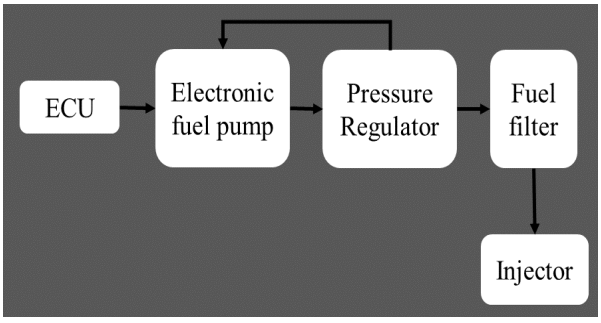

Figure 5. Block diagram of electronic fuel control system.

2) Electro-Hydraulic Breaking System:

The main advantage of this braking system is that it does not affect the actual braking system provided in the vehicle. This is implemented in the car and only actuated if it comes into the area of the RFID range. ECU output is connected to this proposed braking system. This hydraulic system is accompanied with electronic components to permit handling of brakes by signals generated by the ECU.

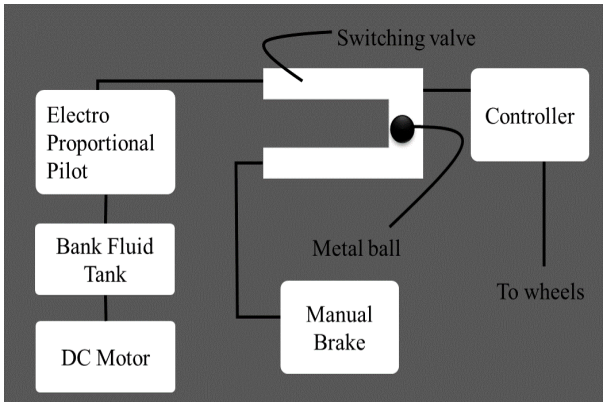

Figure 6. Block diagram of Electro-Hydraulic braking system.

The circuit diagram of the transmitting unit and the receiving unit are given below.

D. Circuit Diagram of Transmitting Unit

In the following circuit diagram of transmitting unit each signboard contains a tag and a RFID sensor. That sends the data to HT12E encoder that encodes the data and send through the data transmitter TXD.

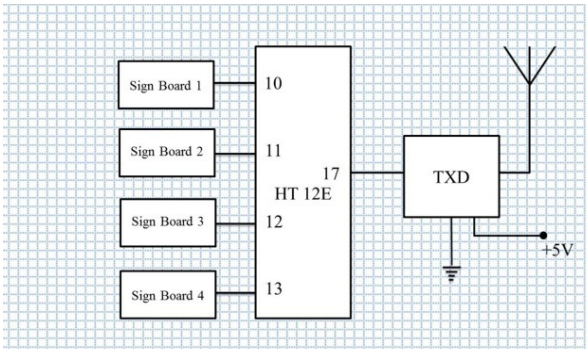

Figure 7. Circuit diagram of transmitting unit.

E. Circuit Diagram of Receiving Unit

In the receiving unit the RXD module is the data receiver. The received data goes to the HT12D decoder. An LED is connected to the decoder, which helps to realize that the device is working or not. The decoder gives analog input to the 89C51 microcontroller. 89C51 has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. A 2X16LCD display is working as the display unit. The audio unit consisting of playback and recording IC APR9600 is also connected to the microcontroller. The motor controlling unit is based on an EEPROM.

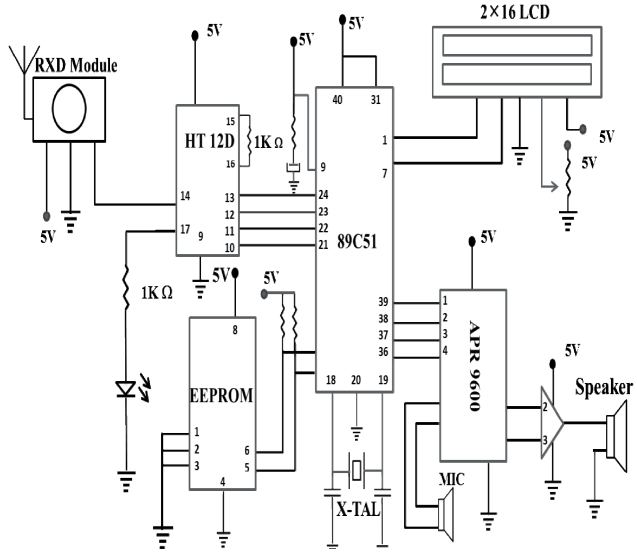

Figure 8. Circuit diagram of Receving unit.

V. RESULTS AND DISCUSSION

According to the BRTA annual traffic accident report the average casualty number is 5953.2 [10] and according to Accident Research Institute (ARI) of BUET speed reducers or speed breaker is responsible for the 30% of the total casualty [11]. If we implement the system this total 30% can be omitted.

TABLE I. TOTAL ACCIDENTS AND CASUALITIES (2006-2010)

Year	Total of accidents	Death Serious	Injury Simple	Injury	Total casualty	(30% of total)
2006	3794	3193	1888	521	5602	1681
2007	4869	3749	2734	539	7022	2107
2008	4427	3765	2720	564	7049	2115
2009	3381	2958	2223	463	5644	1693
2010	2827	2646	1389	414	4449	1335

For example in the year 2010 total casualty was 4449 [1]. After using the proposed speed breaker it would be about 1335. So, about 1335 casualties could be reduced that time. If we can implement the system there can be some system loss due to different futile. We can assume 20% system loss. If such, we could save 1068 people. And the casualties would be 3381. So this system can be helpful for the BRTA.

TABLE II. CASUALTIES USING RFID BASED VIRTUAL SPEED BREAKER

Year	Without speed breakers (casualty)	System Loss (20%)	People could be saved (without SB –system loss)	Total casualties	Casualties (if we would use the system)
2006	1681	336.2	1344.8	5602	4257.2
2007	2107	421.4	1685.6	7022	5336.4
2008	2115	423	1692	7049	5357
2009	1693	338.6	1354.4	5644	4289.6
2010	1335	267	1068	4449	3381

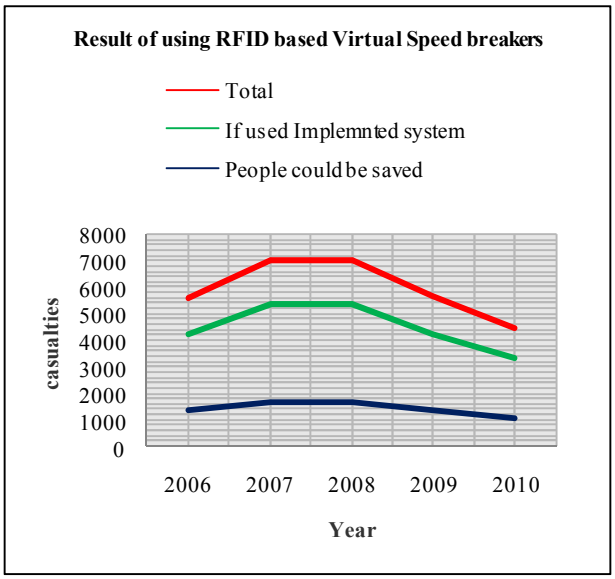

Figure 9. Result of using RFID based virtual Speed breakers.

The following chart shows the result of using RFID based virtual speed breaker. The red curve shows the total causalities till 2010 from 2006. The green curve shows the probable result of number of the causalities if the RFID based virtual speed breaker was used and the blue curve shows the number of people who could be saved.

VI. CONCLUSION

This is to be concluded that the RFID based virtual speed breaker system is easier to implement instead of the traditional speed breakers. The cost of implementation is low and the system is durable. This ensures maximum safety to passengers and public. It also free the vehicle from excess friction and saves the vehicle particle from friction losses. The drivers get all information about the road without distracting him from driving and gets even in bad weather or low power consumption. It can be implemented for the roads and highways of Bangladesh for the safety and digitalization of the transportation system.

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