Load Interceptor

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***Abstract*—In this modern era of life, numerous technological advancements are trying to decide our fate in this world. All the present day gadgets are providing a much better life to humans that they are ignorant about the banes of such technologies. One such bane is the ever increasing number of accidents mocking at us in our surroundings. According to systematic analysis and censual measurements, the causes are infinite. But some are highlighted often such as accidents due to overloads. Weighbridge is the currently employed mechanism to avoid overload traffic and it has many operational difficulties which are overcome by the proposed mechanism. The proposed solution for detection of overload in vehicles is the Load Interceptor. It monitors all those vehicles in the roads and detects the overloaded ones. Here the technology involves mainly a Load Cell and a Zigbee transceiver module. All the vehicles which have the proposed load cell unit fitted with them are scanned whenever the vehicle reaches the vicinity of interceptor having the zigbee receiver and if in overloaded condition, it is notified. Also, the technology inculcates the use of an Instrumentation Amplifier and a Microcontroller of the PIC family. There are two modules, namely a transmitter module and an interceptor module.**

Keywords—LoadCell, Zigbee module, Weighbridge, Instrumentation Amplifier, PIC family.

I. INTRODUCTION

Now-a-days, the accident rates are increasing rapidly, on that road accidents plays the main part. About 75% of the accidents are taking place due to the overload of the vehicles. Although many rules and regulations are initiated to prevent the overload condition on vehicles on the road none of them is being followed. Only rare vehicle inspections are done by the police for the overloads. Load Interceptor is an innovative and application based technology. It aims at locating vehicles with overload condition. It focuses on sensing load on vehicles using hardware and software components. It uses a transmitter that transmits the vehicle number along with their position to the police nearby. It also has a hardware fitted on the vehicle that senses the stress on the vehicle which is then used for the comparison with the database. Based on the comparison messages will be transmitted. The driver may be issued with a prohibition notice that prevents him or her from continuing their journey until the weight is corrected -either the goods have been unloaded to bring the weight down, or redistributed in axle overload cases. In some cases the driver may be issued with a 'direction to drive notice' allowing them to drive to a specific place to offload. As an operator, if your vehicle is overloaded on the road, you have committed an offence under the Road Traffic Act 1988.

Here in this project we introduce a new mechanism for intercepting the weight of a moving vehicle. It focuses on sensing load on vehicles using hardware and software components. It uses an Zigbee transmitter that transmits the vehicle number along with their position to the police nearby. It also has a hardware fitted on the vehicle that senses the stress on the vehicle which is then used for the comparison with the database. Based on the comparison messages will be transmitted.

A load cell [1] fitted on the suspension of the vehicle detects the weight exerted or the strain exerted on the vehicle. The weight is then transmitted to a microcontroller. It finds the difference in weight from the normally allowed weight. If it is a positive value, the Zigbee transmitter sends a message containing vehicle number and the current position of the vehicle using GPS to the police within a distance of 100metres.

II. RELATED WORK

Various advancements in the infrastructural fields have proved efficient in detecting many anomalies. When it comes to overload detection and similar techniques, the prevalent but hefty work is only relevant when people are following the standards provided by the government. One method, existing nowadays to calculate the weight of the vehicle is by using weighbridge. The working involves measuring the weight of the vehicle before loading and after loading. This is only a paper document and it can so be corrupted. A weighbridge is placed permanently at a gravel

pit. The weighbridge is the two part platform over which trucks are driven. The upper works is auxiliary equipment for leveling the load in the truck and is not part of the scale. This scale uses electronic measuring equipment. Thus usual employment of these mechanisms are tedious in a sense.

A. Literature Review

The common mechanism is having its own advantages and is usually referred to as a Weigh Bridge. A weighbridge is placed at a gravel pit. The weighbridge is the two part platform over which trucks are driven. The upper works is auxiliary equipment for leveling the load in the truck and is not part of the scale. This scale uses electronic measuring equipment.

A Truck scale (US), weighbridge (non-US) or railroad scale is a large set of scales, usually mounted permanently on a concrete foundation, that is used to weigh entire rail or road vehicles and their contents. By weighing the vehicle both empty and when loaded, the load carried by the vehicle can be calculated. The key component that uses a weighbridge in order to make the weigh measurement is load cells.

Weighing and measuring devices are commercially used or employed in establishing the size, quantity, extent, area, or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure. NTEP approved scales are generally considered those scales which are intended by the manufacturer for use in commercial applications where products are sold by weight. NTEP Approved is also known as Legal for Trade. NTEP scales are commonly used for applications ranging from weighing cold cuts at the deli, to fruit at the roadside farm stand, shipping centers for determining shipping cost to weighing gold and silver and more.

Types of Weigh Bridges

- Electronic (deep pit type)
- Electronic (pitless type)
- Digital (deep pit type)
- Digital (shallow pit)
- Digital (pitless type)
- Rail Weighbridges
- Movable Weighbridge
- Mechanical weighbridge
- Mechanical (digital type)
- Electro-mechanical
- Portable weighbridge

Truck scales can be surface mounted with a ramp leading up a short distance and the weighing equipment underneath or they can be pit mounted with the weighing equipment and platform in a pit so that the weighing surface is level with the road. They are typically built from steel or concrete and by nature are extremely robust.

In earlier versions the bridge is installed over a rectangular pit that contains levers that ultimately connect to a balance mechanism. The most complex portion of this type is the arrangement of levers underneath the weighbridge since the response of the scale must be independent of the distribution of the load. Modern devices use multiple load cells that connect to an electronic equipment to totalize the sensor inputs. In either type of semi-permanent scale the weight readings are typically recorded in a nearby hoser hut or office. Many weighbridges are now linked to a personal computer which runs truck scale software capable of printing tickets and providing reporting features.

Truck scales can be used for two main purposes:

1. Selling or charging by weight over the bridge (Trade Approved).
2. Check weighing both axle weights and gross vehicle weights. This helps to stop axle overloading and possible heavy fines.

Most mechanical weighbridges have now given way to fully electronic versions where the weighbridge deck or deck sections are supported on a number of strain gauge load cells, connected to weight instrumentation.

- *Pit mounted weighbridges* are flush with the ground. As a result they pose no restrictions to vehicles and are therefore particularly useful at sites where vehicle flow can be in multiple directions. Most mechanical weighbridges were installed in pits so when they are upgraded or replaced the new pit mounted weighbridges provide a very cost effective answer.
- *Surface weighbridges* offer one of the strongest designs and the side frames ensure vehicles always drive centrally through the bridge. Approach and departure ramps can either be of steel construction or pre- cast in concrete on-site. Removable steel ramps have the advantage of being able to be moved with the bridge if relocation is required, leaving the site level.
- *Portable weighbridges* have special load cell assemblies and feet, allowing temporary installation with minimum foundation preparation. Steel ramps provide access.
- *Concrete weighbridges* can offer advantages for certain applications. Pour on site composite versions provide a cost effective solution for medium use operations. These consist of a steel outer frame, inner strengthening beams and reinforcing mesh. Once the unit is assembled on site, the ready mixed concrete is poured in and when the deck has cured, the load cells are fitted. Alternatively the complete weighbridge can be constructed at the factory and delivered to site.

III. PROBLEMS

Weighbridges are expected to operate in the harshest of environments, fully open to the elements. Therefore a well structured finishing procedure is essential to provide optimum longevity. In a typical coating process all steel is shot-blasted to remove mill scale and surface imperfections prior to painting. This ensures maximum adhesion of the surface coating applications. In parallel sound design principles ensure a well drained deck and no hidden traps underneath where hidden corrosion can occur.

The foundations of any weighbridge are crucial to their performance. It is of little use having the most accurate load cells and well designed weighbridge structure if the foundations are unlevel or unstable. For pit weighbridges, adequate drainage is also important to prevent flooding. Where applicable it is possible to install weighbridges on sloping terrain using special steel wedges in the load cell mounting assemblies. Significant end to end forces can be generated when vehicles drive on and off the weighbridge, especially if heavy breaking occurs. Such forces can damage critical components such as load cells and can also cause serious damage to the surrounding structure. Built-in restraints are therefore an important part of any weighbridge design. Modern weighbridge systems can offer considerably more than weight information and their integration with other technologies is bringing dramatic changes to a wide range of industries. However the quality of the data they provide is still totally dependent on sound mechanical design principles and well defined installation procedures.

Some points to ponder over when the prevalent system becomes a bane are :

- Manual corruption by altering scaled values
- Difficulty in weight evaluation by the officials
- Weight limits are applicable only to certain vehicles.
- Space required for the calculation is quite large and tedious.
- Application only to trucks n carrier vehicles.
- Also the process is time consuming.

IV. METHODOLOGY

The methodology is innovative as well as preventive incorporating a new mechanism for intercepting the weight of a moving vehicle. It focuses on sensing load on vehicles using hardware and software components. It uses a Zigbee transmitter that transmits the vehicle number along with their position to the police nearby. It also has a hardware fitted on the vehicle that senses the stress on the vehicle which is then used for the comparison with the database. Based on the comparison messages will be transmitted.

A strain gauge fitted on the suspension of the vehicle detects the weight exerted or the strain exerted on the vehicle. The weight is then transmitted to the microcontroller. It finds the difference in weight from the normally allowed weight. If it is a positive value, the Zigbee transmitter sends a message containing vehicle number and the current position of the vehicle using GPS to the police within a distance of 100metres.

Load interceptor is a hardware oriented technology that is supposed to be used for the public interests in avoiding road accidents due to overload in vehicles. So the main requirements for the proposed system is to identify the vehicles that carry overloads. The system is supposed to be used by the police officers rather than checking each vehicle on road manually just by automatic detection using mass interceptor. The main functional requirement in this project, include detecting the vehicles on road carrying more load than the Government permitted. The detection process involves identifying the vehicle with the help of its unique registration number, current position of the vehicle and the overloaded weight. For this purpose, there should be some mechanism to look out for the overloaded vehicle, for that a Zigbee transceiver can be used. There should be a transmitter fitted on vehicle such that it sends the needed information such as vehicle number, axle distance, current weight of the vehicle. The non functional requirements include those such that the system should be reliable enough to work in any situation such as in heavy traffic and other atmospheric conditions such as rain. It should be a secure one such that no one can go with malpractice of carrying overload. The system should have a long life time.

A. COMPONENTS

- Load Cell
- Zigbee module
- Instrumentation Amplifier
- PIC

Load Cell : A load cell is a transducer that is used to convert a force into electrical signal. The most common type is a strain gauge load cell [2]. Load cells are the prime measuring sensors for weighbridges and therefore are the most critical component. Modern sealing methods and materials of construction provide excellent environmental protection whilst well-designed mounting hardware ensures optimum load introduction. Two basic types of load cell are used in weighbridges - analogue and digital. Although analogue load cells are well tried and tested, giving excellent service, digital load cells offer distinct advantages, especially during installation, calibration and troubleshooting.

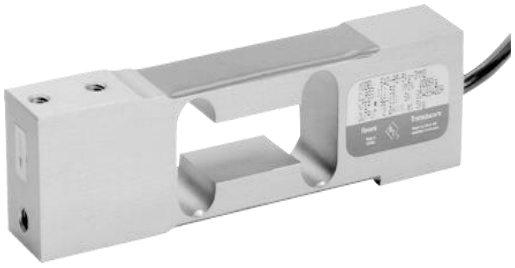

Fig. 1 Load cell

The load cell is attached to the object by a suitable adhesive. As the object is deformed, the foil is deformed, causing its electrical resistance to change. The resistance change is commonly measured using a Wheatstone bridge. A Wheatstone Bridge[4] is an electrical circuit used in a load cell to measure an overall change in resistance and it also increases sensitivity and reduces the affects of temperature.

Strain-gauge load cells[3] convert the load acting on them into electrical signals. The gauges themselves are bonded onto a beam or structural member that deforms when weight is applied. In most cases, four strain gages are used to obtain maximum sensitivity and temperature compensation. Two of the gauges are usually in tension, and two in compression, and are wired with compensation adjustments. When weight is applied, the strain changes the electrical resistance of the gauges in proportion to the load. Other load cells are fading into obscurity, as strain gage load cells continue to increase their accuracy and lower their unit. Compression load cells often have an integral button design. They are ideal for mounting where space is restricted. They offer excellent long term stability.

Zigbee Module : ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee[9] is based on an IEEE 802.15.4 standard. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi.

ZigBee is a low-cost, low-power, wireless mesh network standard targeted at wide development of long battery life devices in wireless control and monitoring applications. Zigbee devices have low latency, which further reduces average current. ZigBee chips are typically integrated with radios and with microcontrollers that have between 60-256 KB flash memory. ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; 784 MHz in China, 868 MHz in Europe and 915 MHz in the USA and Australia. Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).

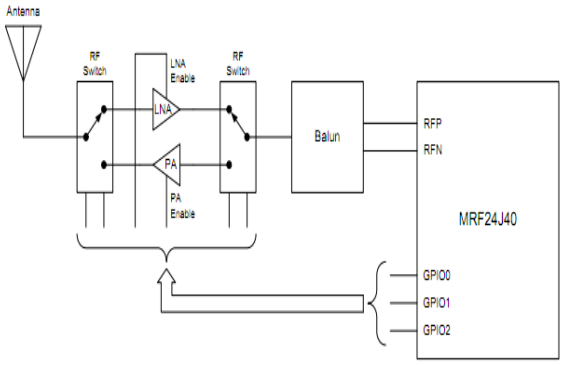

Fig. 2 Zigbee Interfaces

Instrumentation Amplifier : An instrumentation (or instrumentational) amplifier is a type of differential amplifier that has been outfitted with input buffer amplifiers, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. Additional characteristics include very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances. Instrumentation amplifiers are used where great accuracy and stability of the circuit both short and long-term are required.

Although the instrumentation amplifier is usually shown schematically identical to a standard operational amplifier (op-amp)[5][6], the electronic instrumentation amp is almost always internally composed of 3 op-amps. These are arranged so that there is one op-amp to buffer each input (+,−), and one to produce the desired output with adequate impedance matching for the function. The most commonly used instrumentation amplifier circuit is shown in the figure. The gain of the circuit is,

$$\frac{V_{\text{out}}}{V_2 - V_1} = \left(1 + \frac{2R_1}{R_{\text{gain}}}\right)\frac{R_3}{R_2}$$

The rightmost amplifier, along with the resistors labelled $R_2$and R_3 is just the standard differential amplifier circuit, with gain = $R_3/R_2$and differential input resistance = 2· R_2. The two amplifiers on the left are the buffers.

With R_{gain} removed (open circuited), they are simple unity gain buffers; the circuit will work in that state, with gain simply equal to R_3/R_2 and high input impedance because of the buffers. The buffer gain could be increased by putting resistors between the buffer inverting inputs and ground to shunt away some of the negative feedback; however, the single resistor R_{gain} between the two inverting inputs is a much more elegant method: it increases the differential-mode gain of the buffer pair while leaving the common-mode gain equal to 1

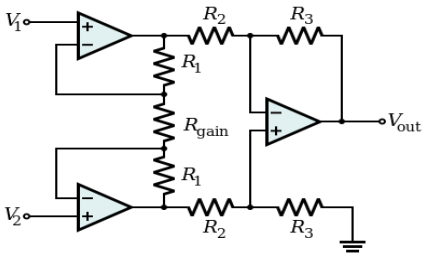

Fig. 3 Instrumentation Amplifier Circuit Diagram

PIC : PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC was initially referred to as

Peripheral Interface Controller. The first parts of the family were available in 1976; by 2013 the company had shipped more than twelve billion individual parts, used in a wide variety of embedded systems.

All current models use Flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is 8-bit, 16-bit and in latest models, 32-bit wide. Program instructions vary bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The hardware capabilities of PIC devices range from 8-pin DIP chips up to 100-pin SMD chips, with discrete I/O pins, ADC and DAC modules, and communications ports such as UART, I2C, CAN, and even USB. Low-power and high-speed variations exist for many types.

The PIC family of microcontrollers are used generally in the field of information exchanges after comparison with programs. The specific IC PIC 16F873 having an EEPROM module helps in the programming of this IC. It has flash capacity and a program memory of upto 64K. The PIC[7] stands for Programmable Intelligent Computer and so is the working of this IC. The C language is embedded in this IC and it compares the values of present and allowed weights. As a result the Zigbee module transmits information.

B. WORKING

The Load Interceptor has three main modules in the practical working area :

Load sensing and evaluation, Data analysis & comparison and Data transmission to & fro.

Here the load cell connected to the vehicle gets a strain value when vehicle gets overloaded. This value is comparatively less in the range of 0.01 and so forth. So this value is amplified with the help of an instrumentation amplifier thus multiplying it with a value range of 1000. The output is the fed into the PCB of the transmitter module .Here the PIC compares the value with the allowed weight of the vehicle and proceeds further based on this result. If the value is higher, the the specified details embedded in the chip are transmitted via the Zigbee transmitter.

Front End of the GUI : C#.NET
Back End of the GUI : Sql Server

V. RESULT

With the usage of both hardware and software implementations combined ,the detailed information of the vehicles can be recorded timely with Vehicle number, allowable weight value, present overloaded weight value, time & date. Thus an effective check on the ever increasing overloading problem may substantially reduce the proportion of road accidents. All the mechanisms employed in the load interceptor are quite responsive with any significant overheads. Enhancements can be suited to their working environment and the fast lane progress of the system. GPS facility and real time notification messages to the vehicle users may prove to be an added attraction of the technology in its stable state.

VI. CONCLUSION

With this system, social and economic evils, accidents and related threats can be eliminated to ensure safety of both the pedestrians and passengers as overload is the main reason nowadays responsible for majority of accidents.

The technology enhancements may also lead to widespread applicability in buses, cars, rickshaws and many more. The overheads associated with manual checking of load allowable in vehicles are easily rectified with the aid of this technology. As the technology can be attached to the vehicles during their manufacturing time, the cost factor will not affect the implementation of this innovative idea. The technologies inculcated with the load interceptor are all low cost and low power mechanisms when compared to current trends. As a future enhancement, the technology can be generalized and applied to be a part and parcel of every automobile with the introduction of fast growing GPS facility connecting interceptor hubs.

Correspondingly, the Zigbee receiver in the interceptor module scans an entire region of upto several metres continuously searching for signals[64000]. When it receives the signal, it provides a GUI to the officials about the information of overloaded vehicles.

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