A Basic Study on Ubiquitous Overloaded Vehicles Regulation System

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Abstract—Load managing method on road became necessary since overloaded vehicles occur damage on road facilities and existing systems for preventing this damage still show many problems.Accordingly, efficient managing system for preventing overloaded vehicles could be organized by using the road itself as a scale by applying genetic algorithm to analyze the load and the drive information of vehicles.Therefore, this paper organized Ubiquitous sensor network system for development of intelligent overload vehicle regulation system, also in this study, to use the behavior of road, the transformation was measured by installing underground box type indoor model and indoor experiment was held using genetic algorithm. And we examined wireless possibility of overloaded vehicle regulation system through experiment of the transmission and reception distance.If this system will apply to road and bridge, might be effective for economy and convenience through establishment of U-IT system..

Keywords—Overload Vehicle. Genetic Algorithm, Embedded System, Wim Sensor, overload vehicle regulation

I. INTRODUCTION

FROM growth of economy, most commercial traffic is using the road, overload vehicles have been increase that exert and influence upon road safety, traffic flow, social overhead capital and economical of nation.

Currently part of overloaded vehicle regulations rely on measurement of static load from installed overload checkpoint because of high accuracy. Fig. 1

Efficiency on overloaded vehicle regulations depend on possibility regulation, need many human power and cost for raise the efficiency

Also the existing overloaded vehicles regulation system have demanded measures about problems that misconduct be possibility and incur the enmity of the people from specialized insufficiency on regulation staffs.

On this, the present research is indicating building methods of unattended U-overloaded vehicles regulation system applied with ubiquitous technology, and practical regulating plans for to solve problems of overload vehicles regulation, and troubles that occurred by overloaded vehicles.
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Fig. 1 The existing overloaded vehicles regulation system

II. COMPOSITION OF UNATTENDED U-OVERLOADED VEHICLES REGULATION SYSTEM

A. Ubiquitous

The origin of "Ubiquitous" comes from Latin, meaning om-nipresent. Developing this theory and giving rise to the field of IT for the next tech era's paradigm is the Ubiquitous Computing technology.

Ubiquitous was started out by Mark Weiser who was the chief scientist for the Palo Alto Research Center of Xerox.

He mentioned the theory of ubiquitous in a thesis titled "The Computer of the 21st Century," which was published in the 1991 September issue of Scientific American.

In this thesis, Mark Weiser justified the theory of ubiquitous as being invisible. In other words, this means that we are able to use a computer through a network in our daily lives with-out being aware about it[1].

B. Ubiquitous Sensor Network

The formation of USN has several sensor networks where the field is connected to the outer network through the gateway.

The sensor nodes that are installed on the median barrier highway will send data through a close receiver and the receiver will deliver these data to the manager.

The data that will be delivered can be sent through satellite communication, cable/wireless internet, and this Access Network will use the previous infrastructure..

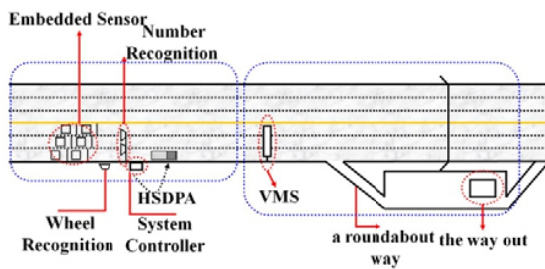### C. Formation of Whole System

Fig. 2 Ubiquitous Intelligent Overload Regulation System

Fig. 2 indicates that the system is made up to be installed on regular roads for rapid judgment whether the vehicles are overloaded or not without influencing to traffic flow, send information to the overloaded vehicles, regulation offices, and related organizations.

The whole system has composed with USN Sensor Field, System Controller, and External Network. The USN Sensor Field measures the speed of vehicles, and it is formed with Loop Sensor that is for checking the passing of each vehicle, Embedded Sensor for measuring the vehicles' axial load, and recognition equipment of (license plate and wheel) for overloaded vehicles.

Likewise, system controller is composed with Sink Node that collects information that are measured by USN, Gate-way that sends the information out, Middleware for pro-gram synchronization with outer network, and HSDPA/WCDMA for communication with outer network. It sends the data to outer network, enables real-time check. Overloading control office sends information of the ve-hicles that are subject of control to competent organization, and decides possibilities for treatment and enforcement of penalty.
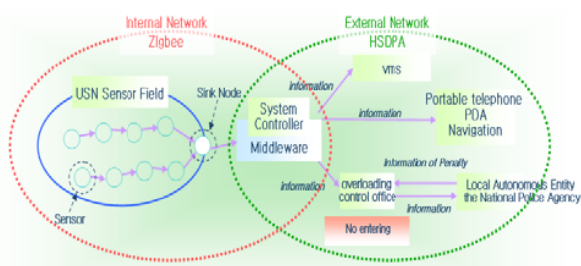
D. Formation of Whole System

Fig. 3 Intelligent Overload Regulation System

Fig. 3 is presenting a U-overloaded vehicles regulation System. It sends information that was measured from several sensors to one Sink Node through USN, and the Sink Node sends the measured information to System Controller. The System Controller sends the information to variable message sign (VMS), report the violation record to offender, send the content to the violator's cell phone, PDA, Navigation, and so on, and inform to overloading regulation office. The overloading regulation office undertakes administration duties of infringement with competent Local Autonomous Entity and

the National Police Agency.Zigbee, one of short distance wireless communications, is used for communication in Internal Network, and 3.5-generation wireless communication HSDPA (High-Speed Downlink Packet Access) is used for External Network as it is presented Fig. 3.

E. U-Overloaded Vehicles Regulation System Algorithm
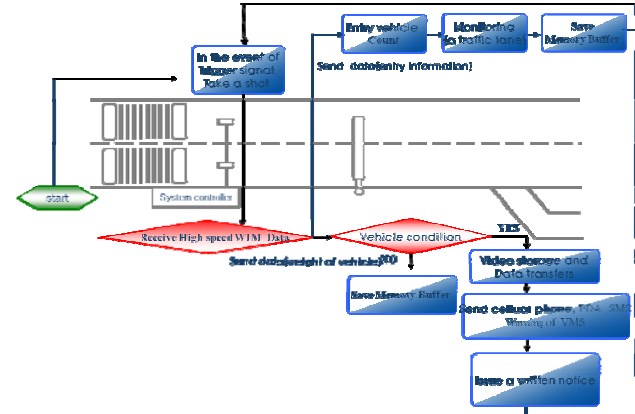

Fig. 4 System algorithm

Fig. 4 is presenting an algorithm of U-overloaded vehicles regulation system. The judgment process order of overloaded vehicle has done as remarked above, and alternation of algorithm that enables supplement and management of operation-permitted vehicles on occasion demands is possible

III. PERFORMANCE TEST OF SENSOR FOR USN FORMATION

A. Vehicle Load Analysis

Although the vehicle load analysis system using the behavior of bridges is being researched in [2], analyzing vehicle load on the road is usually being done through WIM sensors on the ground. In this research, we took a look at a vehicle load analysis system using strain signals which reflect the behavior of box-type structures, which are installed in some sections of roads, instead of WIM sensors installed on the pavement. This study prepared Indoor models for experiment to conduct related loading tests. The indoor models were built into box-type structures in order to take into account the peak value of strains caused by vehicle load. The study designed the width and length of model structures in consideration of axle spacing of model vehicles for loading and it established the system for calculation of gross vehicle weight by measuring axle load. The analysis method used in this study adopted genetic algorithm which can consider dynamic characteristics. It is an inverse load analysis which, minimizes the error between values of sensor data from indoor and those from a finite modeling such as indoor models [3]. The method to extract load data only from measured signals by using such a genetic algorithm can be used in various situations, especially, where it is hard to get load data without WIM sensors such as current roads or bridges[4]. To apply this method, a system is required, which analyzes values through sophisticated analysis on structures, and then tracks vehicle load through simulations with data from vehicle tests.

This study used the Genetic Algorithm Tool box provided by Matlab and the following is the formation of the entire system[5].
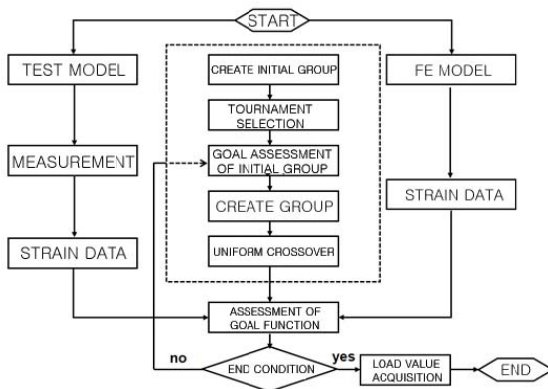

Fig. 4 The vehicle load analysis system

For vehicle load analysis, the study conducted numerical analysis by applying moving load of general 3D finite element modeling and inverse analysis by applying generic algorithm to data from real model tests. To secure a higher accuracy, this study applied both the speed of load and the values of strains recorded by the three sensors which were installed in the box used for indoor experiment.

B. Analysis of Test Vehicle Load s

The finite element modeling and sophisticated system composition for indoor tests were done for genetic algorithm inverse analysis system. Then, after driving vehicle 5 times, the dynamic responding data were attained. The load analysis was conducted based on data measured by the system. To examine the performance of vehicle load analysis using proposed genetic algorithm system, after measuring load through static load measuring instrument, the study estimated the relative error compared to the result values.
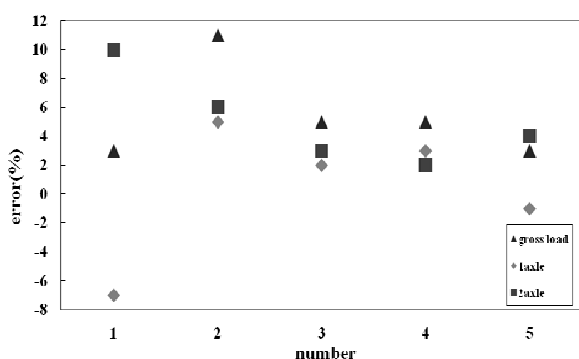

Fig. 5 Comparison of Errors

The Fig. 5 shows relative error of axle load and gross load through genetic algorithm of test vehicles. The errors were within the tolerance 10%, a tolerance, and the errors were attributed to partial inconsistency between indoor model test and finite element modeling.

IV. Designing Ubiquitous Platform

To solve the problems of existing Overloading Control System, we need to apply ubiquitous technology to Overloading Control System and construct an unattended and wireless system.

For this, we need a wireless technology and system designing technology that enables the sensor to send the measured information wirelessly and let the user and overloaded-vehicle know the violation. The present system is composed with USN Sensor Field, and System Controller.
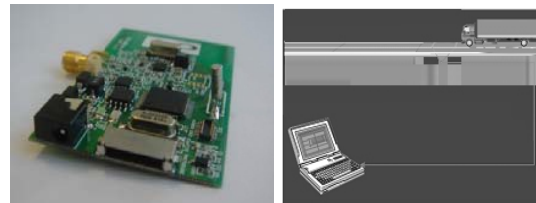
A. USN Sensor Field s

Fig. 6 Sensor Node and Embedded Sensor

It is important to make wireless through USN Sensor Field composition with several sensors such as Embedded Sensor that measures a vehicle's weight, Loop Sensor that sense passing of vehicles, image perception facility, and so on. In the case of Ubiquitous Sensor, it is possible to fix Sensor Node, and send information wirelessly. Through linkage several sensors, we can compose Sensor Field with wireless communication technology such as Zigbee and Bluetooth to organize Wireless Sensor Field.

B. Wireless Sensor Node efficiency test

This experiment on distance of transmission and reception of wireless sensor node for acquire data from applied sensor node

In U-overloaded vehicles regulation system case, we assumed suitability of communicative distance over 300m because distance of USN Sensor Field and other Internal Network is closed as within 10m. The field experiment have been done on Seoul Hanyoung University's playground and Salgoji Park. The experiment of method; when the start point, confirm the 100% transmission quality and extend distance checked transmission quality. Also, we considered sensor node based information that transmission quality is over 50%, data does not loss.

C. System Controller

Gateway that performs as a Sink Node, which gathers collected information from USN, Data Logger that processes sensing data, Middleware that enables communication with the exterior, and Modem that is related to WCDMA or HSDPA, which sends direct data, are built in a System Controller. Gateway and Middleware designing technology is playing a role as a gate that information goes out when gathered information is sent from USN Sensor Field to another Sensor Field or network. Gateway is possible to function equally in Sink Node where the gathered information from Sensor Field is

passing through.

Data Logger is a facility that alters analogue input of sensor measuring data to digital number, and record automatically. It convert analogue signal to digital signal through AD converter.Middleware is a programming service that arbitrates in between of more than two systems, and the present system is operating synchronization between Sensor Field and each applied service through Middleware.VMS, user's cell phone, PDA, Navigation and HASPA (High-Speed Downlink Packet Access), which is for sending overloaded vehicles' information to overloading control office, is possible to send larger volume and data faster than CDMA Technology. It has merits that it does not need extra investment, and it is possible to use with a little improvement of WCDMA system. This present system is possible to send information fast and precisely, which has been gathered and processed by HSDPA, to overloaded vehicle, control office, and related agency. In addition, it enables sending massive information, checking through wireless internet, and provides real-time confirming service.

V. APPLICATION PLAN OF U-OVERLOADED VEHICLES REGULATION SYSTEM

The U-overloaded vehicles regulation system is able to institute free operation method according to various purposes such as restriction or regulation of overloaded vehicles. It is a small scale USN. It transmits overloaded vehicle's information to main control system, and it can be connected with another ITS (Intelligent Traffic System) field, and applied to national traffic system. In addition, it can be used to prevent load carrying capacity declination of structures such as bridges through controlling vehicles, which are control-objected, coming and going in several system operations. This kind of free utilization of U-overloaded vehicles regulation system can be used to national or personal purposes, and improve the efficiency of system application.

VI. CONCLUSION

From this study, grasp problem of the existing overloaded vehicles regulation system, and experimented on development of system with based indoor test for unattended overloaded vehicles regulation system using Ubiquitous technology. Results of experiment are as follow.

1.) Whole system is organized USN Sensor Field, System Controller, External Network. Measured data from several sensors transmit to one Sink Node through USN and tranmit to System controller. System controller report to diver's cell phone, PDA, Navigation and VMS (Variable Message System)

2.) This study offered standard of effective overloaded vehicle regulation from development of Overloaded vehicles regulation system algorithms.

When vehicle go through Loop Sensor, camera take a picture of vehicle and Embedded Sensor measure vehicle's load.

System controller received vehicle's data and load data. When vehicle is not overloaded, data saved on Memory Buffer. However, vehicle is overloaded, System controller notice to diver's cell phone as SMS Message, print contents on the VMS

3.) Instead of using WIM sensors installed in the paved surface, analyzing vehicle load in indoor tests using strain sensors of the road itself showed satisfactory accuracy.

4.)The result of transmission distance test about wireless sensor node on the free-space. Communication quality on 120m is 86%, communication quality on 300m is 56% that more than 50% quality. Considered based sensor node information that transmission quality is over 50%, data does not loss. Also acquisition data using wireless for possibility compatible with sensor node

5.) This system have applied on the road, bridge and others, will be expected economical effects because decreased labor costs through uninhabited system and improved system reliability from using high efficient sensor and fitting algorithms. Also system install is convenience from Ubiquitous Sensor Network system, installation charge is diminution through application with existing overloaded vehicle regulation system and established u-ITS

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