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A Web-based geographic information system for monitoring animal welfare during long journeys

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Summary

Animal welfare protection during long journeys is mandatory according to European Union regulations designed to ensure that animals are transported in accordance with animal welfare requirements and to provide control bodies with a regulatory tool to react promptly in cases of non-compliance and to ensure a safe network between products, animals and farms. Regulation 1/2005/EC foresees recourse to a system of traceability within European Union member states. The Joint Research Centre of the European Commission (JRC) has developed a prototype system fulfilling the requirements of the Regulation which is able to monitor compliance with animal welfare requirements during transportation, register electronic identification of transported animals and store data in a central database shared with the other member states through a Web-based application. Test equipment has recently been installed on a vehicle that records data on vehicle position (geographic coordinates, date/time) and animal welfare conditions (measurements of internal temperature of the vehicle, etc.). The information is recorded at fixed intervals and transmitted to the central database. The authors describe the Web-based geographic information system, through which authorised users can visualise instantly the real-time position of the vehicle, monitor the sensor-recorded data and follow the time-space path of the truck during journeys.

Keywords

Animal welfare, Animal transportation, European Union, Geographic information system, Italy, Traceability, Web.

Un Web-GIS per il monitoraggio del benessere animale durante il trasporto

Riassunto

La protezione del benessere animale durante i lunghi viaggi è obbligatoria in accordo con la legislazione comunitaria che prescrive che gli animali siano trasportati in conformità con i requisiti del benessere animale e che parimenti fornisce, alle autorità alle quali è demandato il controllo, una serie di strumenti legislativi per reagire prontamente nei casi di irregolarità e per assicurare l'esistenza di una rete sicura tra prodotti, animali ed aziende. Il regolamento comunitario 1/2005/CE prevede anche il ricorso ad un sistema di tracciabilità all'interno del territorio comunitario. Il Joint Research Centre della Commissione Europea (JRC) ha sviluppato un sistema prototipo che soddisfa i requisiti del regolamento CE 1/2005/CE, in grado di monitorare la conformità con i requisiti di benessere animale durante il trasporto, di registrare l'identificazione elettronica degli animali trasportati e di immagazzinare i dati in un database centralizzato e condiviso con altri paesi membri per mezzo di un applicativo Web. Un primo equipaggiamento pilota è stato recentemente installato su un veicolo; esso memorizza i dati relativi alla posizione

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del veicolo (coordinate geografiche, data/ora) ed allo stato di benessere degli animali (temperatura interna del veicolo, etc.). L'informazione è registrata ad intervalli pre-stabiliti e trasmessa al database centralizzato. Gli autori descrivono il Web-GIS del sistema di navigazione, utilizzando il quale gli utenti autorizzati possono visualizzare in tempo reale la posizione del veicolo, monitorare i dati registrati dai sensori e seguire il percorso spazio-temporale del camion durante i viaggi.

Parole chiave

Benessere animale, Italia, Sistema informativo geografico, Tracciabilità, Trasporto di animali, Unione Europea, Web.

Introduction

Transport is considered one of the most stressing events that can happen to an animal, be it transported to slaughter or moving from one farm to another (2). During road transportation, animals are exposed to a variety of stress factors, such as animal density, heat, cold, humidity, poor air quality, vibration, motion of the lorry, noise, etc. in a relatively short period of time. The stress caused by transportation has a considerable economic impact, since it can lead to deaths and can negatively affect meat quality (1, 2, 8).

Transport of animals occurs on a large scale both within and between European countries and between European Union (EU) and non-EU countries; about 4 million cattle, 4 million sheep, 10 million pigs and 150 000 horses are exported from EU countries each year (7).

Long journeys (defined by the EU as journeys lasting more than 8 h) are more likely to negatively affect animal welfare than short trips. Hence, specific procedures should be designed to ensure better enforcement of the standards, in particular by establishing real-time monitoring of transportation conditions and increasing the traceability of such transport operations (3, 4).

The European Union, considering the proposal advanced by the authorities of member states and also taking into account the need to mitigate the impact of transportation on animal welfare, adopted Regulation (EC) 1/2005 devoted to the protection of animals during transport and related operations (3).

The Joint Research Centre (JRC) of the European Commission is responsible for providing technical support to the Directorate General for Consumer Protection (*Santé et protection des consommateurs*) (DG SANCO). Concerning animal protection during transport, JRC has developed an effective navigation system in accordance with Regulation (EC) 1/2005; the system is currently being tested (4, 5, 6).

All data concerning livestock movements are collected in a central database. To ensure prompt and efficient reaction, it is important to provide veterinary authorities, slaughter-houses, stakeholders and all interested bodies and institutions with powerful and user-friendly tools to access data on a timely basis, thus accelerating the decision-making process (6).

The system was developed to enable targeted, effective and efficient controls by competent authorities with the following aims:

- govern animal trade, contributing to a more efficient disease control
- identify non-compliant transport in real time and to intervene proactively when monitored animal welfare parameters are violated
- decrease administrative burdens for both transporters and competent authorities
- contribute to prevent fraud
- contribute to a fast updating of the national animal databases (6).

The World Organisation for Animal Health (OIE: Office International des Épizooties) Collaborating Centre for veterinary training, epidemiology, food safety and animal welfare of the *Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'* (OIE CC-IZS A&M) has developed a Web-based geographic information system (GIS) to visualise and query data collected. Through a generic internet browser, the Web-GIS enables the immediate visualisation on a map of the current position of animals being transported and also makes it possible to monitor the status of animal welfare requirements.

This paper describes the Web-GIS developed during the first phase of the JRC project.

Materials and methods

The prototype is composed of navigation and communication systems (Fig. 1).

In accordance with the requirements of Regulation (EC) 1/2005 (3), the navigation system is designed to collect, record and transmit a defined set of data as specified in the Regulation and in the DG SANCO working document (4). The system consists of a variety of hardware components, as listed below.

On-board unit

The on-board unit (OBU) is the core unit of the navigation system and is composed of:

- a global positioning system (GPS) engine to locate the vehicle and to provide precise timing
- a global system for mobile/global packet radio service (GSM/GPRS) engine for the transmission of data acquired to a remote receiver
- a persistent memory to retain the stored data in case the OBU is turned off or the chip and/or module is physically removed
- a predefined set of communication ports where digital and analogical sensors are connected, such as environmental temperature sensors
- loading door sensor (a switch that senses the state of a door as being open or closed), truck coupling/decoupling sensor

Cabin user interface

Using a cabin user interface (CUI), the driver of the vehicle is able to enter a predefined set of information into the OBU (category, species and number of animals loaded, start and end of journey, number of animals injured/dead during transport). The CUI informs the driver about the status of the system and also releases alert messages when the temperature in the animal compartment exceeds a predefined threshold.

All parts are interconnected. The system is autonomous, collects data at fixed intervals (5 min, at this development stage) and is able to run independently of the truck/trailer power supply system.

The OBU transmits data collected from the GPS receiver and from the truck sensors to the central database via the GPRS module and a Web-service is provided by the central database (Fig. 2). The stored data are sent at regular intervals (60 min, at this stage of development) and/or when certain events occur (asynchronous events include: start, rest, resume, end of journey, login event or download event, tamper or malfunctioning event). The Web service checks and stores the received data in an Oracle® Relational Database Management System (RDBMS); each data block is distinguished by a journey identification, data block identifier and name and authorisation of the transporter.

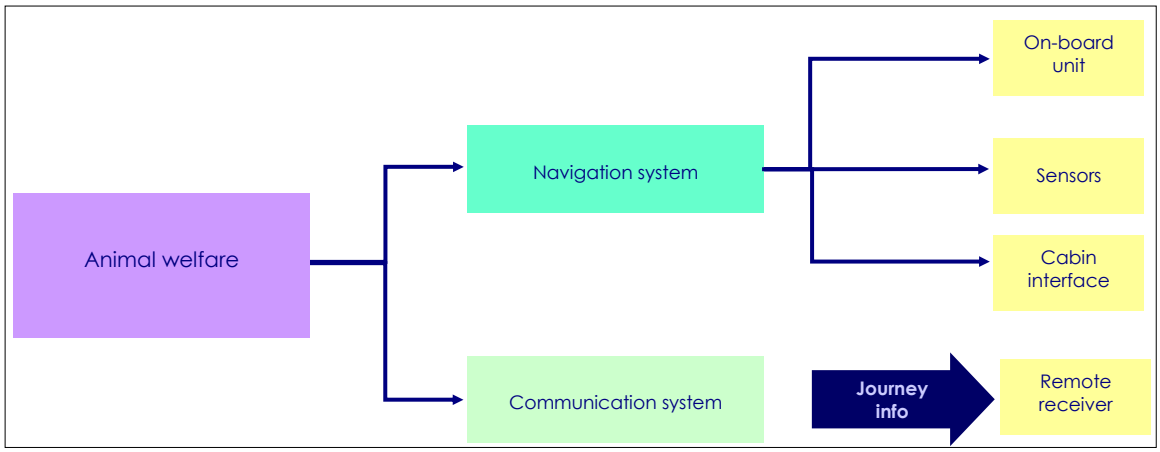

Figure 1
Prototype developed by the Joint Research Centre
Regulation (EC) 1/2005

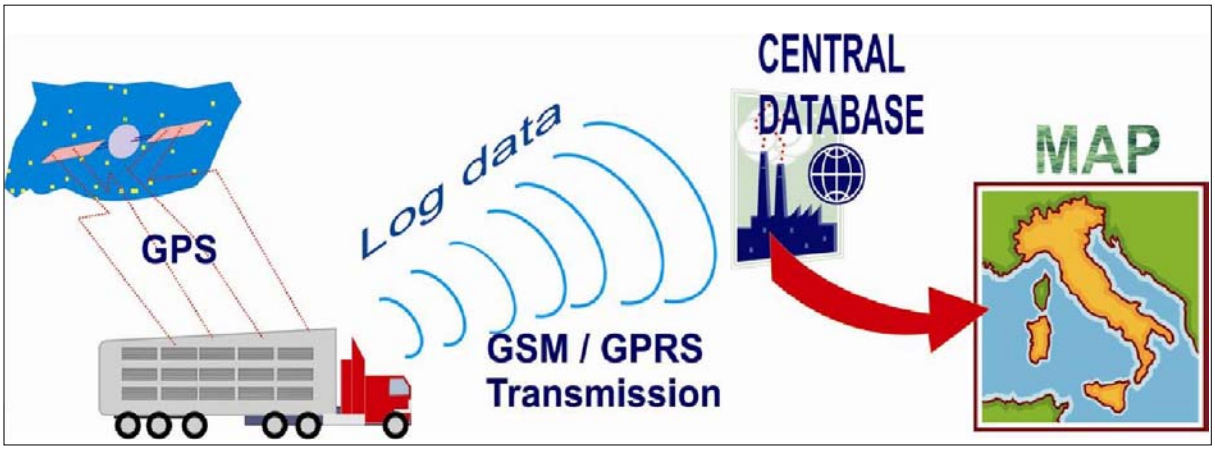

Figure 2
Information flow from the truck to Web-based geographic information system

These alphanumeric data can be geographically accessed as they occur and analysed on the Web using a GIS application.

An ArcMap™ Image Service (ArcIMS™) provides vehicle location and sensor information as 'event theme' layers. An event theme is a geographic layer built 'on the fly' reading tabular values of latitude and longitude; updating or adding geographical coordinates in the table are immediately reflected as updated or added features on the map.

Layers available in the map are as follows:

- temperatures in the animal compartment: warning threshold values are fixed at 30°C as a maximum and 5°C as a minimum as defined in Regulation (EC) 1/2005
- status of the loading door: open/closed
- tampering or malfunctioning event, such as power disconnection, sensor failure, low battery status, opening, removing the OBU, etc.

The central database was created at the Italian Animal Identification and Registration System database (*banca dati nazionale*: BDN) using Oracle® RDBMS (www.oracle.com), while the GIS-website was developed using ESRI ArcGIS™ 9.0 to manage the basic orientation and interpretation layers and the event theme layers; ArcIMS™ 9.0 software was also used, to publish information on the Web (9).

Results

Some of the output results produced by the Web-GIS application are showed in Figures 3 and 4. These figures show a sample of data recorded during two journeys of the same vehicle: one going from Florence to Hungary, and the other going from Umbria to the Marche region of Italy. Data in the examples were collected in simulation journeys without animals in the truck.

In particular, Figure 3 shows the track route of the vehicle: blue dots represent the position of the vehicle during the journey. Detailed information (latitude, longitude, time, sensors values, etc.) can also be accessed through tables, derived through a query tool available for all layers in the map. Figure 4 shows an example of sensor information recorded at each position: in the main map, dots are coloured and sized according to the temperature values; in the central box, the map shows data on the status of the door (open/closed), and in the bottom box, the map returns the sensor status (tampered or working). Each sensor is represented by a different layer in the map and can then be accessed and queried independently.

Discussion

Regulation (EC) 1/2005, Article 3, states that 'no person shall transport animals or cause animals to be transported in a way likely to cause injury or undue suffering to them'.

Figure 3
The Web-based geographic information system application showing the route of a truck

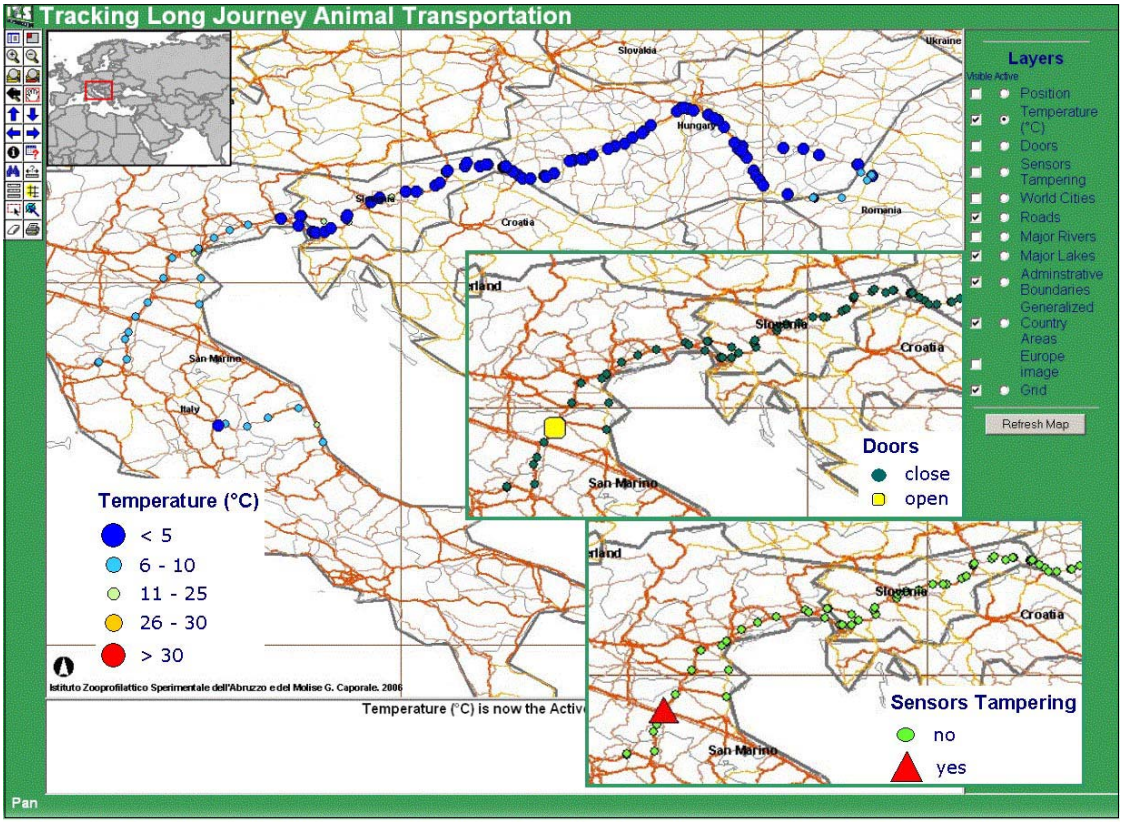

Figure 4
Layers showing different information recorded by the sensors at each position

The prototype system developed by JRC provides transporters and authorities with a tool that is able to monitor and control animal welfare during long journey transportation, i.e. the navigation system enables verification of compliance with animal welfare requirements.

The Web-GIS application provides authorised users with a real-time geographic 'picture' of the current position of the animals being transported and information on the general environmental conditions inside the truck. It allows visualisation in real-time deviations from the journey plan, or non-stop journeys lasting more than 24 h (illegal according to EU legislation) and it sends out an alert if certain sensors are recording dangerous variations in the parameters which might affect animal welfare (sensors in an alarm mode). This readily available and up-to-date information is presented in a visual and intuitive way and is accessible with a user-friendly tool. In this way, the decision process can be accelerated, more efficient and targeted to the spatial area of interest.

A number of additional tools are being developed in the project, which is still ongoing. It will be possible to:

- differentiate displayed data, selecting specific trucks and/or journeys
- visualise journeys by time: the user can visualise the current journey of a truck, or query the system to obtain data about journeys performed in a specific time period (query by date)
- add layers related to new sensors (for example, humidity sensors) or to data entered by the driver or veterinary authorities regarding species, number of animals, journey events, intervention on the system.

Moreover, the system will be integrated with epidemiological data: boundaries of restricted areas (for instance, due to disease outbreaks) will be included in the application, so that the driver can be alerted to any necessary route changes.

The system provides users with updated data on journey conditions and provides technical tools to define and query the geographical position of trucks. The real-time interactive mapping system increases the efficiency of the entire system, allowing easier data management. Information generated and spread via the Internet provides a precious resource to facilitate decision-making processes and management of activities in cases of emergencies. Moreover, the flexibility of the system and of its tools makes it possible to manage data from any context where the spatial component plays a fundamental role.

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