

FARMNET - a GIS application of an automatic wireless declaration and monitoring system for perished or diseased animal collection vehicles in Taiwan

M. L. Shih

Department of Safety, Health and Environmental Engineering, National Yunlin University of Science and Technology
No.123, University Rd., Section 3, Douliou, Yunlin 640, TAIWAN
shihml@yuntech.edu.tw

C. J. Hsu

Department of Civil Engineering, National Central University
No.300, Jungda Rd., Jungli City, Taoyuan 320, TAIWAN
hsujoker@ms21.hinet.net

C.F. Chen

Center for Space and Remote Sensing Research, National Central University
No.300, Jungda Rd., Jungli City, Taoyuan 320, TAIWAN
cfchen@csrsr.ncu.edu.tw

P. S. Yu

Department of Hydraulic & Ocean Engineering, National Cheng Kung University
No.1, Ta-Hsueh Rd., Tainan 701, TAIWAN
yups@mail.ncku.edu.tw

Abstract: Taiwan's animal industry has already been transformed from being a traditional small scale farming culture to a capital and technological intensive agro-industrial operation. Facing pressure from imported animal products, Taiwan has already begun to realize its strategy of producing high-quality, healthy and safe animal products to meet consumers' demands. In recent years Taiwan has tried to establish an integrated management system to help raise the overall competitiveness of its animal industry.

In 1999, we started to investigate and collect animal farm spatial data creating a GIS farm database, and now more than 80 percent of animal farms have been formally registered on this database. We have achieved good improvements in the area of pollution and disease control. Further more, we also established a monitoring system that can efficiently monitor and control the collection vehicles for perished or diseased animals from farms for cremation. We also created a module for each collection vehicle that consisted of a declaration input device and a weighing system. This module receives integrated real-time positions, loadings and declaration data for perished or diseased animals during the daily operating period for each collection vehicle via the global positioning system (GPS) and the general packet radio service (GPRS). We also have an in situ supervising vehicle that can retrieve and monitor information from the remote server system by GPRS, enabling the monitoring of possible improper usage conducted by the perished or diseased animal collection vehicles. Consequently, FARMNET closely interconnects the delivery information between the collection vehicles, control center, and supervisor on duty, central and local government.

Keywords: GIS, GPS, GPRS, FARMNET

1. Introduction

In recent years, Taiwan's meat market (chicken, pork, beef, duck, goose and mutton) has become big business both domestically and for sale abroad, especially after Taiwan joined the World Trade Organization (WTO). Therefore, Taiwan as well as the other members of the WTO has to improve its products' value and quality to meet this new larger market. Unfortunately, during the time the government would have liked to have promoted its farmer's food on the WTO market place, only a few of its farmers and business men were taught about diseases such as foot and mouth and bird flu, they colluded with the diseased animal collection vehicle drivers for illegal benefit and so some diseased meat still arrived on the market. This study will introduce the GIS database and associated systems to prevent the above scenario.

The combination of the Global Positioning System (GPS) and Geographic Information System (GIS) has been used in many applications [1][2][3][4][5]. In this study, we used the Global Positioning System (GPS), Geographic Information System (GIS), Global System for Mobile Communication (GSM), loading sensor devices and internet technologies integrating all of these sub-systems to produce FARMNET; - an automatic wireless declaration and

monitoring system for perished and diseased animal collection vehicles.

A research stage was initially implemented consisting of three collection vehicles fitted with the declaration and loading sensor modules. This research stage was used to test FARMNET's viability.

2. System Architecture

1) Overview

In order to track the collection vehicles and avoid illegal usage of dead animals, FARMNET monitors the activity and the relative GPS status for each of the perished and diseased animal collection vehicles (ACVs). The system is composed of three major parts, the monitoring center, the animal collection vehicle modules (consisting of GPS and GSM units, a micro-controller, a declaration interface and a loading sensor) and the in situ supervising vehicle, see figure 1 below.

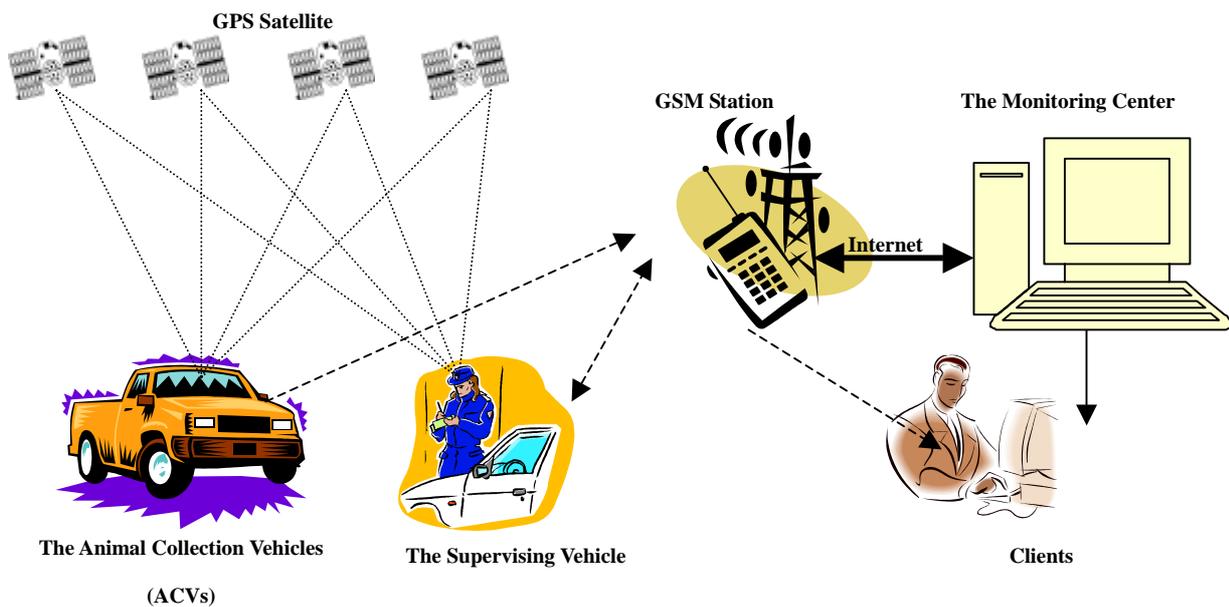


Fig. 1. FARMNET system architecture

2) The Animal Collection Vehicle Modules (ACVMs)

Each ACVM includes a micro-controller, a GPS and a GSM unit, four loading sensors and a declaration interface. The micro-controller is the kernel processor which collects and transmits all of the ACV's activity, such as its position, the date and time, its velocity and direction, the GPS status and the weight of its current load to the monitoring center. The GPS unit provides the ACV's real-time activity such as its position, the date and time and its velocity and direction. The loading sensors are used to measure the animals' weight from the farms to the cremation center. The declaration interface displays the current status of the ACV and allows the driver to enter each farm's serial code and the quantity of perished and diseased animals collected, this information can be entered either through its keypad or its built-in barcode reading function. The micro-controller collects and regularly reports the above units and sensors' information to the monitoring center via a GSM communication medium. A diagram of an ACVM is shown below in Figure 2.

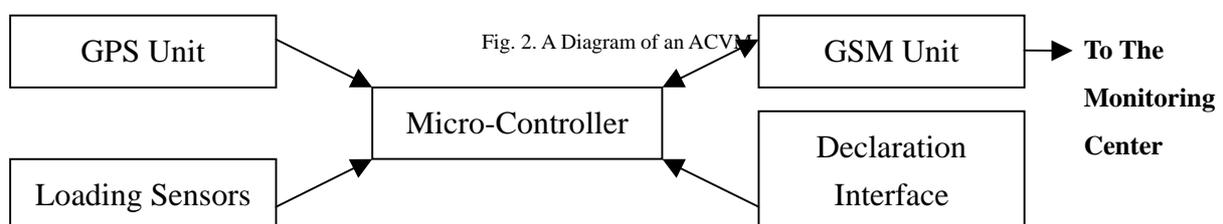


Fig. 2. A Diagram of an ACVM

3) The Supervising Vehicle

The on board system in the supervising vehicle allows the supervisors to check the status of the perished and diseased animal collection vehicles (ACVs), but it's a difficult job without any tools to help and guide them. Therefore, we developed the on board supervising vehicle system to predict and monitor each ACV's location, route and load at any time they wish. The system was installed on a tablet PC and connected to the GPS mouse with a Bluetooth wireless interface. A GPRS PC card links the supervising vehicle to the monitoring center's database via the internet. The supervisors do not need to contact the monitoring center's operator to search and find a particular ACV, making it easier for them to do their job. A diagram of the supervising vehicle on board system is shown below in Figure 3.

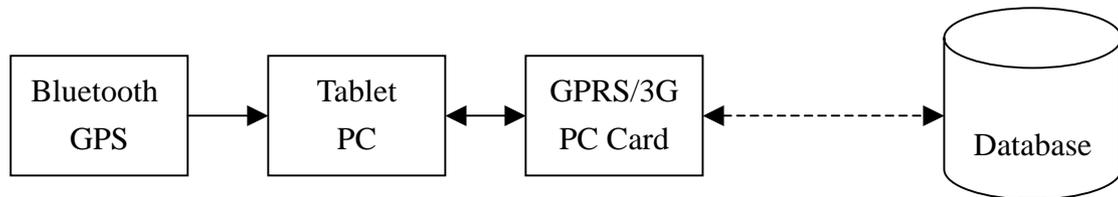


Fig. 3. The supervising vehicle on board system

4) The Monitoring Center

The monitoring center includes several facilities: a database server, an application server, a web server, a firewall and a GSM modem. The database server collects the ACVs' information from the internet and passes it the supervising vehicle. The application server has software that analyses each ACV's information currently held on the database, helping the client to judge whether the vehicle has stayed in the same place too long or more importantly if any diseased meat has been removed from an ACV before reaching a crematorium. The application server through the GSM modem will also send a short message warning (through the SMS) to the client telling him/her if any of the ACVs have done anything suspicious. The web server provides a simple query application for the clients' use over the web using a standard web browser such as Microsoft's Explorer. The firewall provides security against any electronic criminal activity.

3. Results

We have spent two years developing the FARMNET system. To date the FARMNET system consists of more than 75 animal collection vehicles (ACVs). Each ACV has been installed with an animal collection vehicle module (ACVM) as shown in figure 7 below. The FARMNET system can also identify an abnormal occurrence and automatically notify the off duty supervisor via its SMS function, as shown below in figure 4. This Chinese New Year, our police arrested and prosecuted a large criminal gang that were involved in the distributing and selling of diseased meat that was scheduled to be cremated but was not. The on duty supervisor contacted the police informing them of some improper behavior being conducted by two ACV drivers. The police acting on this information were able to look at the routes of these two ACV drivers over their recent past history. The on duty supervisor was able to identify the abnormal load losses and find their location using the GIS application software as shown in figure 5a and 5b below. A screen shot of the TrackMap GIS application software depicting all the ACVs currently in the FARMNET system is shown below in Figure 6.

Last year we developed a proto-type weighing plate for an ACV. However, this proto-type weighing plate, as shown in Figure 8 below, was too heavy because it increased the consumption of gasoline and the maintenance costs of the ACV. Therefore, this year we replaced this heavy weighing plate with four loading sensors installed at each corner of the ACV's chassis, see figure 9 below. This new weighing method significantly reduced the cost of modifying a standard truck to create an ACV as well as reducing the ACV fuel and maintenance costs. The weighing system needed to be initially calibrated and checked every year, the new loading sensor have proven to be very accurate and reliable, the calibration process is shown below in Figure 10. This year we also added a declaration interface for the driver to record the number of perished and diseased animals that the driver collects at each farm and the farm's unique identifying number. This information maybe entered either through the declaration interface's keypad or its built-in barcode reader.



Fig. 4. The SMS notification to the off-duty supervisors' cell phone

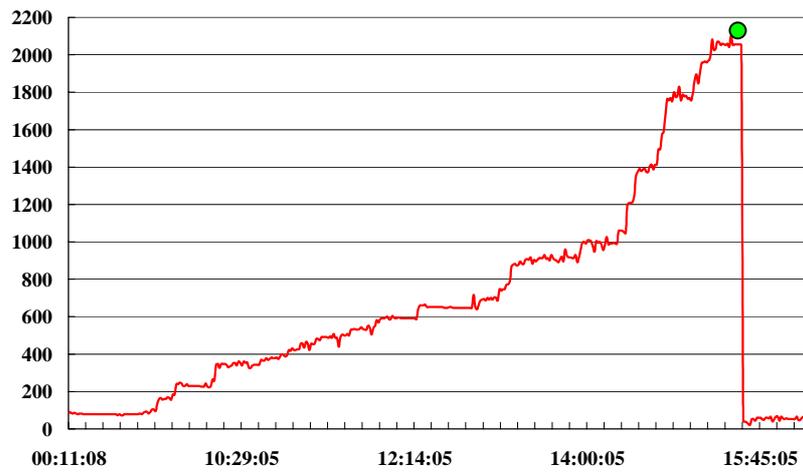


Fig. 5a. A load graph showing an ACV's activity during a normal day

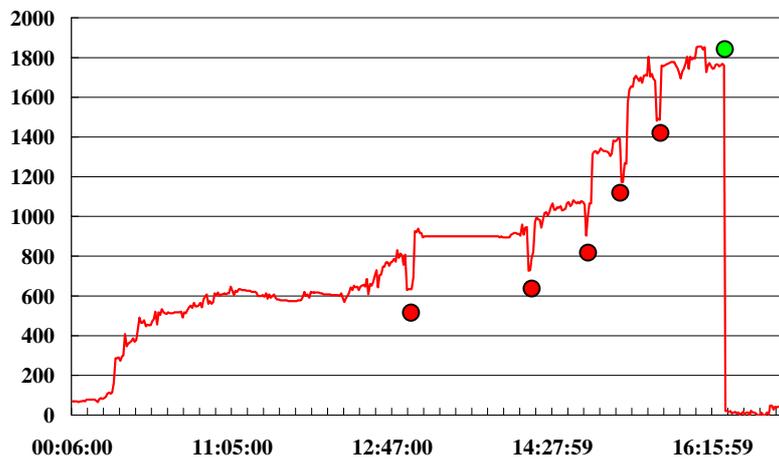


Fig. 5b. A load graph showing an ACV's activity during an abnormal day

- Location of the crematorium
- Location of an abnormal loss of diseased animals

NB. all locations were confirmed by FARMNET's GIS application software

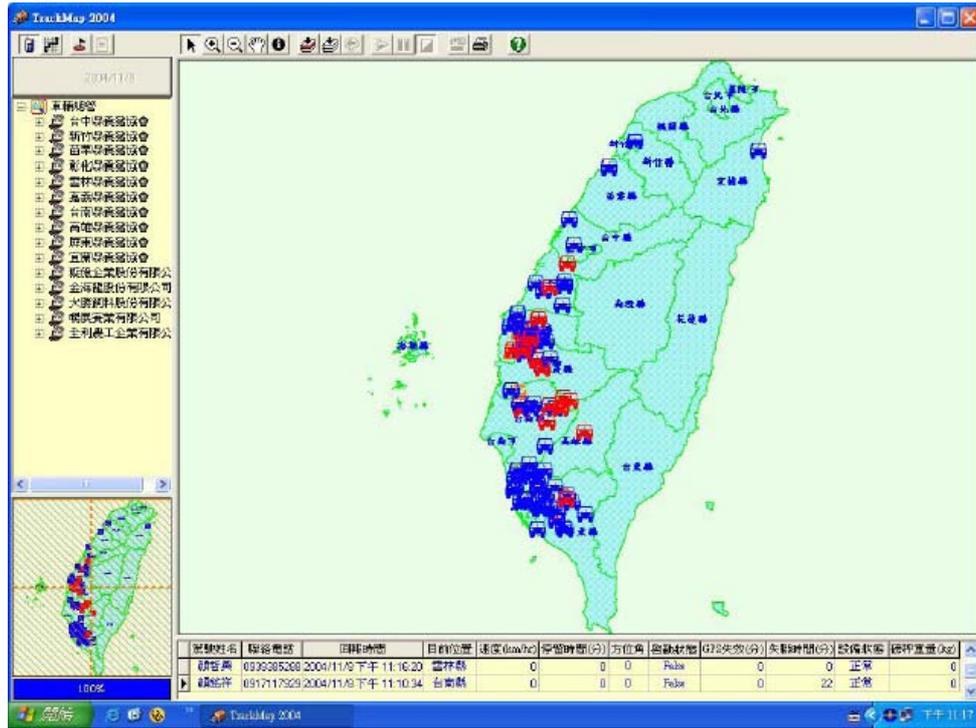


Fig. 6. The ACVs on the GIS application software



Fig. 7. The Animal Collection Vehicle Module (ACVM)



Fig. 8. The proto-type weighing plate



Fig. 9. The new improving loading sensors installed on the ACV's chassis



Fig. 10. The calibration process

4. Conclusions

We have completed a farm database that helps us prevent any new diseases breaking out as well as isolating and preventing the spread of any current diseases.

FARMNET can help prevent the distribution of diseased meat on the World's markets, protecting the health of the world's population. As the results have shown it can help monitor and police a country's internal food distribution network.

The initial research stage has shown that FARMNET is a viable venture and so we now plan to recommend its full implementation all across the country.

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