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Research paper

Implementation of Portable Foot and Mouth Disease Inference System Using a Smartphone

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Abstract

Background/Objectives: Damage has been caused by foot and mouth disease worldwide. The vaccine is used for prevention, but it is difficult because of the variant virus and lack of vaccine. In this paper, we have implemented a system to prevent the expand of foot - and mouth disease in the early onset stage.
Methods/Statistical analysis: In order to solve the disadvantages of the fixed-type thermal imaging camera, a smartphone is used to check the temperature of the livestock hoof using an external thermal imaging camera and notify the farmer when the temperature exceeds 34.4 degrees.
Findings: The sample livestock was selected as cows and pigs belonging to two-split hooves, and the livestock was deduced from the normal livestock and foot-and-mouth disease, and the result message was sent to the farm owner and the nearby farmer. It is difficult and the accuracy lacks to figure out with a fixed-type thermal imaging camera in a group-raised environment by shooting the hooves and check the temperature and determine which livestock is suspected of foot-and-mouth disease.
Improvements: Smartphone-based shooting can be instantly confirmed by the farmer in any environment, and the captured results are collected as Big Data and provided by FCM push alarm function of Android so that it can be recognized on other farms.

Keywords: *Foot-and-mouth disease, Thermal imaging camera, MongoDB, FCM, USB HOST accessories, NOSQL*

1. Introduction

Foot-and-mouth disease is an epidemic of livestock causing massive damage worldwide. In Korea, foot-and-mouth disease occurred in 1933, 2000 and 2002, and it occurred three times in 2002 resulting in the disposal of the largest number of livestock ever with massive farm damage [1][2]. Although the vaccine is vaccinated against foot-and-mouth disease, various serotypes are emerging like the foot-and-mouth disease of variant viruses such as type A and type O, making it difficult to prepare the vaccine [3][4]. There have been many efforts to prevent the proliferation of foot-and-mouth disease, but it was not enough to prevent spreading. Recently, several studies have been conducted on foot-and-mouth disease, and techniques for inferring foot-and-mouth disease by using a fixed-type thermal imaging camera have been introduced [5][6]. However, there is a matter of problem that requires the installation of several high-cost thermal imaging cameras to fix the stationary type, and the characteristics of the foot-and-mouth disease require the camera to be installed at the bottom part where it is convenient to shoot the hooves. There is also a difficulty in identifying which livestock has been photographed in a group-raised environment. To solve this problem, this paper has implemented a mobile type using an external thermal camera of a smart phone. A survey shows that two of three adults around the world will use smartphones in 2018.The country with the highest penetration rate of adult smartphones was the Netherlands (93.8%), followed by Korea (84.2%) rating the 13th.According to the market research specialist Zenith, the global adult smartphone penetration rate in 2018 is 66.5%.In the top five countries, including the Netherlands (93.8%), Taiwan (93%), Hong Kong (92%), Norway (91.2%) and Ireland (91%), adult smartphone penetration exceeded 90% [7][8]. The system allows that most farmers are able to infer the real-time foot-and-mouth disease by using the smartphone and thus defend in advance through collecting the data.

2. Materials and Methods

2.1. Thermal Imaging Camera

A thermal imaging camera is a device that tracks and detects heat and displays it on the screen at a glance. A general camera has a structure similar to that of a human eye, which is similar to what our eyes see, but a thermal camera is a specialized device that uses only heat. It is applied to various fields by utilizing this point. It is equipped with a thermal imaging camera on a drone and is used for forest fire monitoring activities. A thermal camera can catch

even a small fire that is invisible from a distance. It is also used to easily determine a disease of a livestock - This is because the livestock observed to have more heat than other livestock is more likely to be infected. It is also used for military purposes - It can be used as a night surveillance device because it can easily detect a person who generates heat even if it is at night times by using the thermal camera. As such, since the thermal imaging camera displays the image according to how much heat is emitted, the object can be identified irrespective of presence or absence of an obstacle such as smoke and light [9].

2.2. Android USB Host Accessory

Android supports the diversity of Android USB accessories and USB parts by two types both USB accessory and USB host. The external USB hardware acts as the USB host in the USB accessory mode. Examples of accessories include robot controllers; Docking station; Diagnostic and musical equipment; Kant architecture; Card reader; and much more. This provides the ability for Android-based devices without host functionality to act with USB hardware. Accessories should be designed to operate with Android devices and have to comply with the Android accessory communication protocol. The Android powered device acts as the host in the USB host mode. It is included game controllers, keyboards, mice, digital cameras as example of devices. Environments and devices of the designed for a lot of applications can interact with Android which is able to communicate properly with the device.

The USB accessory and host modes are supported directly on Android 3.1 that is API level 12 or new platforms. The USB accessory mode is Android 2.3.4 (API level 10) backported as an additional device library to support a wider range of devices. The device manufacturer can choose whether to include the add-on library in the system image of the device [10].

2.3. Comparison between NDK and SDK

The implementation of the program on Android is now implemented on the Dalbit Virtual Machine using Java. However, for performance reasons, the development of programs using NDK, rather than the existing SDK method is getting into full swing Implementation techniques using NDK are more effective in areas such as physics simulation and signal processing. There is the advantage that it can reuse the C / C ++ language written in the base language.

The performance of NDK program shows 10 ~ 20 times better than that of SDK when creating a basic program. However, when creating a program through NDK, it is needed for optimizing the number of calls and to perform a lot of operations in one call, because the context switching requires a lot of load in order to call the part written in C language. [11]

2.4. Mongo DB

MongoDB, classified as a NoSQL database, is a cross-platform document-oriented database system and a document-based database with high performance and scalability developed by 10gen. The main feature of MongoDB is which it is not necessary to define a schema.

When you enter data, you do not have to define the schema because you are storing the data structure information in BSON that is binary of JSON format. However, you only need to manage the program code since there is no schema.

Although MongoDB does not define a schema, like a relational database, it allows complex searches for arbitrary key-values. Compared to a relational database, it is faster to respond and is able to process indexes more quickly, such as relational databases. JOIN or transaction processing in MongoDB is not possible. Also, it does not write to disk immediately when updating and inputting data. There is a possibility that data may be lost as writing to the disk is asynchronous. [12]

3. The Proposed System

In this paper, we have constructed a system for estimating the foot - hoof temperature of a livestock using a thermal imaging camera. The following [Figure 1] is the proposed system execution sequence.

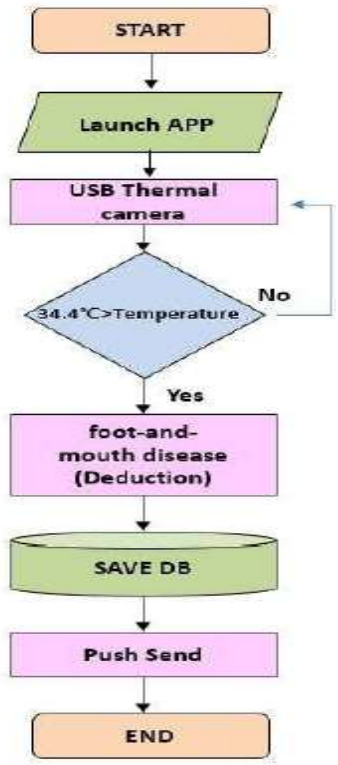

Figure 1: System execution sequence

First, run the app implemented in this paper to operate the thermal camera to check the temperature of the livestock. Second, take a picture of the livestock hoof to check the state of the livestock and check the screen in the app. Third, if the temperature of the hoof is higher than 34.4 degrees, it displays a foot-and-mouth reasoning message on the app screen. Fourth, data deduced as foot-and-mouth disease is stored automatically and collects big data. The last step is to notify the suspicion of foot-and-mouth to the surrounding farmers using the push alarm of the FCM function.

In this way, farmers can protect their livestock and manage their farms with additional necessary vaccines and countermeasures.

The following [Figure 2] is a part of the source driving the external thermal imaging camera.

```
UsbManager manager = (UsbManager) mContext.getSystemService(Context.USB_SERVICE);
List<UsbSerialDriver>availableDrivers = UsbSerialProber.getDefaultProber().findAllDrivers(manager);
mDriver = availableDrivers.get(0);
UsbDeviceConnection connection = manager.openDevice(device);
mPort = mDriver.getPorts().get(0);
try {
mPort.open(connection);
mPort.setParameters(9600, 0, 0, 0); // baudrate, dataBits, stopBits, parity
} catch (IOException e) {
}
// Everything is fine. Start serial monitoring thread.
startThread();
 mPort.write(cmd.getBytes(), cmd.length()); // Send to remote device
```

Figure 2: A part of the source driving the external thermal imaging camera

At First, connect the camera using the usb of the Android device to drive an external camera. Second, use Usb Manager to find the connected thermal camera. Third, find the thermal imaging camera and connect it.
Fourth, all data transmission and reception are implemented through mPort if the UsbSerialPort instance mPort is connection is properly set. Finally, the start Thread () function consists of a thread and it infinitely repeats the process of checking if there is any incoming data while the app is turned on.
It is composed to send the data coming in to UI when any data comes in. Also, the thermal imaging camera can be controlled through the mPort. write command.
The following [Figure 3] is a part of the source to determine foot-and -mouth disease.

```
byte buffer[] = new byte[4096];
int recbyte=0;

try {
recbyte = port.read(buffer, 100);
} catch (IOExceptione){
throw e;
}
String temp= new String(buffer);
If(temp>"34.4")
{
initiatePopupWindow(); //foot-and-mouth disease(inference)alram
save_db(); // big datasave
send_fcm();  //push send
}
```

Figure 3: A part of the source to determine foot-and -mouth disease

The temperature should be above 34.4 degrees in order to determine foot-and-mouth disease. This source is a process that checks the temperature acquired from the thermal imaging camera and processes it if suspected of foot-and-mouth disease. If you suspect foot-and-mouth disease, the system calls the initiate Popup Window () function, which first tells the farmer to check for it right away in his app and calls the save_db () function to collect big data to prevent spread to other farms. The system also sends messages to the nearby farmers by calling the send_fcm () function to signal this.

Table1: the DB layout for collecting data

Database Design		STEP	Design	Action	Design Database		
		Writer	KideokKweon	Reviewer			
Document No.		Date	2018-03-11	Ver.	1.0		
Database	MASTER		Table		INFERENCE		
Table Space			ENTT NAME				
Function							
NO.	Column	Properties	Key	Null	Type	length	Index
1	SEQUENCE_No.			NO	int		
2	GPS_X			YES	varchar	20	
3	GPS_Y			YES	varchar	20	
4	TEMP			YES	varchar	50	
5	DEVICE ID			YES	varchar	250	
6	Livestock_NAME			YES	varchar	10	
7	Creat_DT			YES	date time		
8							

Data deduced as foot-and-mouth disease is collected automatically by the server. The description of the column is as follows. First, the sequential number is a unique number that is sequentially generated each time data is generated.
Second, GPS_X and GPS_Y are places of photographed data and they can be displayed on the map based on this data.
Third, TEMP is the extracted temperature data. Fourth, DEVICE_ID is a unique ID of the photographed device.
Fifth, the livestock name is a code to distinguish livestock such as cattle and pigs. Sixth, the creation date is the time taken.

4. Results and Discussion

The following [Figure.4] is the picture and specification of the thermal imaging camera for this study.

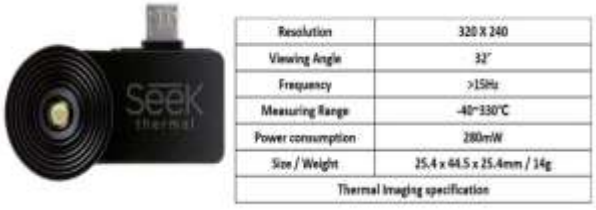

Figure 4: The picture and specification of the thermal imaging camera

Seek compact pro is a low cost thermal imaging camera that is easy to carry around and can be connected to an Android device. It can shoot from -40 to 330 degrees, small in the size and light in the weight and it is easy to carry around.

The following [Figure 5] is the pictures between real camera and thermal imaging camera for deducing foot and mouth disease.

Figure 5: the pictures between real camera and thermal imaging camera

The message is displayed as shown in the picture if the temperature of the hooves exceeds 34.4 degrees.
The data thus deduced automatically stores the data so that it can be verified by other farmers.
The following [Figure 6] is the image where data is being collected.

Figure 6: the pictures between real camera and thermal imaging camera

It was difficult to obtain livestock as a sample. So, I arbitrarily set the temperature in the app more than 34.4 to more than 20 degrees and collected the data inferred as if it was a foot-and-mouth disease in real time.
Data were collected using 5 cattle and 7 pigs and no normal data were collected for determining foot-and-mouth disease, but only as the simple user log data.
The following [Figure 7] is a message screen sent to the surrounding farmers when suspected to be foot-and-mouth disease.

Figure 7: A message screen sent to the surrounding farmers

The system allows rapid action of the farmers with the foot-and-mouth reminder app installed, by informing them through their smart phones like the above picture screen.
Also, the system enables the location and detail information of the farm suspected foot-and-mouth disease, by clicking on the livestock image.

5. Conclusion

It has been lots of studies since a few years ago with massive damage coming from foot-and-mouth disease viruses that do not resolve over time. But it was not easy to solve. The vaccine, which I thought was the best way, was not effective due to the variant virus, and the anxiety of the farmer is getting bigger. In this paper, we have studied thermal imaging cameras using smartphones and implemented the app which could maximize the effect at low cost. In the future, we will use the AI technology to automatically determine the type of livestock, determine the appropriate temperature according to the judgment, inform the farmer where the disease is expected, and continue research to prevent further spread of the virus.

References

[1] You-chan Bae, Soon-seek Yoon, Kyung-il Kang, In-soon Roh, Heui-jin Kim, Byung-jae So, Jung-won Park,Yong-hwa Jean, Mun-il Kang. (2004),Clinical Signs and Pathologic Lesions of Foot and Mouth Disease in Pigs, Korea. *The Korean Society of Veterinary Clinics*,2004(6), 172-176.
[2] Bong-Hwan Kim, Sang-Ho Choi. (2001),Epizootiological Properties of Foot-and-Mouth Disease with Special Reference to Prevention and Control of the Outbreaks. *Korean Society for Agricultural Medicine and Community Health*,2001(6), 185-198.
[3] Belsham GJ. (1993),Distinctive features of foot-and-mouth disease virus, a member of the picornavirus family; aspects of virus protein synthesis, protein processing and structure. *Prog Biophys Mol Biol* 60:241-60.
[4] Han Sang Yoo. (2011),Foot and Mouth Disease : Etiology, Epidemiology and Control Measures. *The Korean Society of Infectious Diseases | Korean Society for Chemotherapy*. 43(2)178-181 doi: 10.3947/ic.2011.43.2.178
[5] Chan-Ju Yu, Jeong-Jun Kim. (2016).FMD response cow hooves and temperature detection algorithm using a thermal imaging camera. *Korea Academy Industrial Cooperation Society*. 17(9), 292-301.
[6] Min Yoon, Jae-Woo Chang. (2012).Design and Implementation of an Advanced Cattle Shed Management System using a Infrared Wireless Sensor nodes and Surveillance Camera. *The Korea Contents Society*. 12(10), 22-34.
[7] Number of smartphone users worldwide from 2014 to 2020. (2018). *Statista*. Retrieved from https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/
[8] Smartphone penetration to reach 66% in 2018. (2018). Zenith. Retrieved fromhttps://www.zenithmedia.com/smartphone-penetration-reach-66-2018/
[9] Jeon Yong Taek, Lee Jeong Min. (2015). A System to predict the probability of foot-and-mouth disease using thermography camera. *Korea Institute Of Communication Sciences*.2015(11), 480-481.
[10] USB host and accessory overview. (2018). *Developer*. Retrieved from https://developer.android.com/guide/topics/connectivity/usb/index.html
[11] Hwa-jeongSeo, Ho-won Kim. (2012). Implementation and Analysis of Multi-Precision Multiplication for Public Key Cryptography Based on Android Platform. *Korea Institute Of Communication Sciences*. 37(10), 940-948.
[12] Hong-Jin Park. (2016). A Study about Performance Evaluation of Various NoSQL Databases. *Korea Information Electron Communication Technology*. 9(3), 298-305.