Structural Vibration Sensing to Evaluate Animal Activity on a Pig Farm*

Extended Abstract

Amelie Bonde
Carnegie Mellon University
Moffett Field, California
amelie@cmu.edu

Shijia Pan
Carnegie Mellon University
Pittsburgh, Pennsylvania
shijiapan@cmu.edu

Orathai Sangpetch
King Monkut's Institute of Technology Ladkrabang
Ladkrabang, Bangkok, Thailand
orathai@cmkl.ac.th

Akkarit Sangpetch
King Monkut's Institute of Technology Ladkrabang
Ladkrabang, Bangkok, Thailand
akkarit@cmkl.ac.th

Woranun Woramontri
Betagro Group
Thailand
woranunw@betagro.com

Hae Young Noh
Carnegie Mellon University
Pittsburgh, Pennsylvania
noh@cmu.edu

Pei Zhang
Carnegie Mellon University
Moffett Field, California
peizhang@cmu.edu

CCS CONCEPTS

• **Human-centered computing** → **Ubiquitous and mobile computing systems and tools**; • **Computer systems organization** → *Embedded and cyber-physical systems*;

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1 INTRODUCTION

Automated monitoring of animal behavior can detect changes in animal welfare and health problems. Different animal behaviors can point to disease, unrest or inadequate management, and detecting such behaviors in real time allows automated monitoring to be a valuable tool in livestock production [2]. When monitoring pigs, important sow events such as oestrus, pregnancy or parturition may also be detected through continuous animal monitoring [1].

Prior work takes a number of approaches, using video or image analysis, infrared detectors, and accelerometers worn by the pigs [1, 4, 6]. The studies using video, image processing, and infrared measure activity level or activity index, while Escalante et. al. do activity classification on several types of pig activity using pig-mounted accelerometers.

We propose using geophones attached to the underside of the floor of a pig pen to sense the vibrations generated by the pigs. We hope that our vibration-based method will allow for both measuring how much activity is happening and what types of activities those might be. Vibration sensors mounted in the floor are less intrusive than wearable sensors, and unlike most video cameras, they don't require light to operate. Vibration sensing from geophones has been successful in many human monitoring scenarios such as identification [7], localization [5], and health tracking [3].

2 HARDWARE SETUP

Our hardware setup uses geophone sensors. Geophones are widely used for seismic sensing and structural health monitoring because of their sensitivity to ground movement. A geophone consists of a spring-mounted magnet that moves within a wire coil to generate a voltage, which can thus measure movement at different frequencies. Its has low noise and high sensitivity at frequencies of 7Hz and above [3]. The geophone we use, SM-24 Geophone Elements [8] has a natural frequency of 10 Hz. We install the geophone with an amplifier and a high pass filter.

Because the floors of a pig pen become covered in excrement and are regularly hosed down with water, the sensors need to be protected. We enclose the electronics in waterproof boxes designed to NEMA 4x specifications, which are suited for this environment. We connect the geophones to the boxes with insulated wire through waterproof connectors. Power is provided through cables attached in the same manner. We superglue the box and geophone to the underside of the floor of the pen, and use insulating foam to further protect them from the elements.

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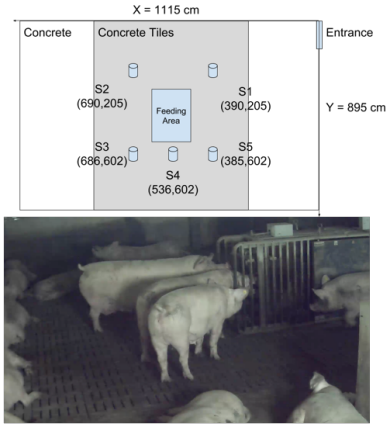

Figure 1: A diagram of sensor placement in the group pen, and view from the ground truth camera. All measurements are in cm.

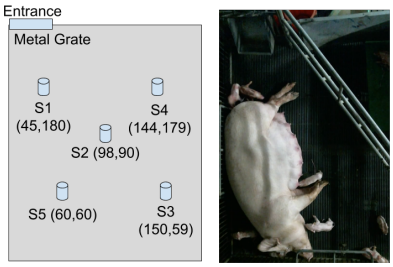

Figure 2: A diagram of sensor placement in the individual pen, and view from the ground truth camera. All measurements are in cm.

3 EXPERIMENTS

We deployed our system at Betagro Farm near Lopburi, Thailand. We installed the sensors in two locations: an individual pen designed for a single sow and her piglets, and a group pen designed for 20-30 pigs. Each pen has five sensors installed on the underside of the floor of the pen, as shown in the diagrams of Figure 1 and Figure 2. A video camera aimed at each pen collects ground truth data of the pigs' activities. The data is time stamped when it arrives at the server.

3.1 Data File Settings

The data is organized by location and day. Each location folder contains a folder for each day, and each day folder contains a folder of video files, labeled by time, and a folder of text files containing the geophone data. The geophone data is collected in one file per sensor. Each text file is a list of JSON arrays with all the data packets sent over the course of the day. Each data packet contains metadata and 1000 data samples sampled at 2000 Hz, so a half second of data. Below is an example of one JSON array, with example values used and the data replaced with "..." for brevity:

```
{
"_id" : ObjectId("5b575b13084d730006e6660e"),
"_class" : "org.json.simple.JSONObject",
"lng" : 100.777404,
"data" : "[...]",
```

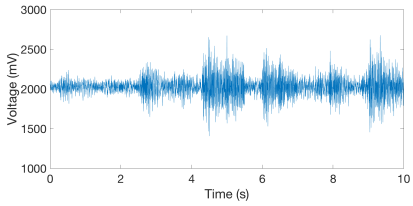

Figure 3: 10 seconds of raw data from sensor 2 in the individual pen.

```
"uuid" : "Geophone_67F5B9",
"lat" : 13.727277,
"ts" : NumberLong("1532451600464"),
"timestamp" : NumberLong("1532451600464")
}
```

The timestamp is Unix epoch time in milliseconds.

4 CONCLUSION

We deployed vibration sensors in two different pens at Betagro pig farm in Lopburi, Thailand. We provide a sample of the data in this continuously running experiment, and will provide more data as the deployment progresses. Our hope is that researchers will use this data set to detect important pig events as well as changes in animal health and welfare.

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