Analysis of Gait Patterns by Using a Sound Sensor and Wireless Communication

Miku Teruya
ic091223@edu.okinawa-ct.ac.jp
Department of Information and Communication
Okinawa National College of Technology

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1. Introduction

Animals are able to distinguish its owner by hearing sounds of footsteps without seeing the owner. By analyzing the sounds generated by footsteps, we are able to get a lot of information that is related to welfare and security [1]. We measured the footstep sounds by using a sound sensor connected with cables or wireless communications, and analyzed the sounds waveforms measured for different types of person and floor.

2. Configuration of sound sensor

We used ECM (Electret Condenser Microphone) as a sensor to measure the sounds caused by footsteps and oscillations of pedestrian. When the sounds vibrate the air at the ECM, the ECM changes the value of the capacitor connected to the gate of Field Effect Transistor (FET). The modulated electric drain current of the FET is converted to voltage through a resistor, as shown in Fig. 1(a). Since the voltage amplitude was very low and the frequency characteristic was varied with the measurement circumstances, we designed a specific transistor amplifier so that we would change the gain for specific frequency by adjusting manually the circuit parameters during the measurements, as shown in Fig.1 (b).

3. Measurements with ECM connected with coaxial cable

We measured the sounds of footsteps of eleven persons, and obtained various different waveforms. Each waveform had different wave number, width and interval of waves. For example, two persons had different width and interval for the wave of sounds, as shown in Fig2. From these three items, we could classify the human gait patterns by the foot step, the walking speed and the walking process.

Figure 1: (a) Configuration of ECM   (b) Transistor amplifier

Figure 2: Sounds waveforms measured with two persons of H: (a) and J: (b).
4. Measurements with ECM connected with wireless transmission

In order to measure the sound from a distance, we fabricated 2.5GHz wireless communication transmitter and receiver, as shown in Fig.3(a). The transmitter had video camera and sound sensor. We were able to receive sound signals remotely that were transmitted from the ECM attached on the outside of shoes, as shown in Fig. 3(b). The sound waveforms were clearly different by the floor materials and foot landing, as shown in Fig.4.

![Figure 3: (a) Wireless transmitter and receiver for measurements of video and sounds, (b) Measurements of sound waveform during walking.](image)

![Figure 4: Sound waveforms measured with different types of floor material and foot landing](image)

5. Conclusions

We were able to classify the human gait pattern by using three factors of the wave width, the wave number and the wave interval from the measurements of the sounds of footsteps. The waveforms of foot landing pattern were affected by the types of floor materials. This sound waveform analysis could be useful for the detection of the human health and the construction of security system.

References