“Mommy Tummy”
A pregnancy experience system simulating fetal movement

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1. Introduction

We propose a pregnancy experience system called “Mommy Tummy”. Mommy Tummy simulates the physical burden of pregnancy including fetal movement and fetal weight. Through this experience the user can feel the joys and difficulties of pregnancy. In addition, the user can affect the virtual fetus`s behavior with gentle or violent movements.

2. Mommy Tummy concept

Mommy Tummy is an interactive system that simulates pregnancy. A user wearing the “Mommy Tummy Jacket” can feel the fetus’s temperature, movement and heartbeat; also, by rubbing the jacket, communication with the fetus can be experienced. Within a few minutes the jacket will change in weight and size simulating a fetus’s growth over nine months. The moods and activity of the fetus will come in a manner natural to how a normal fetus develops.

An auxiliary screen displays the condition of both the fetus and the mother in each simulated month with a 3D model of the fetus.

3. System architecture

Figure 1 shows the construction of Mommy Tummy. The jacket is composed of a water bag, touch sensors, a vibrator, an acceleration sensor and a fetal activity belt.

To simulate the growth and weight gain of a fetus, warm water is pumped into the water bag. Using Japanese pregnancy as a reference, the weight of a fetus at nine months is usually about 3000g (7 lb.) and amnion liquid is 1000g (2.5 lb.). This system uses about 4000g (9.5 lb.) to fill the water bag. The warm water is kept in a connected tank at 37-38°C (99-100°F) using an electric water heater. Figure 1 shows how the jacket is worn. The vibrator in the jacket simulates the heartbeat of the virtual fetus. In the front of the jacket, touch sensors are attached to measure the force of a hand stroking the tummy. The fetal movement belt simulates the kicking and moving of the fetus. Balloons settled in the chest expand to simulate swelling of the breasts.

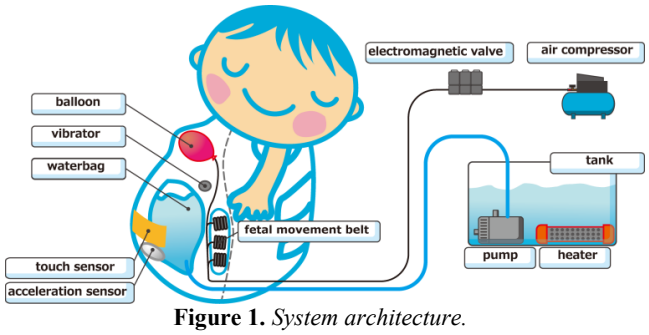


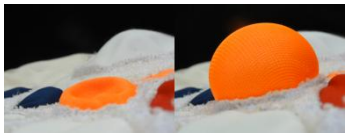
Figure 1. *System architecture.*

3.1 Results

Figure 2 shows the fetal activity belt. It is composed of 45 air actuators. The air from an air compressor (0.2MPa) is controlled by an electromagnetic valve. This control of the air flow allows the actuators to inflate and deflate simulating fetal activity on the user’s abdomen (Figure 3).

There are 2 types of fetal movement, “kicking” and “wiggling”. Kicking simulation is not so difficult; however, the simulation of wiggling is difficult. Simulating a wiggling sensation was achieved by using a technique called “phantom sensation” (PhS)”. PhS was initially discovered by Von Bekesy as a type of a “funneling” illusion, and is an illusory tactile sensation that arises between two points of simultaneous vibration or electric stimulation. Using PhS, a wiggling sensation is simulated through continuous, temporally displaced operation of multiple air actuators.

Figure 2.*Fetal activity belt*



left : deflated right : inflated

Figure 3.*Air actuator*

4. Virtual simulation and interaction

Mommy Tummy simulates a fetus’s growth over nine months in the course of two minutes. The system simulates fetal weight, movement; and heartbeat while displaying the condition of both the fetus and mother (Figure 4).

1st Month 4th Month 8th Month

Figure4.*Simulating*

The user can interact with the virtual fetus, which will respond according to a mood model. When the user moves violently, the fetus enters a bad mood state and makes intense movements. On the other hand, when the user caresses the abdomen, the fetus enters a good mood state and makes steady movements. Heavy physical exercise is discouraged until a stable period is reached. The system can simulate influence on the fetus resulting from such exercise. In the case of a fetus in breech position, the system can also account for the differences in fetal movement.

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