SIDS Monitoring System using the LVQ

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Abstract: Sudden infant death syndrome (SIDS) is the leading cause of unexplained death of an apparently healthy infant aged one month to one year. This paper presents an infant monitoring system which detects the movement of infants to prevent SIDS. The proposed system is composed of a movement sensing part and a motion detecting part. The movement sensing part uses a tri-axis accelerometer. The motion detecting part is based on the LVQ algorithm. The proposed monitoring system connects to an alarm for alerting a parent when an infant is in a predetermined position. We evaluated the performance of the monitoring system through experiments.

1. Introduction

Sudden infant death syndrome (SIDS) is the leading cause of unexplained death of an apparently healthy infant aged one month to one year. Many parents lose sleep for the first several months of an infant's life. The loss of sleep may be caused by the need to care for the infant's needs, worry about the infant's health or safety, or any of a number of other reasons. Many parents place the infant in a bassinet or crib in their own room so that they are better able to respond to any need the infant may have. It is not uncommon for a parent to wake up in the night and place a hand on their sleeping infant's chest or abdomen to make sure the infant is moving [1].

This paper presents an infant monitoring system which detects the movement of infants to prevent SIDS. The proposed system is composed of a movement sensing part and a motion detecting part. The movement sensing part uses a tri-axis accelerometer. The motion detecting part is based on the LVQ algorithm. The proposed monitoring system connects to an alarm for alerting a parent when an infant is in a predetermined position. We evaluated the performance of the monitoring system through experiments.

2. SIDS monitoring system

Figure 1 is overview of proposed SIDS prevention monitoring system, and figure 2 is Block diagram of proposed system.

3. Motion detection using the LVQ

The Learning Vector Quantization (LVQ) is an algorithm for learning classifiers from labeled data samples. Instead of modeling the class densities, it models the discrimination function defined by the set of labeled reference vectors and the nearest neighborhood search between the reference vector and data. In classification, a data sample is assigned to a class according to the class label of the closest reference vector. The direction of the gradient update depends on the correctness of the classification using a nearest neighborhood rule in Euclidean space. If a data sample is correctly classified, the reference vector closest to the data sample is attracted towards the sample; if incorrectly classified, the data sample has a repulsive effect on the reference vector [4].

We define movement patterns, and acceleration data of Front Up (FU), Front Left (FL), Front Right (FR), Front Down (FD), and Transition State (TS) shown in Figure 3.
Figure 3. Acceleration data. Figure 4 is reference pattern used acceleration data of y-z axis because acceleration data of x axis is unchanged. In the Figure 4, we defined the transition state (TS).

LVQ network has 2 input neuron and 1 sub class for 5 patterns output. Learning rate is 0.9 and on the decrease according to progress in learning. Initial value of reference vectors is 0, and learning was performed 10000 times. Figure 5 is a LVQ network.
4. Experimental results

Figure 6 is an experimental set-up of the accelerometer-based infant movement monitoring and alarm device attached to an infant. Used tri-axis accelerometer is ‘MMA7260Q’ of the Freescale company, and MCU is ‘CC1010’ of TI within RF transceiver and 8051 [2-3]. It takes a sample from the tri-axis accelerometer for 10 times per second, and transmits the data over the wireless link to base receivers connected to a host computer. Figure 7 is a photo of baby doll for experiment.

In order to verify the effectiveness of the proposed system, experiments were performed by acceleration for movement. Figure 8 is measurement data, and Figure 9 is test pattern of experiment data.

Figure 7. A Photo of baby doll for experiment.

Figure 8. Measurement data.

Experiment patterns were composed of measurement data. Table 1. is classification rate of experiment patterns used by LVQ.
Figure 9. Test pattern of experiment data.

Table 1. Classification rate of movements.

<table>
<thead>
<tr>
<th></th>
<th># of Experiment</th>
<th># of Success</th>
<th>Rate</th>
</tr>
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<tbody>
<tr>
<td>FU</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>FL</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>FR</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>FD</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>TS</td>
<td>80</td>
<td>76</td>
<td>95</td>
</tr>
</tbody>
</table>

Classification rate was 99% for 5 movement patterns, particularly classification rate of FD was 100% as infant is in an emergency.

5. Conclusions

This paper presented an infant monitoring system which detects the movement of infants to prevent SIDS. The proposed system measures acceleration for movement of infant using tri-axis accelerometer, and classify 5 movement patterns (FU, FL, FR, FD, TS) using the LVQ algorithm. The proposed monitoring system connects to an alarm for alerting a parent when an infant is in a predetermined position. LVQ network has 2 input neuron, 5 output neuron and 1 sub class.

In order to verify the effectiveness of the proposed system, experiments were performed using a baby doll. Tri-axis accelerometer of experimental system is ‘MMA7260Q’ of the Freescale Company, and MCU is ‘CC1010’ of TI Company within RF transceiver and 8051. Experimental results showed that the classification rate was 99% for 5 movement patterns, particularly classification rate of FD was 100% as infant is in an emergency.

Future work will miniaturize system, and apply low power algorithm to RF and acceleration measurement.

References