Application Group
A17-082

智慧安撫嬰兒床
Smart Appease Cot

隊伍名稱　智慧安撫嬰兒床
　　Smart Appease Cot
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研究領域
嵌入式系統設計、智慧家庭技術、音訊處理技術、智慧型控制系統、非線性系統分析控制與應用。

作品摘要

本作品目的為實現一種可以即時辨識嬰兒各式聲音並進而塑造情境以達到安撫嬰兒的嵌入式系統。本作品內含三個子系統：「聲音辨識」、「情境塑造」、「監控 APP」。關於「聲音辨識」子系統，我們利用基頻、過零率及短時距能量等訊號在時域上特徵的關聯性，建立出嬰兒哭聲（cry）、笑聲（laugh）、說話聲（murmur）、咳嗽聲（cough）、其他聲（others）及無聲（quiet）六種聲音的樣本空間進行分類。本系統擷取時域上有效特徵點，並利用自行設計的嬰兒聲音濾波器消除各種低頻環境聲、機械雜訊聲及成人聲干擾，提高擷取特徵值的精確度，並大幅降低程式的計算量與記憶體需求。「聲音辨識」所得結果乃即時回饋至「情境塑造」子系統，經由旋轉嬰兒床鈴、播放安撫音樂及搖擺嬰兒床等機制，針對不同的聲音辨識結果塑造相對應的安撫情境。「監控 APP」子系統則透過藍芽傳遞嬰兒訊息至使用者手機 APP，使其即時了解嬰兒的現況。另外，使用者可以透過手機 APP 設定客製化的情境安撫參數，例如，嬰兒床鈴的旋轉與否、播放不同音樂或是不同的嬰兒床搖擺方式等。

關於聲音分析與辨識的文獻中，大部分使用頻域之特徵分析為主，然而頻域上的特徵擷取，程式需要龐大的計算量，且演算法複雜不易撰寫或移植；為實現即時辨識，硬體上需要一定程度的處理速度，造成硬體規格的要求相對高階。本作品對於「聲音辨識」完全採用基於時域特徵分析的創新分類演算法，因此容易實現於嵌入式系統，其實測結果的高正確率頗令我們喜出望外！且辨識率亦不太受音量大小影響。除此之外，我們在「情境塑造」的實現上亦深具亮點。本作品提供的智慧安撫功能，無論提出的構想或是採用的方法，我們尚未在商品或文獻上發現類似的地方！

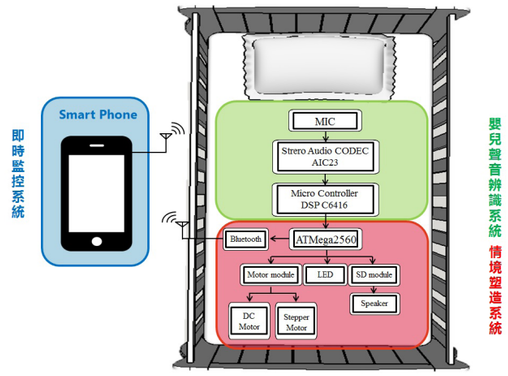

圖 1. 智慧安撫嬰兒床軟硬體整合架構圖

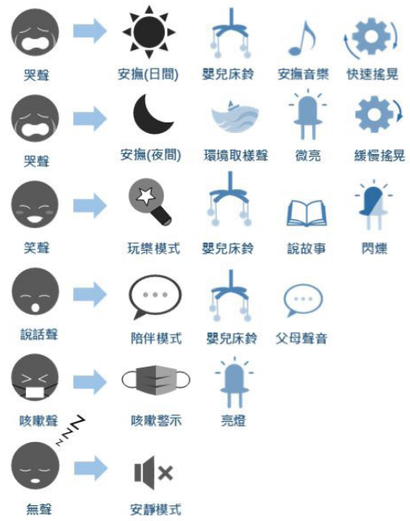

圖 2. 智慧安撫嬰兒床情境照護模式

Abstract

The work is to realize an embedded system, which can immediately identify all kinds of baby voice and shape the environment to appease baby. The work contains three subsystems: “Voice Recognition”, “Environmental Shaping” and “Monitor APP”. On the “Voice Recognition” subsystem, we use the relationships among fundamental frequency, zero-crossing rate（ZCR）and short-time energy（STE）, which are the voice signal's features in the time domain, to establish the six kinds of baby voice samples（cry, laugh, murmur, cough, other and quiet）for classification. The system calculates the effective features in the time domain, using the self-designed baby voice filter to eliminate a variety of low-frequency ambient noise, mechanical noise and adult noise which greatly reduces the amount of computation and program memory requirements. The result of “Voice Recognition” will be immediately fed back to the “Environmental Shaping” subsystem. Through rotating the baby toys, playing comfort music and swing cribs etc., shaping the corresponding appease environment by different voice identification results. “Monitor APP” subsystem uses Bluetooth transmitting the baby message to the user's mobile phone APP. Let the user can instantly understand the baby's current condition. In addition, the user can set the customization appease mode of parameters by APP. For example, the user can set the baby toy to rotate or not, play different music, select different crib swinging and so on.

In the literature of sound analysis and identification, most of them use frequency domain features to analysis. However, to calculate frequency domain features, the program requires a huge amount of computation and the algorithm is complicated to write or transplant. In order to identify in real-time, hardware requires a certain degree of processing speed which results in a relatively high level of hardware specifications. This work, for the “sound recognition”, is based on the full use of time domain feature analysis of the innovative classification algorithm. Therefore, it is easy to achieve in the embedded system. The measured results maintain high accuracy and the recognition rate is not affected by the volume. Additionally, the realization of “Environment Shaping” adds more functionality to the system and makes it unique from the existing baby monitoring systems and provides more comfort to baby.

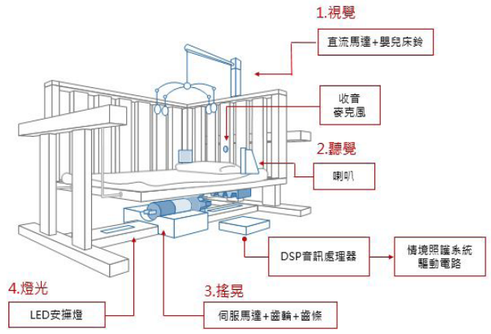

Fig 3. Illustration of Smart Appease Cot