研究概要報告書

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資料－１１

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研究目的

To implement a better way for a computer to communicate with a human being, it is necessary to incoporate non-verval communications. Music is one example of non-verval communications among many other possible candidates. The final goal of this study is to realize a "virtual musician" who can interact with human players in real time.

Computer music also poses a new challange for a parallel processing. To interact with human palyers, the processing must be done in real time and parallel processing is an obvious solution. The parallel processing model for computer music is not a simple data parallel type. It is a micture of a data parallel and a control parallel type, which results in a new parallel programming model.

1. Beat traking system

Among many processes, beat tracking which recognizes the position of quarter notes is a basic one. This paper reports a beat tracking system which processes acoustic signals and recognizes the position of beats in real time. The system has been implemented on a parallel computer Fujitsu AP-1000 (64 cell system) and deals with popular music such as rock and pop music in which drums mainly keep the beats. The tracked beats correspond to quarter notes.

2. Problems and solutions

The major problems to implement a beat trackong system for acoustic signals and our solutions are as follows.

(1) As a beat is a perceptual concept that a human feels in music, it may not directly coresspond to a real sound, i.e. there is no specific sound that directly indicates the position of beats.

We keep track of beats by managing multiple information such as onset times in the input signal, their loudness, and onset times of two different kinds of drums.

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研究内容

(2) As acoustic signals sampled consisits of various kinds of musical instruments, it is difficult to obtain the onsets of notes precisely.

We extracts the onset components in the frequency spectrum and then finds the onset times. Since this information is not reliable, we calculate the reliability of each onset time and use this information later to decide beats.

(3) It is difficult to infer the location of a beat in a measure.

As it is impossible to recognize every sound component, we use the location in a half-measure. To do so, we rely on the fact that a bass drum and a snare drum play a key roles in popular musics. We acquire the specific frequencies of these sounds.

(4) It is difficult to judge whether the inter-beat-interval is the length of a quarter note.

We conclude that the current inter-beat-interval is the length of a quater note if a snare drum mainly alternates with a bass drum.

(5) To track beats in real time, only acoustis signals that have been obtained so far can be used.

As the time when we finishes recognition of a sound in acoustic signals, its onset time would have already passed. So we predict the next beat time in advance from the previously obtained informations.

(6) We should track beats even if the current interpretation becomes unsure.

Multiple agents are provided to keep track of beats according to different strategies. They compete each other to examine multiple interpretations in parallel.

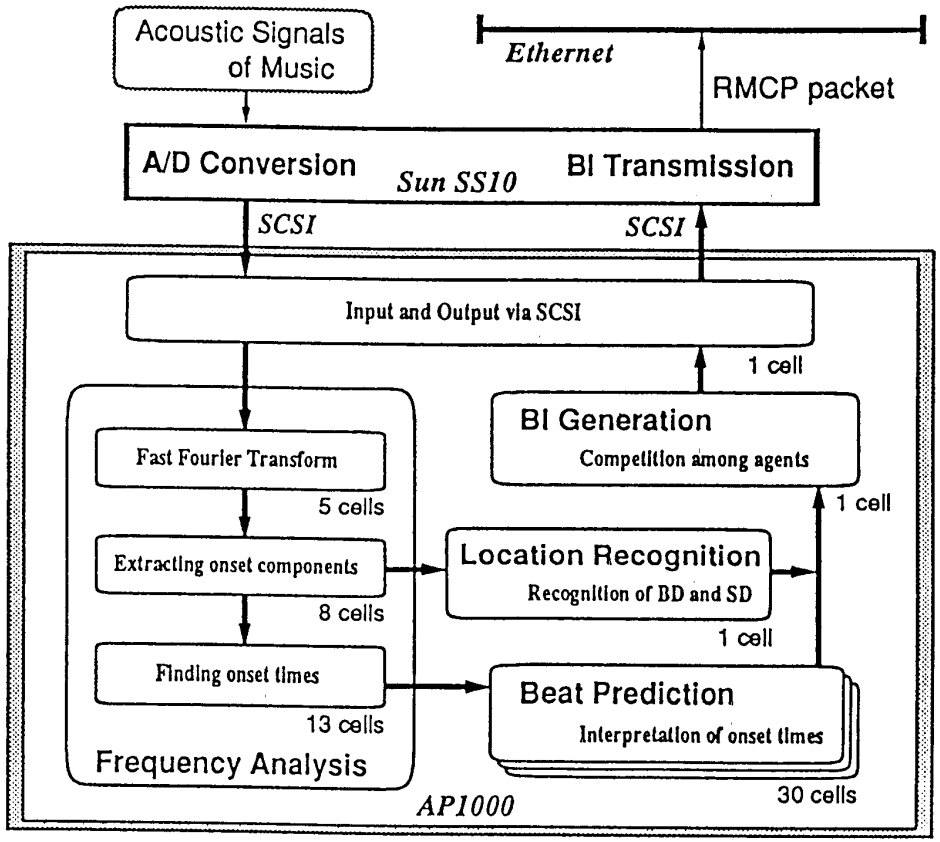
3. System inplementation

Figure 1 is the overview of a beat tracking system. The system is implemented on a distribute memory parallel computer Fujitsu AP-1000 (64 cells).

We divide 64 cellss into 7 groups. Frequency analysis part finds the onset times of notes in an acoustic signal. Then multiple agents in Beat Prediction part interprets onset times found previously and predict the next beat time. Location Recognition oart attempts to locate a bass drum and a snare drum, and recognizes the location of the next beat in a half-measure. BI Generation part examines the outputs of multiple agents and select the most reliable result. Finally, BI Transmission part output the beat information.

4. Result

The system is tested for twenty titles, and correctly tracked beats in eighteen of them.



BI stands for beat information.
Cell means a processing element in AP1000.

Figure 1: Overview of BTS