The invention relates to a method for a CD player in which, following the insertion of a compact disc, the contents of the disc's track directory are read-out and at least a section of the track directory is stored in a memory.

The basic sorts of data which are stored on a compact disc and the manner in which these are processed by the CD player are described in the article "Zusammenstellen eines CD-Programmes" at pages 26-28 of Funkschau, 15, 18/7/1986.

Every compact disc contains a directory in which data is stored that provides information regarding the number of tracks recorded on the disc and their starting times as well as the total playing time of the disc. As a rule, the individual tracks contain pieces of music but they may also, for example, incorporate spoken text or various sound effects for adding sound tracks to films or slides. Up to 99 tracks can be recorded on a compact disc, but usually only 10 to 20 different pieces of music are present on a music CD.

The track directory of a compact disc has a data format as depicted in the Figure. The title of the first piece of music is located in the first block A0, that of the last piece of music in the second block A1 and the total playing time of the compact disc is indicated in the third block A2. The starting times of the n individual pieces of music which are recorded on the compact disc are located in the succeeding blocks D1 to Dn. The blocks A0, A1, A2, D1 to Dn together form a group in which the track directory of the compact disc is completely stored once.

The total storage space allocated for the track directory on a compact disc is entirely occupied by several of these immediately successive groups G1 - Gm so that the data relating to the track directory of the compact disc is stored in a multiply redundant manner.

When playing the compact disc, the starting time points D1 to Dn, which make up the larger part of the data stored in the track directory when there are more than three pieces of music, serve for calculating the starting times of the individual pieces of music. However, it is only in the more expensive CD players that the memory has sufficient capacity to store the complete track directory. In simpler machines, only a portion of the track directory e.g. only the first ten of the n pieces of music can be stored. The CD player's memory then contains the three blocks A0 to A2 as well as the blocks D1 to D10. The remaining blocks D11 to Dn cannot be stored however.

A CD player requires about 40 ms in order to read-out a block from the compact disc and then to store its data in the memory. If 99 pieces of music really have been recorded on the compact disc, then the reading and storing of the three blocks A0, A1, A2 and the 99 blocks D1 to D99 would take approximately (3+99) x 40 ms = 4.08 sec even if the laser beam used for scanning the data were to be resting by chance on the starting point of the first block A0 of a group immediately on commencement of the reading operation. The probability of this happening however is very small.

By using as an example a CD player that can store the titles of ten pieces of music and a compact disc which has fifty pieces of music recorded thereon, it will become apparent just how long the reading time can be in certain circumstances.

Suppose that at the commencement of the reading operation, the laser beam is aimed by chance at the block D11 which stores the starting time of the 11th piece of music. Then, the forty blocks D11 to D50 would first have to be scanned by the laser beam before the reading and storing operations for the blocks A0 to A2 and D1 to D10 of the next group could begin. The reading of the blocks D11 to D50 lasts 40 x 40 ms = 1.6 secs, the reading and storing of the blocks A0 to A2 and D1 to D10 a further 13 x 40 ms = 0.52 secs, so that altogether 1.6 + 0.52 sec = 2.12 secs passes before the first piece of music can be played.

The time elapsing before the first piece of music is played-back can however be much longer if a block e.g. the block D10, is not readable due to a scratch on the compact disc. In this case, the CD player continues reading until it gets to the block D10 in the next group which, it is assumed, is readable. Consequently, the blocks D11 to D50 and then the blocks A0 to A2 and D1 to D10 of the next group will be read-out. In order to read these 40 + 3 + 10 = 53 blocks, the CD player requires another 53 x 50 ms = 2.12 secs, so that the listener would have to wait roughly 4 secs before he could hear the first piece of music.

Consequently, the object of the invention is to reduce the time required by a CD player to read the track directory of a compact disc.

The invention achieves this object in that the laser beam for scanning the data is diverted from the block on which it happens to rest at the commencement of a reading operation onto the track of a first block so that, beginning with this first block, it then reads-out and stores those blocks which have to be stored.

A second solution to the problem, which is embodied in Claim 2 resides in that, beginning with the block on which the laser beam for scanning the data happens to rest at the commencement of a reading operation, the data is read-out and stored up to that block whose data must still be stored and that the laser beam is diverted from this block onto the track of the first block so as to read-out and store the data from the remaining blocks between the the first block and the block on which the laser beam happened to rest initially.

The invention according to Claim 1 will now be explained by means of the earlier mentioned example of a CD player that can store the titles of ten pieces of music and a compact disc having fifty pieces of music thereon.

At the commencement of the reading operation, the laser beam is again assumed to be resting on the block D11. This time however, instead of reading the blocks D11 to D50 and only starting to store the data upon reaching the block A0 of the next group, the laser beam now jumps back from block D11 to block A0 in the same group and then immediately starts to read-out and store the blocks A0 to A2 and D1 to D10.

The reading and storing of the thirteen blocks A0 to A2 and D1 to D10 now lasts just 13 x 40 ms = 0.52 secs whereas a listener using the existing state of the art would have to wait 2.12 secs for the first piece of music. The time for the jump is negligibly small and even in the worst case of a full revolution of the compact disk would only amount to between 110 and 130 ms since it is only possible to jump exactly onto a track and not onto a particular part of a track.

If the block D10 should not be readable because of a scratch, as in the earlier mentioned example, the scanning laser beam in the CD player according to the invention is diverted in one jump onto the block D10 of either a previous or a succeeding group in order to read-out and store the contents of the block D10. Because the duration of the jump is negligibly small, the first piece of music will be played within about 0.5 sec whereas a listener using the existing state of the art would have to put up with a waiting time of 4.2 secs in this adverse case.

The distance which the scanning laser beam must jump can be calculated in two ways.

In the first method, the number of tracks is calculated from the number of blocks which lie between the two blocks A0 and D11 or between D10 of one group and D10 of the following group. Based on a time of approximately 110 to 130 ms for a single revolution of the compact disc, the length of three blocks corresponds approximately to a separation of one track. In jumping from block D11 to block A0, 13 blocks have to be jumped-over which corresponds to a distance of about 13 : 4 = 4 tracks.

Since CD players are already equipped with a microprocessor, it is particularly advantageous to let this microprocessor perform the calculation since in this way no additional expense for hardware is necessary but merely a modification of the programming of the microprocessor needs to be made.

A time marker which is increased by 3 for each block is recorded on a compact disc in parallel with the blocks.

An advantageous embodiment of the CD player according to the invention consists in that, groups which have blocks containing errors are stored in a memory in the CD player. For this purpose for example, the start and end digits of the time markers which are allocated to the blocks containing errors are stored. Blocks or groups containing errors can be caused by scratches or fingerprints on the compact disc for example.

This method will be illustrated by the following example. One group consists of ten blocks. The second group is assumed to contain blocks containing errors. The starting digit of the first group in the time marker is 1, the last digit is 10. The number 11 is allocated to the first block in the group having the blocks containing errors and the number 20 to the last block. These two numbers, 11 and 20, are stored. The CD player now knows that whenever it starts a reading operation in the track directory, it should ignore the blocks having the numbers 11 to 20 since amongst these there are blocks containing errors.

A further advantageous development is that groups and/or blocks containing errors are identified as such in the CD player so that during a reading operation the laser beam can jump-over these error containing blocks or groups.

The solution proposed in Claim 2 will now be explained.

Suppose that initially the laser beam is again resting on the block D3 and that the CD player is to store the titles of the first ten pieces of music.

The data in the blocks D3 to D10 inclusive is read-out and stored. Thereafter, the laser beam is diverted from block D10 onto the first block A0 in order to read-out and store the data from the remaining blocks A0, A1, A2, D1 and D2.

Also in the invention in accordance with Claim 2, it is advantageous that during a read operation the laser beam can jump in one or more jumps from a block containing errors in one group onto the equivalent block in a preceding or a succeeding group.

Moreover, groups and/or blocks containing errors may also be identified as such in the CD player so that during a read operation the laser beam can jump-over the blocks or groups containing the errors.

* C L M S *

Claims

1. Method for a CD player in which, following the insertion of a compact disc having a track directory area consisting of a plurality of successive identical groups (G1, G2, ..., Gm) wherein each group (G1, G2, ..., Gm) contains a plurality of blocks (A0, A1, A2, D1, ... , Dn) which together contain the track directory completely once, at least one section of a track directory including at least a first block (A0) of the group is read-out and stored in a memory, characterised in that, the laser beam for scanning the data is diverted from the block on which it happens to rest at the commencement of a reading operation onto the track of a first block (A0) so that, beginning with this first block (A0), it then reads-out and stores those blocks which have to be stored.

2. Method for a CD player in which, following the insertion of a compact disc having a track directory area containing a plurality of successive identical groups (G1, G2, ..., Gm) wherein each group (G1, G2, ..., Gm) contains a plurality of blocks (A0, A1, A2, D1, ... , Dn) which together contain the track directory completely once, at least one section of a track directory including at least a first block (A0) of the group is read-out and stored in a memory, characterised in that, beginning with the block on which the laser beam for scanning the data happens to rest at the commencement of a reading operation, the data is read-out and stored up to that block whose data must still be stored and that the laser beam is diverted from this block onto the track of the first block (A0) so as to read-out and store the data from the remaining blocks between the first block (A0) and the block on which the laser beam happened to rest initially.

3. Method according to Claim 1 or 2, characterised in that, upon reading a block containing errors in a group of the track directory, the laser beam is diverted in one or more jumps to the equivalent block in a succeeding block.

4. Method according to Claim 1 or 2, characterised in that upon reading a block containing errors in a group of the track directory, the laser beam is diverted in one or more jumps to the equivalent block in a preceding block.

5. Method according to Claim 1, 2, 3 or 4, characterised in that, for jumping the laser beam from one block to another, the number of data tracks lying between the two blocks is calculated.