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ethod of recording and reproducing data.

The invention relates to a method of recording items of data on a moving recording medium and for the lossless reproduction of the data from the recording medium, wherein a compression of the data using different degrees of compression is undertaken at the recording end and a data expansion process is effected at the reproduction end.

Data compression and data expansion are frequently used in the broadcasting field in order to increase the capacity of the transmission channels for example, or to increase the storage capacity of the recording media. For example, the items of data on the so-called mini-disc, a development of the compact disc, are recorded in compressed form.

During the data compression process, the items of data which are to be stored or transmitted are compressed by means of a suitable algorithm. Expressed in other words, this means that the quantity of data which is to be stored or transmitted is reduced in order to increase the transmission capacity of the transmission channel or the storage capacity of the recording medium.

At the reproduction or receiving end, an expander generates the original items of data from the reduced quantity of data by means of the inverse algorithm.

As already explained, the aim of the data compression is to reduce the quantity of data as much as possible without producing any loss of data in order to be able to use the transmission capacity of a transmission channel or the storage capacity of a recording medium to better effect.

When making a data recording, it is known to read the items of data which are to be recorded into a buffer store before the recording process. It is likewise known, when reproducing the

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igure 2 the first embodiment in the case of the reproduction f items of data from a disc shaped recording medium

Figure 3 a second embodiment of the invention in the case of the recording of items of data on a disc shaped recording medium

Figure 4 the second embodiment in the case of the reproduction of items of data from a disc shaped recording medium.

The method in accordance with the invention in the case of the recording of items of data will now be explained with the aid of the first embodiment shown in Figure 1.

A data recording device A, which serves as a source of digital items of data, delivers the items of data which are to be recorded in digital form in a predetermined pattern of time slots to a compressor K which compresses the items of data in accordance with a given algorithm. The compressed items of data are recorded on a recording medium. A magneto-optical disc CD, which is rotated by a motor M, is shown in Figure 1 as an example for the recording medium. The items of data are recorded on the disc CD by means of a light beam L which a recording and reproduction head AW produces, this generally being called a pick-up in the case of CD players. A control output of the compressor K is connected to the input of a regulator R1 which controls the rotational speed of the motor M.

In the case of a CD player, the items of data are recorded and reproduced with a constant track speed. Consequently, one speaks of a Constant-Linear-Velocity-System - abbreviated to CLV-System - in contrast to a Constant-Angular-Velocity-System, abbreviated to CAV-System, in which the items of data are recorded and reproduced at a constant angular speed. Now, as already mentioned, data losses can occur when the buffer store overflows.

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ention now proposes that the speed of the recording CD be controlled in dependence on the degree of pression. In the case of a high degree of compression, the eed of the disc is reduced both during the recording as well as during the reproduction of the items of data, whilst it is increased in the case of a lower degree of compression. Due to the measure, of deviating from the normal speed by reducing the speed of the recording medium in the case of a high degree of compression, the storage capacity of the recording medium is considerably increased.

The regulator R1 controls the rotational speed of the disc CD in dependence on the momentary degree of compression of the compressor K. It is sensible for example, to control the rotational speed of the disc CD to be inversely proportional to the degree of compression. By virtue of the method in accordance with the invention, it is not absolutely necessary to use a buffer store in order to avoid data losses.

In the second embodiment of the invention, which is shown in Figures 3 and 4, a buffer store and also a second and a third regulator are provided in addition to the first regulator.

During the recording of the items of data, which is illustrated in Figure 3, the data recording device A delivers digital items of data to a buffer store Z1 which passes them on to the compressor K for the compression process following the process of buffer storage. The compressed items of data are recorded on the disc CD by means of the light beam L produced by the recording and reproduction head AW. A control output of the compressor K is connected to the input of a first regulator R1 which, together with a second regulator R2 and a third regulator R3, controls the rotational speed of the motor M that is rotating the disc CD.

The second regulator R2 is connected to the first control output of the buffer store Z1. The first regulator R1 controls the

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rotational speed of the disc CD in dependence on the degree of compression produced by the compressor K as in the first embodiment. The superimposed, second control loop including the regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z1 is filled. If the buffer store Z1 is full or virtually full, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1; if, on the other hand, the buffer store is empty or almost empty, then the rotational speed of the disc CD is lowered in order to fill up the buffer store with items of data.

A third control variable for controlling the rotational speed of the disc CD is produced from the difference between the inflow of data DZ and the outflow of data DA at the buffer store Z1 by means of the third regulator R3. If the difference DZ - DA is positive, then the rotational speed of the disc CD is increased in order to prevent any overflow of the buffer store Z1, while in the case of a negative difference DZ - DA, the rotational speed is lowered in order to refill the buffer store with items of data.

Now it is possible to provide only one of the three regulators R1, R2 and R3, or only 2, or all 3 regulators for controlling the rotational speed of the disc CD. Every combination - 7 altogether - is possible.

The second embodiment for the case of the reproduction of the data is depicted in Figure 4.

The items of data are read from the disc CD by means of the light beam L from the recording and reproduction head AW and passed to the expander E which guides them on to a buffer store Z2. From the buffer store Z2, the items of data reach a data reproduction device W e.g. a loudspeaker.

regulator R1, which is connected to the control output of the expander E, controls the rotational speed of the disc CD in dependence on the degree of compression. For a high degree of compression, the rotational speed is reduced from the normal speed of rotation, but, by contrast, is again raised to the normal speed of rotation when it is low.

The second regulator R2 controls the rotational speed of the disc CD in dependence on the level to which the buffer store Z2 is filled. When the level is high, it causes a reduction of the rotational speed in order to prevent an overflow of the buffer store Z2 whilst it increases the rotational speed in the case of a low level in order to avoid the buffer store Z2 from running empty.

The third regulator R3 evaluates the difference DZ - DA between the inflow of data DZ and the outflow of data DA. If there is more data flowing into the buffer store Z2 than there is flowing onto the reproduction device W, then DZ - DA is positive and the rotational speed is reduced so that the buffer store Z2 does not overflow. By contrast, if the buffer store Z2 is receiving less data from the recording and reproduction head AW than it is emitting to the data reproduction device W, then the regulator R3 increases the rotational speed in order to once more fill up the buffer store Z2 with items of data. It is also possible, in the case of the reproduction of data, to employ only one, two or all three of the regulators. Every conceivable combination is possible.

The invention is not however limited in any way to disc-shaped recording media. In addition to CD players, magneto-optical recording and reproduction equipment which work with discs as the storage medium, tape equipments can also be taken into consideration for the invention. A drum is also suitable as a recording medium for example.

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Method of recording items of data on a recording medium (CD) and for lossless reproduction from the recording medium (CD) wherein a compression of the items of data using different degrees of compression is undertaken at the recording end and an expansion process is effected at the reproduction end, characterised in that, the speed of the recording medium (CD) is controlled during the recording of the data and during the reproduction of the data in dependence on the degree of compression.

2. Method in accordance with Claim 1, characterised in that, the speed of the recording medium (CD) is selected to be smaller in the case of a high degree of compression of the items of data than for a lower degree of compression.

3. Method in accordance with Claim 1 or 2, characterised in that, the items of data that are to be recorded are stored in a first buffer store (Z1) before the recording process and that the items of data read from the recording medium (CD) are stored in a second buffer store (Z2) prior to the reproduction process.

4. Method in accordance with Claim 3, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the level to which the two buffer stores (Z1, Z2) are filled.

5. Method in accordance with Claim 4, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the level to which the first buffer store (Z1) is filled is high whilst it is decreased when the level to which it is filled is low, that during the reproduction of the data, the speed of the recording medium (CD) is decreased when the level to which the second buffer store (Z2) is filled is high whilst it is increased when the level to which it is filled is lower.

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. Method in accordance with Claim 3, 4 or 5, characterised in that, the speed of the recording medium (CD) is controlled in dependence on the difference DZ - DA between the inflow of data DZ and the outflow of data DA.

7. Method in accordance with Claim 3, 4, 5 or 6, characterised in that, during the recording of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the first buffer store (Z1) is greater than the outflow of data DA, whilst the speed of the recording medium (CD) is lowered when the inflow of data DZ at the first buffer store (Z1) is lower than the outflow of data DA, that during the reproduction of the data, the speed of the recording medium (CD) is increased when the inflow of data DZ at the second buffer store (Z2) is greater than the outflow of data DA, whilst the rotational speed is decreased when the inflow of data DZ to the second buffer store (Z2) is smaller than the outflow of data DA.

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