Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2892714 A1 2016/11/27

(21) **2 892 714**

(12) **DEMANDE DE BREVET CANADIEN**
CANADIAN PATENT APPLICATION

(13) **A1**

(22) **Date de dépôt/Filing Date:** 2015/05/27

(41) **Mise à la disp. pub./Open to Public Insp.:** 2016/11/27

(51) **Cl.Int./Int.Cl.** ***H04N 5/349*** (2011.01)

(71) **Demandeur/Applicant:**
IGNIS INNOVATION INC, CA

(72) **Inventeur/Inventor:**
CHAJI, GHOLAMREZA, CA

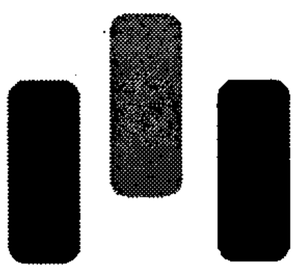
(74) **Agent:** MARKS & CLERK

(54) **Titre : REDUCTION DE LARGEUR DE BANDE DE MEMOIRE DANS UN SYSTEME DE COMPENSATION**
(54) **Title: MEMORY BANDWIDTH REDUCTION IN COMPENSATION SYSTEM**

(57) **Abrégé/Abstract:**
What is disclosed are systems and methods of compensation of images produced by active matrix light emitting diode device (AMOLED) and other emissive displays. Sub-sampling of pixel measurement data utilized in compensation of the display is utilized to reduce the data bandwidth between memory and a compensation module where the data is locally interpolated.

ABSTRACT

What is disclosed are systems and methods of compensation of images produced by active matrix light emitting diode device (AMOLED) and other emissive displays. Sub-sampling of pixel measurement data utilized in compensation of the display is utilized to reduce the data bandwidth between memory and a compensation module where the data is locally interpolated.



IGNIS
Innovation Inc.

IGNIS PATENTS

MEMORY BANDWIDTH REDUCTION FOR COMPENSATION

REZA CHAJI

Revision: 1.0

Contents

1. INTRODUCTION 3

2. ASPECTS OF THE PROPOSED METHODS 3

3. BLOCK DIAGRAM 4

FIGURE 1: SUBSAMPLING DATA BEFORE STORING THE EXTRACTED DATA. 4

FIGURE 2: SUBSAMPLING DATA AFTER STORING THE EXTRACTED DATA. 5

1. Introduction

As the resolution and/or frame rate of an array semiconductor device increases, or the number of issues that needed to be compensated/calibrated, the data transfer between memory and compensation module increases dramatically. This can result in higher power, higher cost and larger foot print.

2. Aspects of the proposed methods

In one aspect of the proposed method, the data is being spatially sub-sampled (between a group of few pixel, only the data for one pixel is passed to the compensation module) and an interpolation module in the compensation module creates the data samples for the other pixels in the array.

In another aspect of the proposed method, the data is divided into low spatial frequency and high spatial frequency. The low spatial frequency data is being sampled at fewer pixels and the higher spatial frequency content is being sampled at more pixels. The interpolation block creates the low frequency and high frequency content and from those data creates the accurate content for each pixel.

In another aspect of the proposed method, the sampled pixel can be dynamically changed to reduce the interpolation error.

In another aspect of the proposed method, an error table stores the data (or delta data) for pixels that interpolation creates an error beyond a threshold. The data from these pixels will be directly fetched from said error table or the data from said error table will be used to fix the error in the interpolated data.

In another aspect of the proposed method, the sub-sampling frequency can be set by user or system. In one example, for some content the compensation is not critical and so the sub-sampling frequency can be decreased. In another example, for saving power, the system may decide to reduce the sub-sampling frequency.

3. Block Diagram

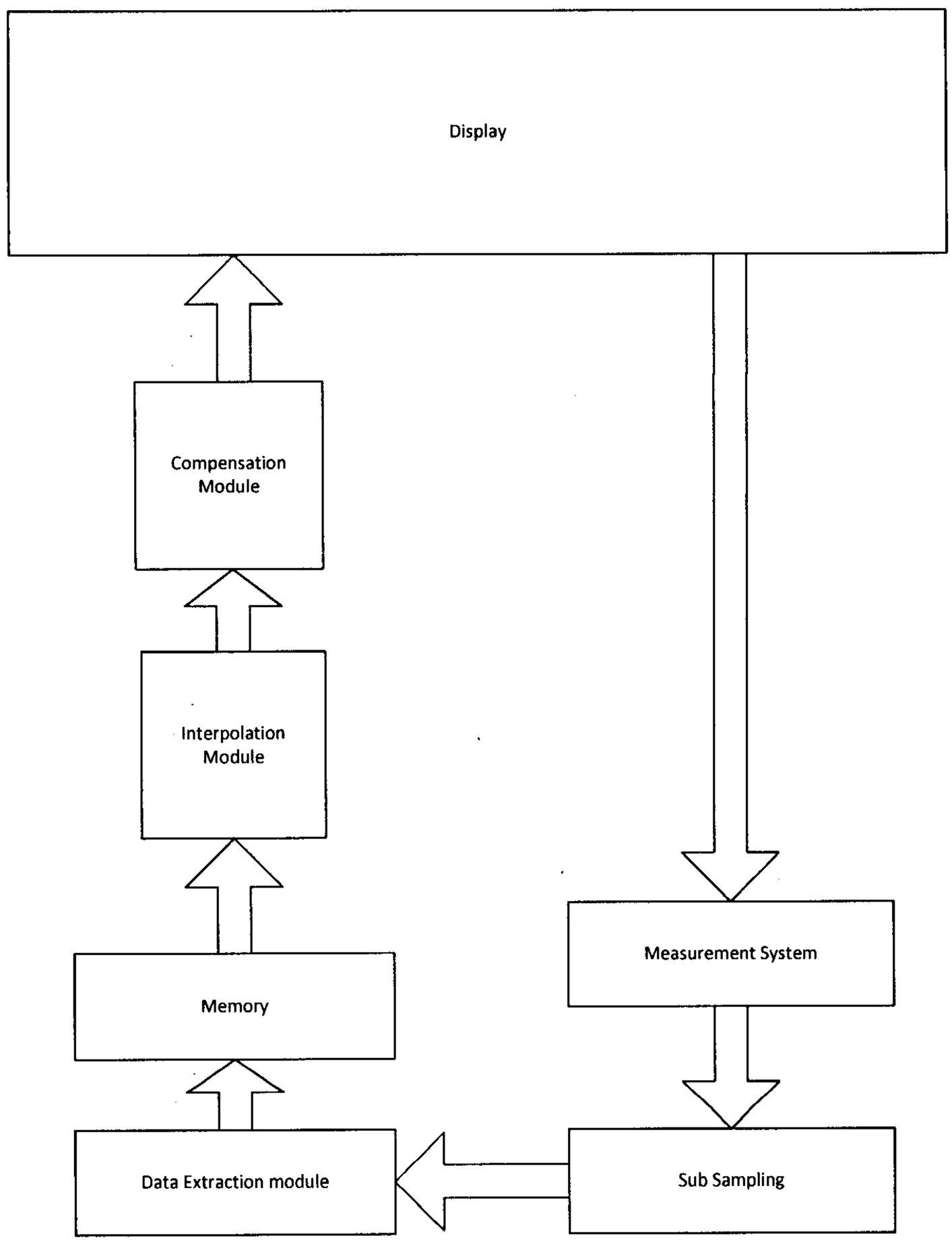


Figure 1: Subsampling data before storing the extracted data.

Figure one shows an embodiment and method of sub sampling measured data. Here, in one case the measurement of the array is done at full spatial resolution and the measured data is sub-sampled. In another case the measurement itself is done for selected pixels in the array.

After that the data is passed to the data extraction module and the extracted information is stored in the memory. The said extracted data is passed to interpolation module to create a full spatial resolution data. These data are used in the compensation module for compensating the issues related with said array.

After measurement the set of selected pixels is fixed and it is hard to change the set of selected sub-pixel for better interpolation.

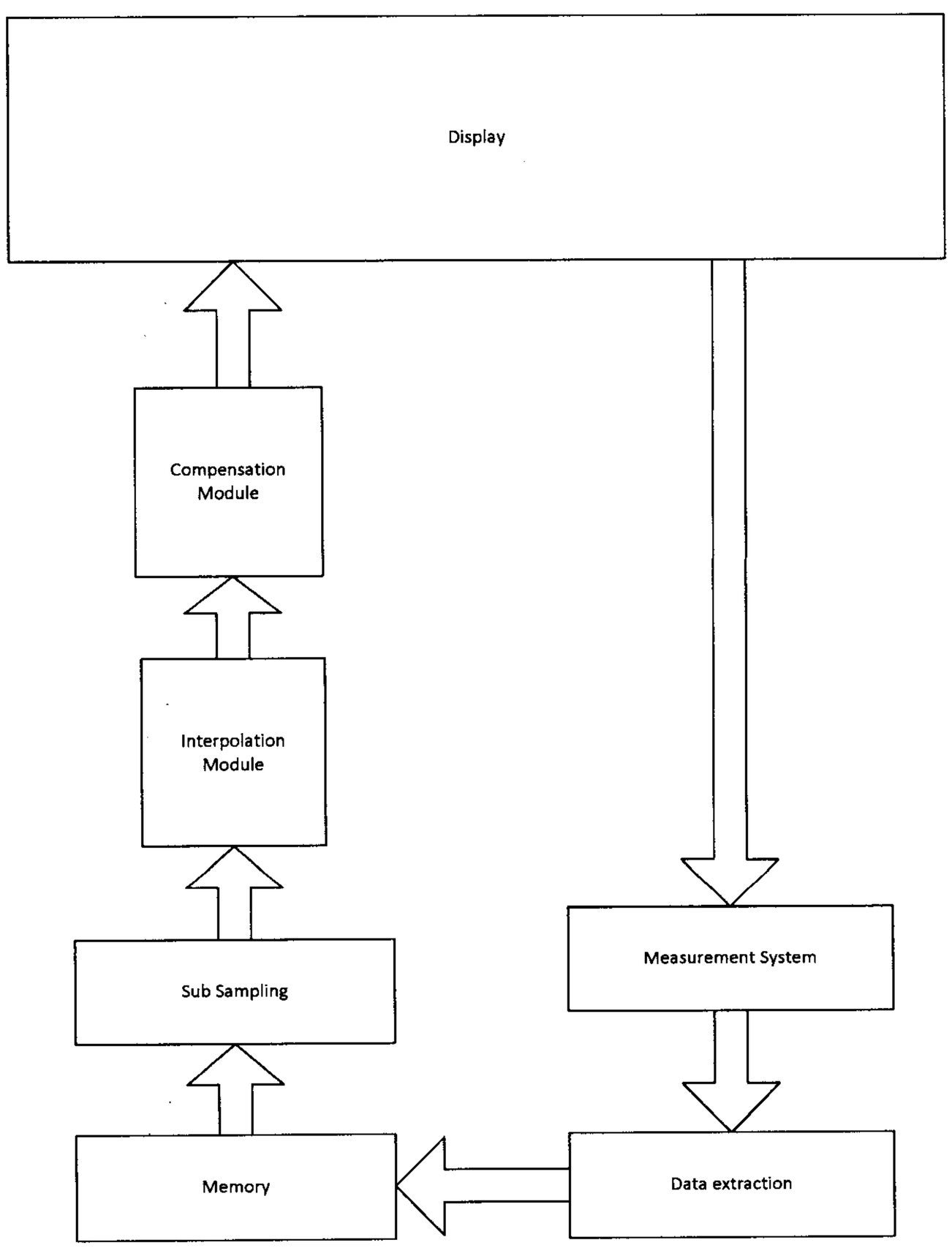


Figure 2: Subsampling data after storing the extracted data.

Figure 2 shows another embodiment and method of reduction in memory bandwidth requirement for compensation system. Here, the stored data have the full spatial resolution of the array

structure. However, only sub set of the data is being fetched from the memory every time and the interpolation module creates the full resolution data. In one method, one can select different set of selected pixel to improve the interpolation output by averaging the error for each pixel. In another case, one can optimize the set of selected pixel by optimizing the error between interpolated data and the actual data stored in the memory.

In another case, an error table is used store the data of the pixels with larger interpolation error than a given threshold. While other pixels are getting their data from the interpolation module, the selected pixels and pixels stored in the said error tables are read directly.

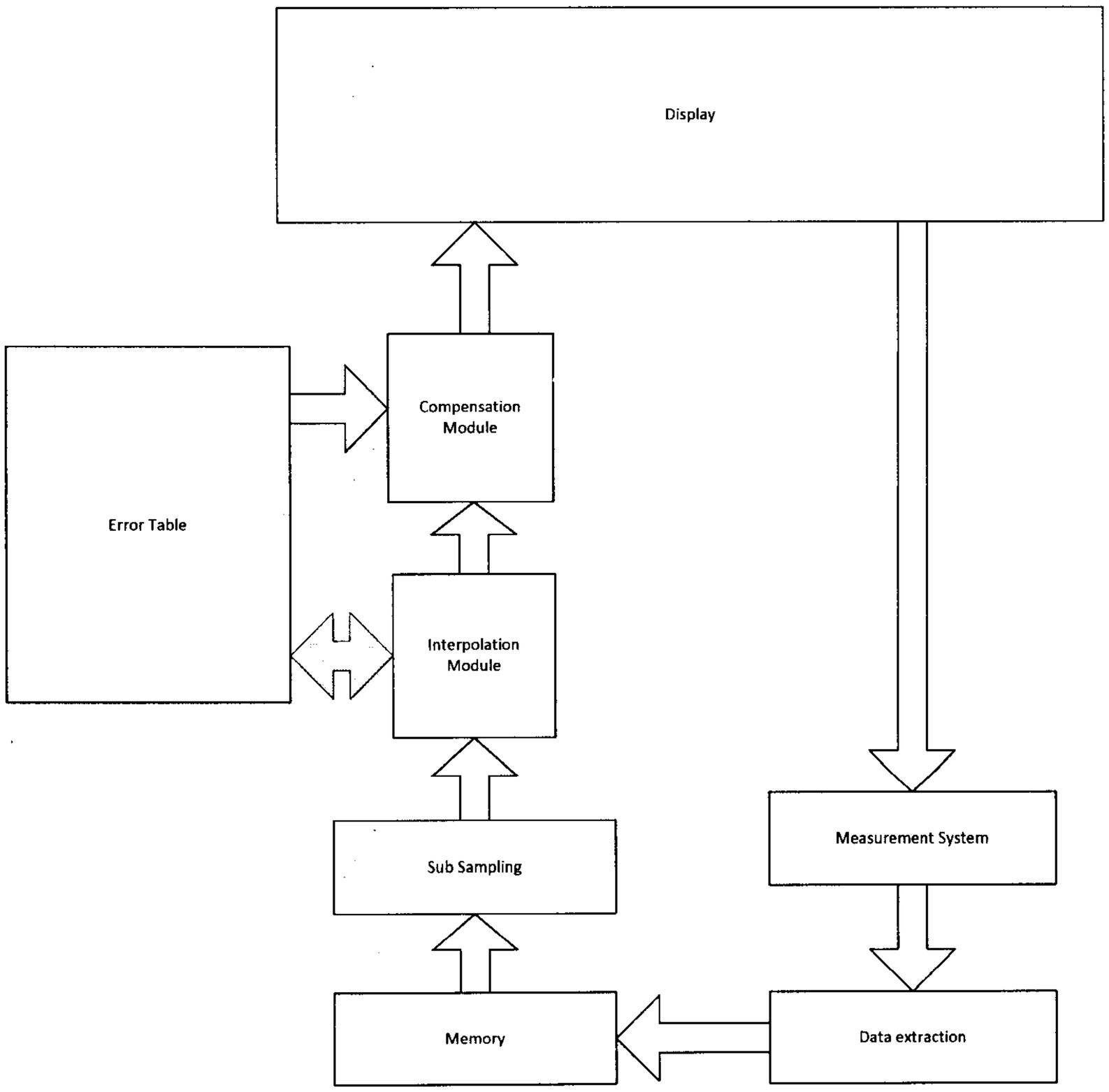


Figure 3: Subsampling data with error table.

The error table is field by the interpolation module or by a separate module that calculates the error in the interpolation and compares it with the said threshold value. The data can be fetched

from the interpolation module from the error table during compensation and send to the compensation module. In another case, the data is fetched by compensation module.

In another case, the error is stored in the error table and so the absolute value in the pixel is calculated based on the interpolated data and the error.

In another case, the absolute value is stored in the error table and so the fetched value is used directly.

The error table can be used for different sub-sampling block diagram including the one presented in figure 1.

In another aspect of the proposed method, the data is divided into low spatial frequency and high spatial frequency. The low spatial frequency data is being sampled at fewer pixels and the higher spatial frequency content is being sampled at more pixels. The interpolation block creates the low frequency and high frequency content and from those data creates the accurate content for each pixel. Here, data can be stored in few different memory based on the sub sampling frequency.

In another aspect of the proposed method, the sub-sampling frequency can be set by user or system. In one example, for some content the compensation is not critical and so the sub-sampling frequency can be decreased. In another example, for saving power, the system may decide to reduce the sub-sampling frequency.

WHAT IS CLAIMED IS:

1. A method for compensating an image produced by an emissive display system having pixels, each pixel having a light-emitting device, the method comprising:

measuring characteristics of a plurality of pixels generating measurement data for use in compensation of the display;

storing the measurement data in a memory;

retrieving partial resolution measurement data from the measurement data stored in the memory;

interpolating the measurement data generating full resolution interpolated measurement data; and

compensating the display with use of the full resolution interpolated measurement data.

2. The method of claim 1 wherein the partial resolution measurement data comprises measurement data only for a selected subset of pixels of the display.

3. The method of claim 1 wherein measuring characteristics of a plurality of pixels comprises measuring with sub-sampling characteristics only of a selected subset of the pixels of the display system generating measurement data which is said partial resolution measurement data.

4. The method of claim 1 wherein measuring characteristics of a plurality of pixels comprises measuring characteristics of all of the pixels of the display system generating measurement data which comprises full resolution measurement data, and wherein retrieving partial resolution measurement data comprises retrieving with sub-sampling measurement data of only a selected subset of pixels of the display from the full resolution measurement data stored in the memory.

5. The method of claim 4 further comprising:

determining the selected pixels of the display so as to reduce an error between the full resolution interpolated measurement data and the full resolution measurement data.

6. The method of claim 1 further comprising for each pixel of the display other than pixels of said selected subset of pixels of the display:

predicting a corresponding interpolated pixel data portion of said full resolution interpolated measurement data;

comparing said corresponding interpolated pixel data portion with a corresponding pixel data portion of said full resolution measurement data generating a predicted pixel interpolation error; and

for pixels where said predicted pixel interpolation error exceeds a threshold, storing interpolation correction data for said pixel in an error table and performing said generation of said full resolution interpolated measurement data comprises determining absolute measurement data for said pixel with use of said interpolation correction data.

7. The method of claim 6 wherein determining absolute measurement data for said pixel comprises replacing corresponding interpolated pixel data portion of said full resolution interpolated measurement data with said interpolation correction data.

8. The method of claim 6 wherein determining absolute measurement data for said pixel comprises replacing corresponding interpolated pixel data portion of said full resolution interpolated measurement data with absolute measurement data generated with use of said interpolation correction data and said corresponding interpolated pixel data portion.

9. The method of claim 1 wherein measuring characteristics of a plurality of pixels generating measurement data comprises generating low spatial frequency measurement data and high spatial frequency measurement data, wherein storing the measurement data in the memory comprises storing the low spatial frequency measurement data and high spatial frequency measurement data in the memory, wherein retrieving partial resolution measurement data from the measurement data stored in the memory comprises retrieving low spatial frequency partial resolution measurement data from the low spatial frequency measurement data stored in the memory and retrieving high spatial frequency partial resolution measurement data from the high spatial frequency measurement data stored in the memory, wherein interpolating the

measurement data generating full resolution interpolated measurement data comprises interpolating the low spatial frequency measurement data and interpolating the high spatial frequency measurement data and combining the interpolated low spatial frequency measurement data and the interpolated high spatial frequency measurement data together generating full resolution interpolated measurement data.

10. The method of claim 1 wherein a sub-sampling frequency utilized to generate partial resolution measurement data is settable by at least one of a user and the display system.

11. A system for compensating an image produced by an emissive display system having pixels, each pixel having a light-emitting device, the system comprising:

a display comprising said pixels;

a monitoring system coupled to said pixels of said display and for measuring characteristics of a plurality of said pixels generating measurement data for use in compensation of the display;

a memory for storing the measurement data;

an interpolation module for retrieving partial resolution measurement data from the measurement data stored in the memory and interpolating the measurement data generating full resolution interpolated measurement data; and

a compensation module for compensating the display with use of the full resolution interpolated measurement data.

12. The system of claim 11 wherein the partial resolution measurement data comprises measurement data only for a selected subset of pixels of the display.

13. The system of claim 11 wherein the monitoring system is for measuring characteristics of a plurality of pixels which comprises measuring with sub-sampling characteristics only of a selected subset of the pixels of the display system generating measurement data which is said partial resolution measurement data.

14. The system of claim 11 wherein the monitoring system is further for measuring characteristics of all of the pixels of the display system generating measurement data which comprises full resolution measurement data, and wherein the interpolation module is further for retrieving with sub-sampling measurement data of only a selected subset of pixels of the display from the full resolution measurement data stored in the memory.

15. The system of claim 14 further comprising:

a sub-sampling module for determining the selected pixels of the display so as to reduce an error between the full interpolated resolution measurement data and the full resolution measurement data.

16. The system of claim 11 wherein the interpolation module is further for, for each pixel of the display other than pixels of said selected subset of pixels of the display: predicting a corresponding interpolated pixel data portion of said full resolution interpolated measurement data; comparing said corresponding interpolated pixel data portion with a corresponding pixel data portion of said full resolution measurement data generating a predicted pixel interpolation error; and for pixels where said predicted pixel interpolation error exceeds a threshold, for storing interpolation correction data for said pixel in an error table and performing said generation of said full resolution interpolated measurement data comprises determining absolute measurement data for said pixel with use of said interpolation correction data.

17. The system of claim 16 wherein determining absolute measurement data for said pixel comprises replacing corresponding interpolated pixel data portion of said full resolution interpolated measurement data with said interpolation correction data.

18. The system of claim 16 wherein determining absolute measurement data for said pixel comprises replacing corresponding interpolated pixel data portion of said full resolution interpolated measurement data with absolute measurement data generated with use of said interpolation correction data and said corresponding interpolated pixel data portion.

19. The system of claim 11 wherein measuring characteristics of a plurality of pixels generating measurement data comprises generating low spatial frequency measurement data and high spatial frequency measurement data, wherein storing the measurement data in the memory comprises storing the low spatial frequency measurement data and high spatial frequency measurement data in the memory, wherein retrieving partial resolution measurement data from the measurement data stored in the memory comprises retrieving low spatial frequency partial resolution measurement data from the low spatial frequency measurement data stored in the memory and retrieving high spatial frequency partial resolution measurement data from the high spatial frequency measurement data stored in the memory, wherein interpolating the measurement data generating full resolution interpolated measurement data comprises interpolating the low spatial frequency measurement data and interpolating the high spatial frequency measurement data and combining the interpolated low spatial frequency measurement data and the interpolated high spatial frequency measurement data together generating full resolution interpolated measurement data.

20. The system of claim 11 wherein a sub-sampling frequency utilized to generate partial resolution measurement data is settable by at least one of a user and the display system.