FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

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The Patent Rules, 2003

COMPLETE SPECIFICATION

(See section 10 and rule 13)

TITLE OF THE INVENTION

"A METHOD FOR ENABLING DIRECT MEMORY ACCESS (DMA) CONTROL SIGNALS ON LIFI IN COMPUTING SYSTEMS"

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The following specification particularly describes the nature of the invention and the manner in which it is performed:

FIELD OF THE INVENTION

[001] The present invention relates to the field of computing systems and communication technologies, particularly focusing on enhancing the performance of Direct Memory Access (DMA) based computing systems through utilization of the Light Fidelity (LiFi) technology. By leveraging LiFi technology, the invention aims to provide faster and more secure communication between different parts of the computer system, thereby optimizing DMA operations for improved performance and reliability.

BACKGROUND OF THE INVENTION

[002] In the realm of computing systems, the utilization of Direct Memory Access (DMA) has been pivotal in optimizing data transfer processes between peripherals and the system memory, thereby enhancing system performance. DMA enables certain hardware subsystems to access the main system memory independent of the central processing unit (CPU), streamlining data movement and reducing CPU overhead. However, conventional DMA implementations predominantly rely on wired communication channels, which may encounter limitations in terms of bandwidth, latency, and susceptibility to electromagnetic interference.

[003] Moreover, the burgeoning demand for higher data transfer rates and enhanced security measures necessitates the exploration of alternative communication technologies. Light Fidelity (LiFi) technology has emerged as a promising candidate, offering the potential for high-speed, secure, and reliable wireless communication through the transmission of data via light

signals. LiFi leverages light-emitting diodes (LEDs) to transmit data, utilizing the visible light spectrum to facilitate communication.

[004] **US4688166A** discloses a direct memory access controller is provided which can service a number of input/output controllers concurrently on a time-division multiplexed basis. The direct memory access controller (DMAC) is capable of interconnecting more than one input/output device with more than one system memory. The DMAC can also transfer data from one system memory to a second system memory, or within one system memory.

[005] **US20060168366A1** discloses a DMA control method in which a DMA controller transfers data in memory to an input/output device in accordance with the control information which is provided by a processing device to a DMA controller, a processing device implements a step in which the processing device sets an information block comprising the control information and the data in the memory; a step in which address information of the information block is provided by the processing device to the DMA controller; a step in which the DMA controller reads the information block from the memory based on the address information and extracts the control information; and a step in which the DMA controller transfers the data in the information block to the I/O device based on the control information.

[006] Despite the inherent advantages of LiFi, its integration with DMA control signals in computing systems remains an uncharted territory. Existing DMA implementations are predominantly tethered to wired communication mediums, thereby limiting the scalability, flexibility, and security of data transfer operations. Furthermore, the conventional DMA methodologies may

encounter challenges related to electromagnetic interference, signal attenuation, and bandwidth constraints, thereby impeding the realization of seamless and efficient data transfer mechanisms.

[007] In this context, the present invention endeavors to address the aforementioned limitations by proposing a novel methodology for enabling Direct Memory Access (DMA) control signals on LiFi in computing systems. The methodology outlined herein harnesses the inherent benefits of LiFi technology to facilitate faster, more secure, and robust communication between various components within the computing system, thereby augmenting the efficiency of DMA operations.

[008] By leveraging LiFi transmitters and receivers, the proposed methodology enables the transmission of DMA control signals via light signals, thereby obviating the need for conventional wired communication channels. This paradigm shift not only mitigates the constraints associated with wired communication mediums but also unlocks new avenues for enhancing the scalability, flexibility, and security of DMA operations in computing systems.

[009] Furthermore, the integration of LiFi technology with DMA control signals enables the realization of faster data transfer rates, reduced latency, and enhanced immunity to electromagnetic interference, thereby bolstering the overall performance and reliability of computing systems. Additionally, the utilization of LiFi technology contributes to the enhancement of system security by leveraging the inherent properties of light, such as line-of-sight transmission and minimal susceptibility to eavesdropping or signal interception.

[010] Hence, there is a dire need to develop a methodology that represents a significant advancement in the field of computing systems by harnessing the transformative potential of LiFi technology to enable more efficient, secure, and reliable DMA operations. By transcending the constraints of conventional wired communication channels, this innovation paves the way for the realization of next-generation computing systems characterized by enhanced performance, scalability, and security.

SUMMARY OF THE PRESENT INVENTION

[011] The present invention discloses a method for enabling Direct Memory Access (DMA) control signals on LiFi (Light Fidelity) in computing systems, thereby facilitating faster and more secure communication between various components within the system. The methodology encompasses a detailed textual representation depicted in the flowchart, delineating the seamless integration of LiFi technology with DMA operations to enhance system performance, scalability, and security.

[012] Central to the invention is the utilization of LiFi communication components, including LiFi Transmitters (Tx) and Receivers (Rx), to transmit and receive data via light signals, thereby obviating the need for conventional wired communication channels. By leveraging the inherent advantages of LiFi technology, such as high-speed transmission and reduced electromagnetic interference, the proposed method enables efficient data transfer specifically between system memory and input/output devices.

[013] The methodology involves the orchestration of data flow and processing stages, commencing with the initiation phase wherein sensors collect data and

transmit it to system memory, while I/O devices issue DMA requests (DRQ) to initiate data transfers. Subsequently, DMA controller, upon receiving a DRQ, dispatches a Hold Request (HRQ) to the CPU, prompting it to pause its current task and grant bus control to the DMA controller upon receiving a Hold Acknowledgement (HLDA) signal.

[014] Following the initiation phase, the method progresses to the data transfer stage, wherein the DMA controller initiates data transfers between the system memory and I/O devices, facilitating seamless communication via LiFi transmitters and receivers. Throughout this process, the DMA controller keeps DMA Acknowledgement (DACK) signal activated to the I/O devices to indicate the progress of data transfer operation.

[015] Upon completion of data transfer, control of the buses is relinquished to the CPU, allowing it to resume its normal operations. Throughout the entire process, communication between system components is facilitated by LiFi transmitters and receivers, ensuring high-speed, secure, and reliable data transmission.

[016] Furthermore, the invention leverages LiFi technology to enhance the efficiency of DMA operations by leveraging its inherent properties such as reducing the length of tracks on the board, high-speed data transmission, reduced latency, and enhanced security. By harnessing LiFi for communication between different parts of the computer system, the proposed methodology significantly enhances the efficiency of DMA operations, thereby advancing the state-of-the-art in computing systems.

BRIEF DESCRIPTION OF THE DRAWINGS

[017] When considering the following thorough explanation of the present invention, it will be easier to understand it and other objects than those mentioned above will become evident. Such description refers to the illustrations in the annex, wherein:

FIG. 1 and 2 illustrate the working associated with methods for enabling direct memory access (DMA) control signals on LiFi in computing systems, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[018] The following sections of this article will provide various embodiments of the current invention with references to the accompanying drawings, whereby the reference numbers utilised in the picture correspond to like elements throughout the description. However, this invention is not limited to the embodiment described here and may be embodied in several other ways. Instead, the embodiment is included to ensure that this disclosure is extensive and complete and that individuals of ordinary skill in the art are properly informed of the extent of the invention.

[019] Numerical values and ranges are given for many parts of the implementations discussed in the following thorough discussion. These numbers and ranges are merely to be used as examples and are not meant to restrict the claims' applicability. A variety of materials are also recognised as fitting for certain aspects of the implementations. These materials should only be used as examples and are not meant to restrict the application of the innovation.

[020] Referring to Fig. 1 and Fig 2, the present invention pertains to a meticulously crafted methodology enabling the integration of Direct Memory Access (DMA) control signals within computing systems utilizing LiFi (Light Fidelity) technology.

[021] The intricate architecture of this invention seamlessly interweaves various essential components integral to the functionality of modern computing systems. Among these are the Central Processing Unit (CPU), Microprocessor (µP), or Microcontroller (µC), serving as the computational powerhouse orchestrating system operations. Augmenting the CPU's capabilities is the DMA Controller, a critical entity tasked with managing direct memory access, thereby facilitating autonomous data transfer between system memory and peripheral devices.

[022] Furthermore, integral to the communication infrastructure are Universal Asynchronous Receiver-Transmitter (UART) units, which facilitate asynchronous serial communication essential for diverse data exchanges. The System Memory, acting as the repository for data and instructions, plays a pivotal role in storing and retrieving information essential for system operations. Additionally, a myriad of Input/Output (I/O) devices seamlessly integrates into the computing ecosystem, ensuring bidirectional data exchange between the system and external peripherals.

[023] Crucially, the incorporation of Sensors further enriches the computing environment, enabling the detection and transmission of environmental stimuli to the system for processing and action. Facilitating the transmission of data through light signals are the LiFi Communication Components, comprising LiFi

Transmitters (Tx) and Receivers (Rx), which serve as the conduits for swift and secure data transmission within the system.

[024] Moreover, central to the functionality of this invention are the meticulously defined Control Signals, including Hold Request (HRQ), Hold Acknowledgement (HLDA), DMA Request (DRQ), and DMA Acknowledgement (DACK). These signals orchestrate the seamless coordination between the CPU, DMA Controller, memory and I/O devices, ensuring efficient data transfer and system operation.

[025] The data flow and processing mechanism of this invention are orchestrated with meticulous precision. Initial data acquisition is initiated through Sensors, which relay the collected data to the DMA Controller. Subsequently, I/O devices trigger DMA requests (DRQ) when necessitating data transfer, prompting the DMA Controller to initiate the data transfer process.

[026] Upon receiving a DRQ, the DMA Controller promptly issues an HRQ to the CPU, signalling its need for control over the system buses. In response, the CPU temporarily halts its ongoing tasks and issues an HLDA signal, granting the DMA Controller authority over the buses, thereby facilitating uninterrupted data transfer.

[027] During the data transfer phase, the DMA Controller orchestrates the seamless exchange of data between the system memory and I/O devices, utilizing the DACK signal to acknowledge and facilitate the transfer process. Upon completion of data transfer, control over the buses is relinquished, enabling the CPU to resume its normal operations seamlessly.

[028] Throughout this intricate process, the innovative integration of LiFi technology serves as a cornerstone, enabling expedited and secure communication between system components. LiFi transmitters and receivers facilitate the transmission of critical control signals and data, enhancing the efficiency and reliability of DMA operations.

[029] Furthermore, the invention leverages the robust architecture of the system's bus system, comprising the Address Bus, Control Bus, and Data Bus. These buses serve as the conduits for transmitting memory addresses, control signals, and data, ensuring seamless communication and operation within the computing ecosystem.

[030] In conclusion, the present invention represents a paradigm shift in the realm of computing systems, harnessing the power of LiFi technology to revolutionize DMA operations. Through meticulous integration and orchestration of essential components and control signals, this methodology ensures enhanced efficiency, security, and reliability in data transfer within computing systems.

We Claim:

1. A method for enabling Direct Memory Access (DMA) control signals on LiFi in computing systems, as herein described and illustrated, comprising the steps of:

    a) Integrating Direct Memory Access (DMA) control signals within computing systems utilizing LiFi (Light Fidelity) technology;

    b) Utilizing essential components including the Central Processing Unit (CPU), Microprocessor (µP), or Microcontroller (µC), the DMA Controller, Universal Asynchronous Receiver-Transmitter (UART) units, System Memory, Input/Output (I/O) devices, Sensors, LiFi Transmitters (Tx), and LiFi Receivers (Rx) within the computing architecture;

    c) Managing direct memory access through the DMA Controller to facilitate autonomous LiFi based data transfer between system memory and peripheral devices;

    d) Facilitating LiFi based asynchronous serial communication essential for diverse data exchanges through UART units;

    e) Storing and retrieving information essential for system operations within the System Memory;

    f) Ensuring LiFi based bidirectional data exchange between the system and external peripherals through the integration of I/O devices;

g) Enriching the computing environment by enabling detection and transmission of environmental stimuli through incorporated Sensors;

h) Orchestrating the LiFi based seamless coordination between the CPU, DMA Controller, and I/O devices through meticulously defined Control Signals including Hold Request (HRQ), Hold Acknowledgement (HLDA), DMA Request (DRQ), and DMA Acknowledgement (DACK);

i) Initiating data acquisition through Sensors and subsequent triggering of DMA requests (DRQ) by I/O devices to prompt the DMA Controller to initiate the data transfer process;

j) Issuing HRQ to the CPU upon receiving DRQ, temporarily halting ongoing tasks and granting authority over buses by issuing HLDA signal, thereby facilitating uninterrupted data transfer;

k) Orchestrating the LiFi based seamless exchange of data between system memory and I/O devices utilizing the DACK signal to acknowledge and facilitate the transfer process by the DMA Controller;

l) Relinquishing control over the buses upon completion of data transfer, enabling the CPU to resume normal operations seamlessly;

m) Leveraging LiFi technology to enable expedited and secure communication between system components, enhancing the efficiency and reliability of DMA operations;

n) Utilizing the robust architecture of the system's bus system, comprising Address Bus, Control Bus, and Data Bus, as conduits for transmitting memory addresses, control signals, and data, ensuring seamless communication and operation within the computing ecosystem; and

o) Representing a paradigm shift in computing systems, harnessing the power of LiFi technology to revolutionize DMA operations, ensuring enhanced efficiency, security, and reliability in data transfer within computing systems.

2. The method as claimed in claim 1, wherein the LiFi Transmitters (Tx) and Receivers (Rx) facilitate the transmission of critical control signals and data, further enhancing the efficiency and reliability of DMA operations.

3. The method as claimed in claim 1, wherein the integration of Sensors enriches the computing environment by enabling the detection and transmission of environmental stimuli to the system for processing and action.

4. The method as claimed in claim 1, wherein the DMA Controller seamlessly orchestrates the exchange of data between the system memory and I/O devices, ensuring efficient data transfer and system operation.

5. The method as claimed in claim 1, wherein the Control Signals, including Hold Request (HRQ), Hold Acknowledgement (HLDA), DMA Request (DRQ), and DMA Acknowledgement (DACK), ensure seamless coordination between the CPU, DMA Controller, and I/O devices, facilitating uninterrupted data transfer.

6. The method as claimed in claim 1, wherein the System Memory stores and retrieves information essential for system operations, thereby playing a pivotal role in the functionality of the computing system.
7. The method as claimed in claim 1, wherein the UART units facilitate asynchronous serial communication essential for diverse data exchanges within the computing system.
8. The method as claimed in claim 1, wherein the I/O devices seamlessly integrate into the computing ecosystem, ensuring bidirectional data exchange between the system and external peripherals.
9. The method as claimed in claim 1, wherein the Address Bus, Control Bus, and Data Bus serve as conduits for transmitting memory addresses, control signals, and data, ensuring seamless communication and operation within the computing ecosystem.

Dated this 1st day of June 2024

Signature:

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ABSTRACT

A METHOD FOR ENABLING DIRECT MEMORY ACCESS (DMA) CONTROL SIGNALS ON LIFI IN COMPUTING SYSTEMS

[031] The present invention introduces a method for integrating Direct Memory Access (DMA) subsystem into command, control and computing systems using LiFi (Light Fidelity) technology. Through meticulous orchestration of essential components including the CPU, DMA Controller, UART units, System Memory, I/O devices, Sensors, and LiFi Communication Components, the methodology facilitates autonomous data transfer between system memory and peripherals. Control signals such as HRQ, HLDA, DRQ, and DACK ensure seamless coordination between system elements, enhancing data transfer performance. Leveraging LiFi technology enables swift and secure communication between components via light signals. This innovation represents a paradigm shift in computing, revolutionizing DMA operations by enhancing system performance, efficiency, security, and reliability. The integration of LiFi technology augments traditional bus systems, ensuring seamless communication and operation within the computing ecosystem.

Accompanied Drawings [**Fig. 1 and 2**]

Dated this 1st day of June 2024

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