

Technical Field

The present invention relates to the technical field of sensors, and more specifically relates to a sensor pulse signal processing method.

Background Art

In recent years, due to rapid technological developments in internet of things and sensors, users' demands for precision of sensors and their frequency of data collection are becoming higher and higher in the fields of smart meter reading and smart water management, implying that pulse output type sensors will have faster and faster pulse output frequency.

In a conventional pulse output type sensor, pulses output from the sensor are mainly in two forms: negative logic level and positive logic level. The form of negative logic level is shown in FIG. 1. The form of positive logic level is shown in FIG. 2.

When the pulse output type sensor is employed in a scenario requiring high precision and high frequency of data collection, an effective pulse width of the sensor is usually smaller than 100MS. In the fields of smart meter reading and smart water management, a data collection device or a main control unit (MCU) is usually in a sleep mode, and is waken up at predetermined times to work on tasks.

A time period when the data collection device or the MCU is transiting to a sleep mode after a pulse detection task, and a time period when a pulse of the sensor transits from an effective pulse to an idle state are so called "window periods". The lengths of cycles of these two window periods are the same. Due to faster frequency of cycles of output pulses used in high-precision and high-frequency data collection, pulse signals may appear during window periods, and so the data collection device or the MCU cannot collect effective pulses; as a result, there are measurement errors, and thus the requirements for high-precision measurement cannot be met.

Disclosure of the Invention

The present invention provides a sensor pulse signal processing method to effectively solve the prior art problem of erroneous measurements caused by missed pulse interruptions due to sleep mode of the data collection device or the MCU.

The present invention is achieved as follows: a sensor pulse signal processing method, comprising the following steps:

Step S1: adding a high frequency pulses group to each of two sides of an effective pulse of the sensor;

Step S2: if a pulse signal is detected by any of the high frequency pulses group during a pulse detection window period, creating an interruption to wake up a data collection device or a main control unit (MCU) immediately after the window period; if a pulse signal is not detected by any of the high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period is not performed.

Specifically, Step S1 comprises the following steps:

adding a first high frequency pulses group at a starting point which the effective pulse starts to output, and adding a second high frequency pulses group at an ending point which the output of the effective pulse ends.

Specifically, Step S2 comprises the following steps:

when the data collection device or the MCU is transiting to a sleep mode, the pulse detection window period occurs; if during this pulse detection window period, a pulse signal is detected by the first high frequency pulses group, the interruption is created to wake up the data collection device or the MCU immediately after the pulse detection window period, such that the data collection device or the MCU enters a detecting state; if a pulse signal is not detected by the first high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the pulse detection window period is not performed;

when a pulse of the sensor is transiting to an idle state, the pulse detection window period occurs; if during this pulse detection window period, a pulse signal is detected by the second high frequency pulses group, the interruption is created to wake up the data collection device or the MCU immediately after the pulse detection window period, such that the data collection device or the MCU enters a detecting state; if a pulse signal is not detected by the second high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the pulse detection window period is not performed.

Further, a number of pulses within the first high frequency pulses group is equal to or greater than 2; and a cycle of the first high frequency pulses group is equal to or greater than 2 times a cycle of the window period.

Further, a number of pulses within the second high frequency pulses group is equal to or greater than 2; and a cycle of the second high frequency pulses group is equal to or greater than 2 times a cycle of the window period.

Further, a cycle of the effective pulse of the sensor is configured to be equal to or greater than 3 times a sampling cycle.

Further, a duty ratio of the pulse of the sensor is 50%, specifically, a total cycle of the pulse of the sensor is two times a total cycle of the effective pulse, wherein the total cycle of the effective pulse = the cycle of the first high frequency pulses group + the cycle of the effective pulse + the cycle of the second high frequency pulses group.

Further, in said Step S1, the effective pulse of the sensor is specifically output in a form of negative logic level of the sensor.

Further, in said Step S1, the effective pulse of the sensor is specifically output in a form of positive logic level of the sensor.

The present invention has the following advantages:

1. The present invention configures a high frequency pulses group on each of the two sides of the effective pulse of the sensor, such that when a pulse signal is not able to be identified by pulse interruption of the data collection device or the MCU, the data collection device or the MCU can be woken up by a change of electrical level caused by the high frequency pulses group, thereby ensuring that the data collection device or the MCU will not miss any pulse interruption, thus effectively preventing erroneous measurement and on the other hand enhancing the detecting precision and detecting frequency of the sensor.

2. The cycle of the effective pulse of the sensor is equal to or greater than 3 times the sampling cycle to ensure accuracy of the effective pulse of the sensor.

3. The duty ratio of the pulse of the sensor is 50%, thereby ensuring consistency and stability of the pulse; also the greatest detecting precision of the sensor can be known by calculating the total cycle of the pulse of the sensor.

Brief Description of Drawings

The present invention will be further described in detail below with reference to the drawings and the illustrated embodiments.

FIG. 1 is a schematic view of a negative logic level output by a prior art pulse output type sensor

FIG. 2 is a schematic view of a positive logic level output by a prior art pulse output type sensor.

FIG. 3 is a schematic view of a positive logic level output by a sensor according to embodiment 1 of the present invention.

FIG. 4 is a schematic view of a negative logic level output by a sensor according to embodiment 2 of the present invention.

FIG. 5 is an operating flow chart of the sensor pulse signal processing method according to the present invention.

Best Mode for Carrying out the Invention

Embodiment 1:

FIGs. 3 and 5 illustrate a preferred embodiment 1 of the sensor pulse signal processing method according to the present invention, comprising the following steps:

Step S1: adding a high frequency pulses group to each of two sides of an effective pulse of a sensor;

wherein a purpose of adding the high frequency pulses group to each of the two sides of the effective pulse of the sensor is that: when the sensor detects with high precision and greater frequency, a pulse frequency of the sensor will be larger than 10Hz. In the field of smart meter reading and smart water management, a data collection device or a main control unit (MCU) is supplied with power using a disposable battery. Therefore, the data collection device or the MCU is periodically awakened to work on tasks. When the data collection device or the MCU is transiting to a sleep mode, there is a pulse detection window period, and if the sensor detects a signal during this window period, it cannot be identified by pulse interruption of the data collection device or the MCU,

and thus causing the problem of erroneous measurement. Likewise, when a pulse of the sensor is transiting to an idle state, there also exists a pulse detection window period, and if the sensor detects a signal during this window period, it likewise cannot be identified by pulse interruption of the data collection device or the MCU. According to the present invention, a high frequency pulses group is added to each of the two sides of an effective pulse of the sensor, such that when a signal cannot be identified by pulse interruption of the data collection device or the MCU, the data collection device or the MCU can be woken up by a change of electrical level caused by the corresponding high frequency pulses group.

Step S1 according to embodiment 1 specifically comprises the following steps: adding a first high frequency pulses group at a starting point which the effective pulse starts to output, and adding a second high frequency pulses group at an ending point which the output of the effective pulse ends; after adding the first high frequency pulses group and the second high frequency pulses group, a pulse of the sensor has a waveform constituted by the idle state, the first high frequency pulses group, the effective pulse and the second high frequency pulses group. During the idle state of the waveform of the pulse output by the sensor, data sampling will not be performed. During the effective pulse of the waveform of the pulse output by the sensor, data sampling will be carried out for multiple times. During the first high frequency pulses group and the second high frequency pulses group of the waveform of the pulse output by the sensor, the data collection device or the MCU will be woken up.

In embodiment 1, the effective pulse of the sensor is specifically output in a form of positive logic level of the sensor, and a waveform of the pulse of the sensor with the effective pulse in the form of positive logic level is illustrated in FIG. 3.

In embodiment 1, in order to effectively prevent the problem of erroneous measurement, a number of pulses within the first high frequency pulses group is equal to or greater than 2; and a cycle of the first high frequency pulses group is equal to or greater than 2 times a cycle of any of the window period. Obviously, the present embodiment is not limiting. If power consumption is not considered when implementing the invention, more number of pulses (e.g. 10 pulses) can be configured within the first high frequency pulses group. If power consumption is considered, a smaller number of pulses (e.g. 2 pulses) should be configured within the first high frequency pulses group.

In embodiment 1, in order to effectively prevent the problem of erroneous measurement, a number of pulses within the second high frequency pulses group is equal to or greater than 2; and a cycle of the second high frequency pulses group is equal to or greater than 2 times a cycle of any of the window period. Obviously, the present embodiment is not limiting. If power consumption is not considered when implementing the invention, more number of pulses (e.g. 8 pulses) can be configured within the second high frequency pulses group. If power consumption is considered, a smaller number of pulses (e.g. 3 pulses) should be configured within the second high frequency pulses group.

To ensure the accuracy of the effective pulse of the sensor, data sampling will be carried out multiple times during the effective pulse of the sensor. Therefore, a cycle of the effective pulse of the sensor is configured to be equal to or greater than 3 times a sampling cycle.

To ensure consistency and stability of a pulse, a duty ratio of a pulse of the sensor is 50%, in other words, a total cycle of the pulse of the sensor is two times a total cycle of the effective pulse, wherein the total cycle of the effective pulse = the cycle of the first high frequency pulses group + the cycle of the effective pulse + the cycle of the second high frequency pulses group. Also, the greatest detecting precision of the sensor can be known from the total cycle of the pulse of the sensor. Of course, the duty ratio of the pulse of the sensor is configured as 50% mainly under the consideration of ensuring consistency and stability of the pulse. If consistency and stability of the pulse is not considered, other duty ratios are possible.

A specific example is given below to illustrate the greatest detecting precision of the sensor: Given that the cycle of any of the window period is 100us, the sampling cycle is 1ms, then it can be determined that the cycle of the first high frequency pulses cycle = the cycle of the second high frequency pulses cycle is $\geq 2 \times 100\text{us}$ (200us), the cycle of the effective pulse of the sensor is $\geq 3 \times 1\text{ms}$ (3ms), the total cycle of the effective pulse is $\geq 200\text{us} + 3\text{ms} + 200\text{us} = 3.4\text{ms}$, and thus the total cycle of the pulse of the sensor is $\geq 2 \times 3.4\text{ms} = 6.8\text{ms}$. Therefore, the greatest detecting precision of the sensor is 6.8ms. In other words, the sensor can detect a pulse signal with a cycle equal to or greater than 6.8ms.

Step S2: if a pulse signal is detected by the first high frequency pulses group or the second high frequency pulses group during any of the window period of pulse detection, creating an interruption to wake up the data collection device or the MCU immediately after the window period; if a pulse signal is not detected by the first high frequency pulses group or the second high frequency pulses group during any of the window period of pulse detection, the process of creating an interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

According to embodiment 1, step S2 specifically comprises the following steps:

When the data collection device or the MCU is transiting to the sleep mode, there is a pulse detection window period. During this window period, the data collection device or the MCU is not able to identify effective pulse. If during this window period, a pulse signal is detected by the first high frequency pulses group, an interruption is created to wake up the data collection device or the MCU immediately after the window period (when the first high frequency pulses group detects the pulse signal, there is an immediate change of electrical level; since the cycle of the first high frequency pulses group is equal to or greater than 2 times the cycle of the window period, the first high frequency pulses group can extend the effectiveness of the pulse signal after the window period, thereby possible to create an interruption to wake up the data collection device or the MCU). Accordingly, the data collection device or the MCU enters a detecting state and thereby preventing erroneous measurement. If a pulse signal is not detected by the first high frequency pulses group

during the window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

When the pulse of the sensor is transiting to an idle state, there is a pulse detection window period. During this window period, the data collection device or the MCU is not able to identify effective pulse. If during this window period, a pulse signal is detected by the second high frequency pulses group, an interruption is created to wake up the data collection device or the MCU immediately after the window period (when the second high frequency pulses group detects the pulse signal, there is an immediate change of electrical level; since the cycle of the second high frequency pulses group is equal to or greater than 2 times the cycle of the window period, the second high frequency pulses group can extend the effectiveness of the pulse signal after the window period, thereby possible to create an interruption to wake up the data collection device or the MCU). Accordingly, the data collection device or the MCU enters a detecting state and thereby preventing erroneous measurement. If a pulse signal is not detected by the second high frequency pulses group during the window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

Embodiment 2:

FIGs. 4 and 5 illustrate a preferred embodiment 2 of the sensor pulse signal processing method according to the present invention, comprising the following steps:

Step S1: adding a high frequency pulses group to each of two sides of an effective pulse of a sensor;

wherein a purpose of adding the high frequency pulses group to each of the two sides of the effective pulse of the sensor is that: when the sensor detects with high precision and greater frequency, a pulse frequency of the sensor will be larger than 10Hz. In the field of smart meter reading and smart water management, a data collection device or a main control unit (MCU) is supplied with power using a disposable battery. Therefore, the data collection device or the MCU is periodically awakened to work on tasks. When the data collection device or the MCU is transiting to a sleep mode, there is a pulse detection window period, and if the sensor detects a signal during this window period, it cannot be identified by pulse interruption of the data collection device or the MCU, and thus causing the problem of erroneous measurement. Likewise, when a pulse of the sensor is transiting to an idle state, there also exists a pulse detection window period, and if the sensor detects a signal during this window period, it likewise cannot be identified by pulse interruption of the data collection device or the MCU. According to the present invention, a high frequency pulses group is added to each of the two sides of an effective pulse of the sensor, such that when a signal cannot be identified by pulse interruption of the data collection device or the MCU, the data collection device or the MCU can be woken up by a change of electrical level caused by the corresponding high frequency pulses group.

Step S1 according to embodiment 2 specifically comprises the following steps: adding a first high frequency pulses group at a starting point which the effective pulse starts to output, and adding a second high frequency pulses group at an ending point which the output of the effective

pulse ends; after adding the first high frequency pulses group and the second high frequency pulses group, a pulse of the sensor has a waveform constituted by the idle state, the first high frequency pulses group, the effective pulse and the second high frequency pulses group. During the idle state of the waveform of the pulse output by the sensor, data sampling will not be performed. During the effective pulse of the waveform of the pulse output by the sensor, data sampling will be carried out for multiple times. During the first high frequency pulses group and the second high frequency pulses group of the waveform of the pulse output by the sensor, the data collection device or the MCU will be woken up.

In embodiment 2, the effective pulse of the sensor is specifically output in a form of negative logic level of the sensor, and a waveform of the pulse of the sensor with the effective pulse in the form of negative logic level is illustrated in FIG. 4.

In embodiment 2, in order to effectively prevent the problem of erroneous measurement, a number of pulses within the first high frequency pulses group is equal to or greater than 2; and a cycle of the first high frequency pulses group is equal to or greater than 2 times a cycle any of the window period. Obviously, the present embodiment is not limiting. If power consumption is not considered when implementing the invention, more number of pulses (e.g. 10 pulses) can be configured within the first high frequency pulses group. If power consumption is considered, a smaller number of pulses (e.g. 3 pulses) should be configured within the first high frequency pulses group.

In embodiment 2, in order to effectively prevent the problem of erroneous measurement, a number of pulses within the second high frequency pulses group is equal to or greater than 2; and a cycle of the second high frequency pulses group is equal to or greater than 2 times a cycle of any of the window period. Obviously, the present embodiment is not limiting. If power consumption is not considered when implementing the invention, more number of pulses (e.g. 10 pulses) can be configured within the second high frequency pulses group. If power consumption is considered, a smaller number of pulses (e.g. 3 pulses) should be configured within the second high frequency pulses group.

To ensure the accuracy of the effective pulse of the sensor, data sampling will be carried out multiple times during the effective pulse of the sensor. Therefore, a cycle of the effective pulse of the sensor is configured to be equal to or greater than 3 times a sampling cycle. For example, if the sampling cycle is 1ms, the cycle of the effective pulse of the sensor is $\geq 3 \times 1\text{ms}$ (i.e. 3ms).

To ensure consistency and stability of a pulse, a duty ratio of a pulse of the sensor is 50%, in other words, a total cycle of the pulse of the sensor is two times a total cycle of the effective pulse, wherein the total cycle of the effective pulse = the cycle of the first high frequency pulses group + the cycle of the effective pulse + the cycle of the second high frequency pulses group. For example, if the cycle of any of the window period is 150us, the sampling cycle is 0.5ms, then it can be determined that the cycle of the first high frequency pulses cycle = the cycle of the second high frequency pulses cycle is $\geq 2 \times 150\text{us}$ (300us), the cycle of the effective pulse of the sensor is $\geq 3 \times 0.5\text{ms}$ (1.5ms), the total cycle of the effective pulse is $\geq 300\text{us} + 1.5\text{ms} + 300\text{us} = 2.1\text{ms}$, and thus

the total cycle of the pulse of the sensor is $\geq 2 \times 2.1\text{ms} = 4.2\text{ms}$. Also, the greatest detecting precision of the sensor can be known from the total cycle of the pulse of the sensor. Of course, the duty ratio of the pulse of the sensor is configured as 50% mainly under the consideration of ensuring consistency and stability of the pulse. If consistency and stability of the pulse is not considered, other duty ratios are possible.

Step S2: if a pulse signal is detected by the first high frequency pulses group or the second high frequency pulses group during any of the window period of pulse detection, creating an interruption to wake up the data collection device or the MCU immediately after the window period; if a pulse signal is not detected by the first high frequency pulses group or the second high frequency pulses group during any of the window period of pulse detection, the process of creating an interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

According to embodiment 2, step S2 specifically comprises the following steps:

When the data collection device or the MCU is transiting to the sleep mode, there is a pulse detection window period. During this window period, the data collection device or the MCU is not able to identify effective pulse. If during this window period, a pulse signal is detected by the first high frequency pulses group, an interruption is created to wake up the data collection device or the MCU immediately after the window period (when the pulse signal is detected by the first high frequency pulses group, there is an immediate change of electrical level; since the cycle of the first high frequency pulses group is equal to or greater than 2 times the cycle of the window period, the first high frequency pulses group can extend the effectiveness of the pulse signal after the window period, thereby possible to create an interruption to wake up the data collection device or the MCU). Accordingly, the data collection device or the MCU enters a detecting state and thereby preventing erroneous measurement. If a pulse signal is not detected by the first high frequency pulses group during the window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

When the pulse of the sensor is transiting to an idle state, there is a pulse detection window period. During this window period, the data collection device or the MCU is not able to identify effective pulse. If during this window period, a pulse signal is detected by the second high frequency pulses group, an interruption is created to wake up the data collection device or the MCU immediately after the window period (when the pulse signal is detected by the second high frequency pulses group there is an immediate change of electrical level; since the cycle of the second high frequency pulses group is equal to or greater than 2 times the cycle of the window period, the second high frequency pulses group can extend the effectiveness of the pulse signal after the window period, thereby possible to create an interruption to wake up the data collection device or the MCU). Accordingly, the data collection device or the MCU enters a detecting state and thereby preventing erroneous measurement. If a pulse signal is not detected by the second high frequency pulses group during the window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period will not be performed.

In view of the above, the present invention has the following advantages:

1. The present invention configures a high frequency pulses group on each of the two sides of the effective pulse of the sensor, such that when a pulse signal is not able to be identified by pulse interruption of the data collection device or the MCU, the data collection device or the MCU can be woken up by a change of electrical level caused by the high frequency pulses group, thereby ensuring that the data collection device or the MCU will not miss any pulse interruption, thus effectively preventing erroneous measurement and on the other hand enhancing the detecting precision and detecting frequency of the sensor.

2. The cycle of the effective pulse of the sensor is equal to or greater than 3 times the sampling cycle to ensure accuracy of the effective pulse of the sensor.

3. The duty ratio of the pulse of the sensor is 50%, thereby ensuring consistency and stability of the pulse; also the greatest detecting precision of the sensor can be known by calculating the total cycle of the pulse of the sensor.

Although the detailed embodiments of the present invention are described above, a person skilled in this field of art could understand that the described embodiments are illustrative examples only and should not limit the scope of the present invention. Modifications and changes achieving equivalent technical effects made by a person skilled in this field of art in accordance with the spirit of the present invention should fall within the scope of protection defined by the claims of the present invention.

10
CLAIMS

1. A sensor pulse signal processing method, comprising the following steps:

Step S1: adding a high frequency pulses group to each of two sides of an effective pulse of the sensor;

Step S2: if a pulse signal is detected by any of the high frequency pulses group during a pulse detection window period, creating an interruption to wake up a data collection device or a main control unit (MCU) immediately after the window period; if a pulse signal is not detected by any of the high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the window period is not performed.

2. The sensor pulse signal processing method of claim 1, wherein said Step S1 comprises the following steps:

adding a first high frequency pulses group at a starting point which the effective pulse starts to output, and adding a second high frequency pulses group at an ending point which the output of the effective pulse ends.

3. The sensor pulse signal processing method of claim 2, wherein said Step S2 comprises the following steps:

when the data collection device or the MCU is transiting to a sleep mode, the pulse detection window period occurs; if during this pulse detection window period, a pulse signal is detected by the first high frequency pulses group, the interruption is created to wake up the data collection device or the MCU immediately after the pulse detection window period, such that the data collection device or the MCU enters a detecting state; if a pulse signal is not detected by the first high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the pulse detection window period is not performed;

when a pulse of the sensor is transiting to an idle state, the pulse detection window period occurs; if during this pulse detection window period, a pulse signal is detected by the second high frequency pulses group, the interruption is created to wake up the data collection device or the MCU immediately after the pulse detection window period, such that the data collection device or the MCU enters a detecting state; if a pulse signal is not detected by the second high frequency pulses group during the pulse detection window period, the process of creating the interruption to wake up the data collection device or the MCU immediately after the pulse detection window period is not performed.

4. The sensor pulse signal processing method of claim 2, wherein a number of pulses within the first high frequency pulses group is equal to or greater than 2; and a cycle of the first high frequency pulses group is equal to or greater than 2 times a cycle of the window period.

5. The sensor pulse signal processing method of claim 2, wherein a number of pulses within the second high frequency pulses group is equal to or greater than 2; and a cycle of the second high frequency pulses group is equal to or greater than 2 times a cycle of the window period.

6. The sensor pulse signal processing method of claim 1, wherein a cycle of the effective pulse of the sensor is configured to be equal to or greater than 3 times a sampling cycle.
7. The sensor pulse signal processing method of claim 1, wherein a duty ratio of a pulse of the sensor is 50%, that is, a total cycle of the pulse of the sensor is two times a total cycle of the effective pulse, wherein the total cycle of the effective pulse = a cycle of the first high frequency pulses group + a cycle of the effective pulse + a cycle of the second high frequency pulses group.
8. The sensor pulse signal processing method of claim 1, wherein in said Step S1, the effective pulse of the sensor is output in a form of negative logic level of the sensor.
9. The sensor pulse signal processing method of claim 1, wherein in said Step S1, the effective pulse of the sensor is specifically output in a form of positive logic level of the sensor.