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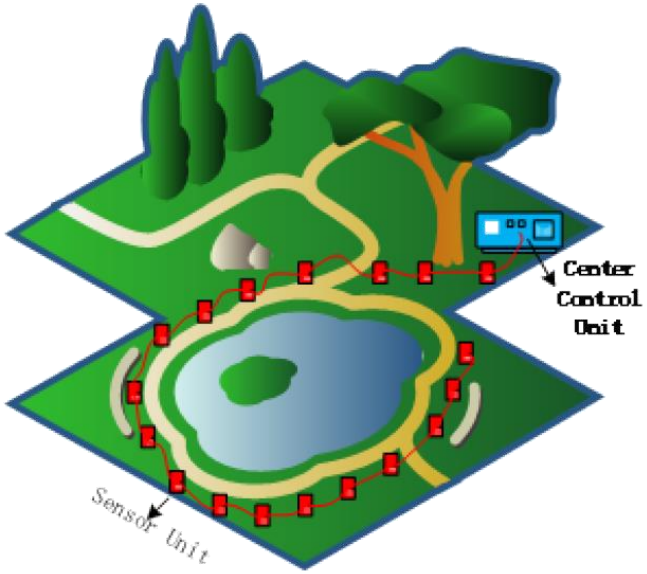

Fig1.sensor network

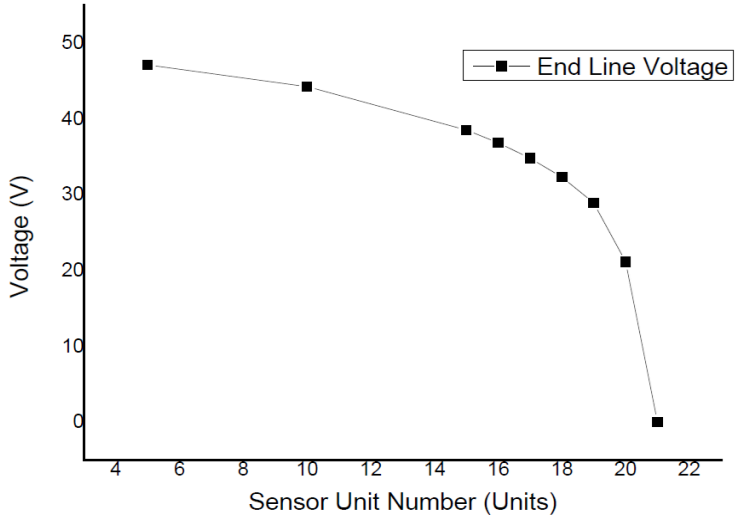

Fig2.Power line loss simulation

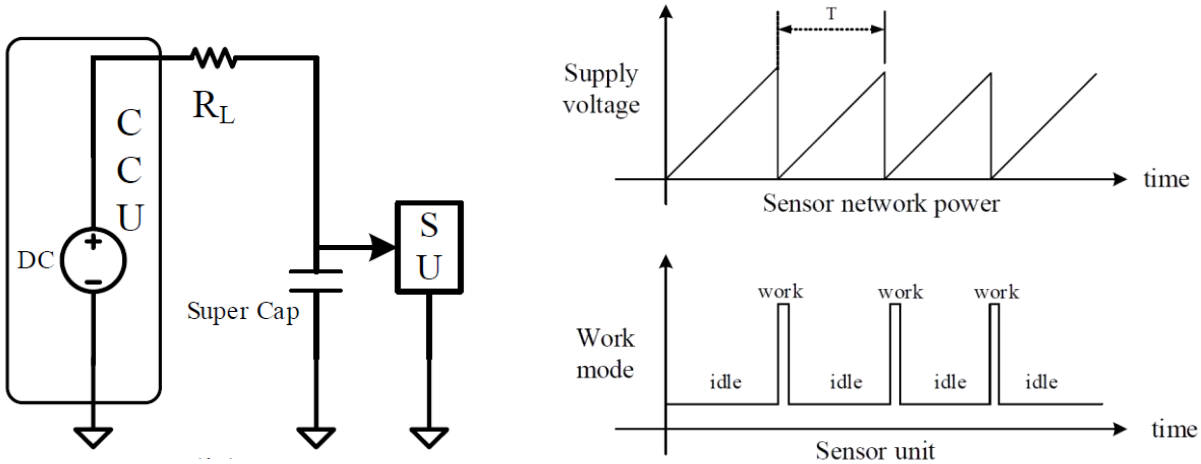

Fig3. power supply model

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Background

Introduction

For a cable based sensor network, power line loss restricts the cable length and cable copper diameter. In this paper, we propose a time stretch method to reduce the power line loss for a sensor network. A sensor network usually works in burst mode, when it is working, a high current consumption is required, while in idle state it needs little power energy. This method uses a super capacitor to collect and store the energy in idle time for each Sensor Unit (SU), so when it changes to active state the SU can use local power to work. Since the power line loss is proportional to the square of the current, the lower current can reduce the line loss significantly. The results shows that this method can reduce the line loss to less than 10%. This method can be used to extend the length of the sensor network cable, or make it possible to use much finer cable copper core.

Analysis

Power Line Loss Analysis

Power line loss is the energy waste in a cable when electronic power is distributed from one place to another place. For sensor networks, power line loss is an important factor of the performance.

Fig.1 Cable based sensor network

As shown in fig.1, a cable based sensor network is used to monitor the lake. The sensor network is composed by one Center Control Unit (CCU) and many Sensor Units (SU). All the SUs is connected with a cable to the CCU, the cable can be used to distributed power from CU to SUs. Fig.2 is the power distribution model of fig.1.

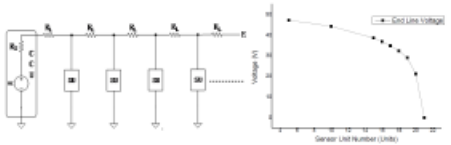

Fig.2 Power line model for fig.1

Fig.3 Power line loss simulation

Fig.3 shows the power line voltage drops quickly when the SU number increases. It means when 20 SUs are connected, the output power of CCU is 48V×0.14A=6.72W, the total power of SUs is 4W. The power efficiency is as low as 59.5%.

Proposed Schemes

sensor network always works in burst mode, which means most of time SUs keep in idle state. The power requirement of a SU in active state and in idle state varies greatly. And also the time in active state and in idle state varies greatly. A typical power consumption diagram is shown in Fig.4.

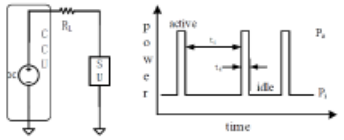

Fig.4 Sensor Unit power consumption in active and idle state

To reduce the average current, a Power Unit (PU) is added for each SU. The PU can be charged the whole time of period so that the average current drops dramatically which leads the less power line loss.

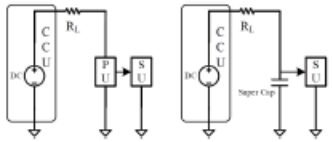

Fig.5 Time stretch to reduce the average power supply current

As shown in fig.5 The PU can be realized by super capacitor. Super capacitors have more than 99% energy efficiency , while its behavior is like a normal capacitor.

The best way to reduce the power line loss is to change the power supplier from a constant voltage mode to a saw wave voltage mode as shown in Fig.6. The T time of the saw wave should match the period of the changing of work mode of the sensor unit.

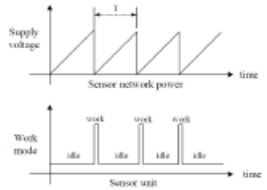

Fig.5 Saw wave voltage power supplier

Method

Conclusion

In this paper, a time stretch method to reduce the power line loss is discussed. It uses the burst work mode characteristic of a sensor network to reduce the peak current when the SU works. Not only the work time, but he idle time is utilized to collect and store energy from cable to local super capacitor. This is called time stretch. The result shows when the ratio of idle time and active time is big enough, the power line loss can be reduced to less than 10%.

Conclusion