

Development of Efficient Multi-Sensor Data Transmit Control Algorithm

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Abstract— in this paper, we propose the development of an efficient multi-sensor data transmission control algorithm for sensor data based on the multiple-sensor nodes using the USN. In this paper the proposed transmission control algorithm uses method that at the same time makes possible to the transmission control of data by compare the tolerance range of the sensing data on multiple sensor nodes as the data processing method for transmission control of sensor data. In this paper, the proposed efficient multi-sensor data transmission control algorithm can be reduces the power consumption of terminal node, and removes the bottleneck state which is concentrated on the sink node using the gateway based the WLAN. In addition, the transmission of stored data in the DB could be obtained improves results of the efficiency improves and data collection accuracy on the wireless sensor networks.

Keywords— Sensor network, Multi-sensor, Transmit control, Power consumption reducing, Sensor node

I. INTRODUCTION

The USN is uses to collect of information in various environments, and a variety research is progressing according to the collection, the offer and the process. Also, USN transports and sensor nodes are being advancement into the bi-directional autonomic control transmit technique in order to provide anywhere services using the ultra-compact, the ultra-light, the low-power consumption and long life, intelligent, mobile function.

The various sensors and the Tiny-OS appeared by considering to potential the low power. And it has been research variously the supplementation method according to the physical limitations of the USN by considering that integration techniques as Wi-Fi, CDMA, and Wibro with the USN applied services. The sensor node required technological advancement to perform functions of intelligent sensors signal processing that can be the identified and judgment based on the intelligent / high performance with signal processing and identified technology development to collection information of multi sensor.

The sensor networks consist as sensor nodes from hundreds to thousands, used in various application realms. The sensor node consists of sensors to measure useful information such as temperature, humidity of ambient using the wireless communication devices. In general, applications of sensor networks are based on the processing of the data collected from sensors. The group and channel information of sensor

nodes will be stored in the DB by transmitting it to a control server. This DB information is a general be used on the street light remote control system. If the sensing data of the existing sensor nodes transfer to a neighbouring sink node or a base node through the sink node, the sink node increases power consumption by attempting to transmit data frequently. And the data rate degradation and error rate increases when an event occurs. In addition, there appear problems of increase in the DB capacity due to the accumulation of data. In order to solve this problem, we use a processing method for the data transmission control using the MCU of sink node [1]-[2].

In this paper, we propose control algorithm design for efficient multi-sensor data transmit based on the multiple-sensor nodes of the USN. The intelligent sensor network for an efficient multi-sensor data transmit is controlled the data that is being transmitted by control algorithm. The proposed algorithm does not transfer by sensing only one data of the sensor node because programmed to allow transmission for multi-sensor data. Also, we used algorithm possible to multi-sensor data transfer control at the same time that the multi-sensor node perform performance verification.

The sensor data processes systems based on proposed algorithm will transfer data by control at the same time as multiple sensor nodes by through comparing the tolerance range of the sensing data. The processing of the transmit data be design to store in DB by allowing transfer of numerous data from sensor nodes through multi-query. It will be able the services of complex and diverse application in case of configuring the sensor network using the proposed method.

II. DESIGN OF SENSOR NETWORK

An existing method be transmit the sensing information according to each channel of street lights belonging to a group from the sensing nodes by collecting to data based on zigbee by consist to the sink node, the base node and the central control server. The existing patents and utility models be transmit all data to the neighbouring control server or base node by sensed the data on the sink node of the sensed part. The group and channel information of sensor nodes will be stored in the DB by transmitting it to a control server. This DB information used general on the streetlight remote control system. [3]-[6].

However the patents and a utility model occurs several problems from the sensed part of the sink node that transfer the sensing data to the neighbouring sink node or the base node, and the control server. The problem be increases to

power consumption because frequently attempt to transmit data on the sink node.

If an event occurs on the sink node the transfer data increases to the error rate and the transmit rate degrades, and the DB capacity increases due to the accumulation of large amount of data. In order to solve this problem, the sensing part and the sink node connect through the interface and the proposed algorithm for effective control is porting to the MCU of the sink node for data transfer control with middleware.

Figure 1 shows components of sensor network. The multi sensor device for sensing the temperature and humidity data consists to that the microprocessor part for processing of all control and processor, and the sensing part for acquire the data of the temperature humidity, and the ADC part for convert as the digital signal.

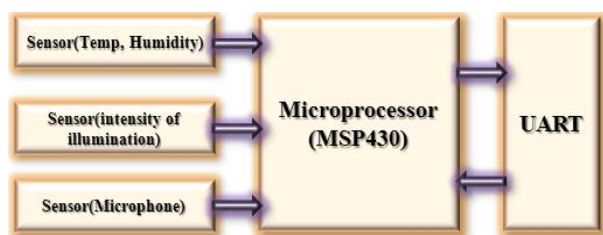


Figure 1. The sensor network components

A. The Transmit Control Algorithm

The sensing data of the sensor nodes is not required on all sensor networks. The accuracy of base node is not a problem to the entire sum result using the existing data, because the average value in all sensor nodes obtained by measuring to temperature on sensor networks does not change significantly compared to the existing data.

The meaningful data in the sensor network is related closely to the usage of the network and the necessary information of users. The network that measure the temperature and the humidity has significance about an error of $\pm 1^{\circ}\text{C}$. However, the sensor networks for the fire monitor may not need the less temperature than 60°C .

The tolerance range of sensor networks may be different to depending on the certain data. The meaningful data can be defined the data changes by compare the tolerance range based on final transmit data to the base node. Also, the sensor node is determined communication by confirming the sensed data.

Figure 2(a) is showing the execution process of a transmission control algorithm. The base node can calculate the average, maximum, minimum error range by the transmission of data using the final data transmission. But, temperature / humidity data can be often maintained without changes for a long time. The data does not transmit because the data change is in the error range which it has reliability in the tolerance range by calculating from the existing data. If it does not transmit data from all nodes, the base node will use the existing data intact by determine that there was no change of existing data. If you always transfer these data, the base node increases the energy consumption of sensor nodes.

The data in order to solve the problem is processed to prevent transmission by specifying a tolerance range for the sensing data of multiple sensor nodes. The data of sensor network does not change significantly according to the passage of time because it has to similar continued characteristics of data. The proposed algorithm is set the global safety zone using the first sensing data when sensing data. The algorithm is set the tolerance range and the area of tolerance range is selected into a local safety area. The data transfer whether is determined according to the set tolerance range within the local safety area.

Figure 2(b) shows the data transmission control algorithm code of multiple-sensor nodes. At first, a transmit control algorithm is set the tolerance range and the sensing data is stored with received, and it is compare with the previously stored data when a different sensing data is received. If the received data less than the tolerance range, the data is maintained. Otherwise the data is transmitting.

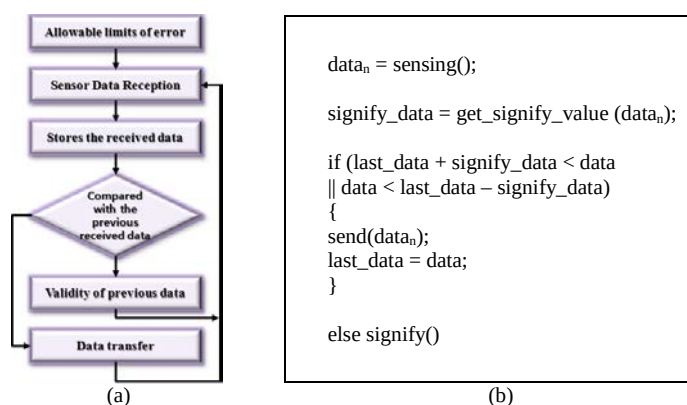


Figure 2. A transmit control algorithm

B. Transmit Data Processing Method

In this paper the middleware is controlled the sensor node for processing of sensing data or it is being developed continuously in order to obtain a desired information from sensor nodes. The middleware of this type create DB consisting of single table on mainly the sensor networks, and each row in the table be consist as the obtained data using the sensor of each of the sensor nodes.

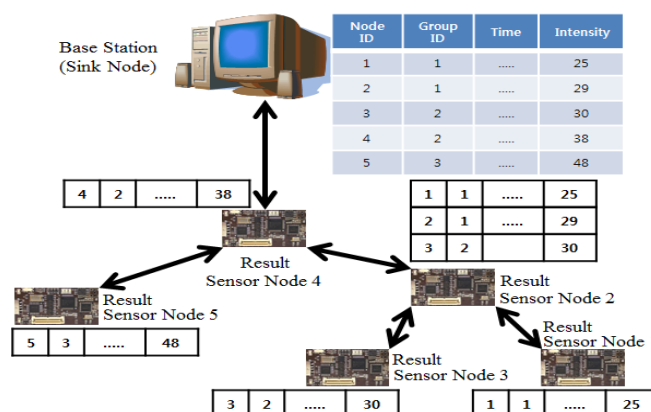


Figure 3. The sensor node topology and the DB table

Figure 3 shows expressing the DB of the sensor network as *s_table* in the Tiny-OS. The sensor nodes consist for collect light, temperature and humidity. And the each row of *s_table* which to express sensor network consists that node ID, group ID, time and intensity. It has to the advantage to simply obtain the desired data by using the declarative query language in the sensor networks when the sensor networks for data processing assumes as DB table as shown in Figure 4.

Q1: SELECT node_id, group_id, time, intensity
From *s_table* WHERE intensity <=40 SAMPLE PERIOD n
Q2: SELECT node_id, group_id, time, intensity
From *s_table* WHERE intensity <=30 SAMPLE PERIOD n

Node ID	Group ID	Time	Intensity		Node ID	Group ID	Time	Intensity
1	1		25	➔	1	1		25
2	1		29		2	1		29
3	2		30		3	2		30
4	2		38					

Figure 4. The multiple queries results

For example, if the illuminance data measured less than 40 into the sensor network for every n seconds, the Tiny-DB uses queries such as Q1 using measure the data of the corresponding node ID and group ID, time and intensity. As shown in Figure 4, if using the relationship of each query by requesting the query Q2 when running the queries Q1, there is a reduce on of energy consumption in sensor nodes that do not run directly in query Q2 on sensor networks, and the base node can obtain the desired data. The current research on the sensor networks puts emphasis on optimizing single-query, but it will be a research that utilizes strengths by using the multiple queries mutual relation.

C. Implementation of Sensor Networks

The terminal node and sink node used to zigbee sensor network implementation that has the same hardware configuration. The previous system used the MSP430 of 16bit RISC architecture, but we used the CC2420 on IEEE 802.15.4 wireless communication method to communicate between terminal nodes and the sink node.

Figure 5 shows the implemented of the sensor network to configure a wider area using multiple gateways which use the several sink nodes.

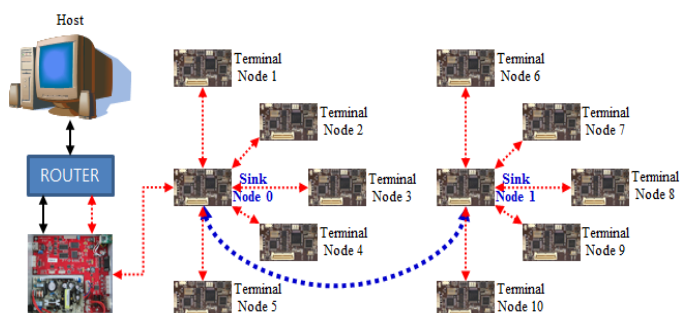


Figure 5. The sensor network configuration

The sensor network is used the gateway that connected to the WLAN card for configure by the zigbee method sensor node, and the heterogeneous networks interlock. The gateway will communicate by LAN/WLAN leverage to this information when receiving to the information of terminal nodes through the sink node.

III. THE RESULT

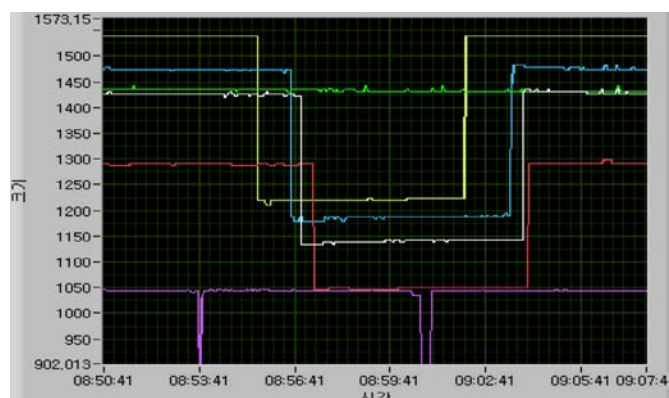
The experimental environment were composed from the sink node become combined into multi-sensor platform, and the base node for receiving into the zigbee method, and the notebook for to stored analysis the sensing data into the DB by connected to the base node. Testing was carried out by porting the multi-sensor data transmit-control program in the sink node and porting the base program for receives messages on one place in the base node.

The network architecture applied to the proposed transmit control algorithm was tested in sensor node to use RTOS operating system kernel. The middleware of sensor nodes were implement using several network algorithms, and it was able to judge the effectiveness of the network structure. The proposed transmit control algorithm were measured an adaptability and performance depending on the network architecture for benchmark.

Figure 6(a) shows the experimental environment that was applied the data transmission control algorithm on the lighting device. Figure 6(b) shows the monitoring result of sink node.



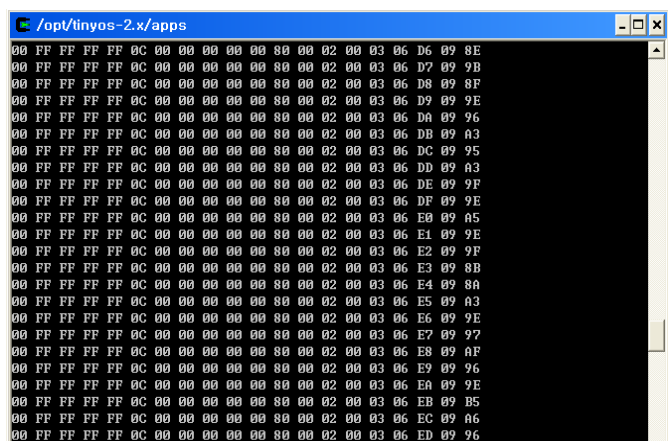
(a) The experimental environment for apply an algorithm



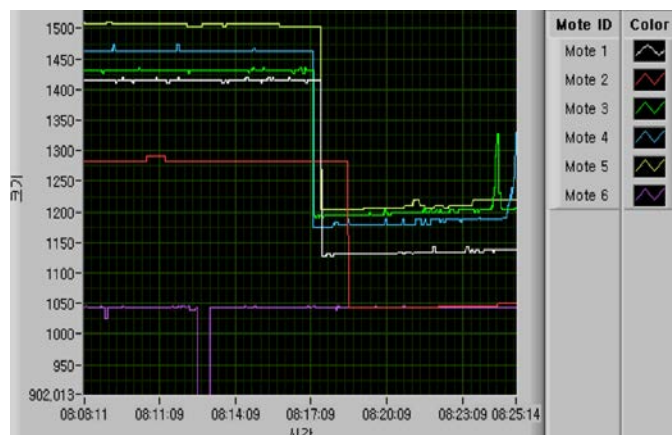
(b) The sink node monitoring result

Figure 6. The experimental environment and the monitoring result

It was apply to network architecture using the proposed transmit control algorithm in street lighting of test field, and data transfer monitoring status depending on the illumination changes show the host measurement results using the lab view. Figure 7 shows the base node received packet and the analysis of data that is received from the node in accordance with control.



(a) The received packet of the base node



(b) The base node incoming data analysis in accordance with control

Figure 7. The base node incoming data analysis

It was the received data analyses to base node by apply data processing method for multi-sensor data transmits control. Looking at the received data of Fig 7(a), the sensing data of multi-sensor were be able to confirm normal changes depending on the results of the query. In this Fig 7(b) showed as a graph after the incoming message analysis.

IV. CONCLUSIONS

In this paper, the proposed data transfer control algorithm was able to eliminate bottlenecks that it has been concentrates on a sink node by apply to gateway which uses WLAN. The terminal nodes were able to prevent unnecessary operations of sensor nodes for multi-hop routing by setting an operation time and reduce power consumption. The bottleneck which occurs from sink node was reduced to a negligible level by

due to the role of the data transfer control algorithm, because transmits the received data to the gateway into a wired or wireless. In this paper can be obtained following conclusion when comparing the methods used in the data transmission control algorithms and the existing transmission control.

- The sensor network was reducing power consumption of the sink node by the data transmission control through the implementation of the algorithm.
- The transmission capacity of data can be increased when an event occurs in a sink node, but it increased reliability of data transmission due to reduce of the errors incidence.
- The data transfer control algorithm can the efficient data management with reduces of DB accumulation on the control server, because the required data transmission by controlled.

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