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Performance improvement of Data gathering protocol for Green house communication

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ABSTRACT

Background: Green house is an inevitable solution to feed the rapidly increasing food consumption of the global population. Green houses accelerate the plant growth within a controlled environment. Sensor and actuator networks play a vital role in effective monitoring and controlling of greenhouse parameters. A complete wired network suffers from frequent wiring repairs and inflexibility towards sensors positioning. A complete wireless network requires large bandwidth for both sensors and actuators and susceptible to frequent data losses. This work proposes a hybrid network, where the sensors are connected to the base station through wireless links and the actuators are controlled through a wired backbone. An integrated wired/wireless solution is to use the advantages of both technologies by improving performances. In the wired section, a controller area network (CAN) type network has been chosen on the account of its simplicity and reliability. For the wireless part, a Zigbee type network has been chosen. The SCADA system is used to monitor and control greenhouse parameters in a simple way. To further improve the energy efficiency of the wireless data gathering a hybrid system of event driven and time driven reporting is introduced. Based on the changes in the parameter of interest, the system adapts its sampling frequency and achieves significant energy conservation with a minimal loss in accuracy.

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INTRODUCTION

A greenhouse represents an extraordinary type of agricultural environment characteristics by the presence of numerous I/O devices and control devices (Narmatha *et al.*, 2013). Requirement of human participation is less compared to open air agriculture for to provide water for irrigation and fertilizes. Greenhouses represent a closed environment which can be exactingly controlled by humans in order to provide finest conditions for the growth of plants. Wireless sensor networks (WSNs) in agriculture have recently received great consideration, and their use has been strongly examined by few authors (Lee *et al.*, 2011). Owing to the use of sensors, it is likely to monitor numerous environ- mental parameters such as air temperature (Akyildiz *et al.*, 2002), ground humidity (Al-Karaki *et al.*, 2004), light, or the concentration of manures. The information of such parameters is of great importance since it allows the farmer to perform the most suitable operations in order to improve the growth of plants and efficiency and low cost, crops are grown within short time duration in greenhouse. Sensors, both wired and wireless are connected to a fit network which allows data gathering and their use by an appropriate management module. For this type of applications, there are numerous advantages offered by a wireless system if compared with a wired one (Fang *et al.*, 2003). They can be manufactured inside the concept of flexibility. Essentially, the large extensions of the cultivated fields (Lindsey *et al.*, 2002) and the need for episodically alter a type of cultivation or to move it from a lot to another one make wired systems too firm and hard to modify. Some species are grown only in particular seasons, those types of farms necessitate careful management of numerous parameters (Rasheed *et al.*, 2007), through data gaining conditions of the environment. Now a day, the data transfer between the greenhouses and the control system is mainly provided by suitable wired communication system, such as a field bus (Rauchhaup *et al.*, 2002). And fully wireless network can also familiarize some disadvantages, for example, the need for a periodical modify of batteries, the presence of signal propagator problems which can rise on long distances. Then, the use of hybrid wired/wireless technologies seems to be currently the best tradeoff solution. The wireless section is located in the enclosed environment where great flexibility is needed, particularly in the manufacture area inside each greenhouse.

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In such a way, it is possible to use the characteristics inter associated to high scalability, low cost, simple setup, and mobility of devices whose location can be simply modified. Instead, the wired section is primarily used in the outdoor to interconnect the greenhouses with the control area. The position of greenhouses being stable for long periods .it use a wired communication structure which is well acknowledged for this type of applications, offers a high bandwidth, and is stronger than a wireless one. We propose a hybrid data-gathering protocol that vigorously switches between the time-driven data-reporting scheme and the event-driven data-reporting scheme. The proposed protocol behaves as event-driven, denoting that an event of concern triggers data distribution by sensor nodes. However, from the point at which an event happens to the point at which the event becomes void, the sensor nodes sensing the event incessantly send data to an observer, thereby allowing accurate analysis of the environment. The novel feature of our method is that not only the sensor nodes that are sensing an event of interest but also those nodes that will potentially detect the event in the near future become involved in the time-driven data-reporting process. This competence enables data from potentially appropriate areas to be proactively collected without necessitating observer intervention (Fig.1). By means of the proposed protocol precisely examines the environment being observed using only reasonable consumption of valued resources.

The implementation of a wireless asset, in fact, would have required the displacement of numerous intellectual nodes that are able to direct the data coming from different greenhouses headed for the control area also, the amount of these nodes would have to be highly sufficient to deliver a certain level of unemployment for both fault forbearance and performances, to allow multiple tracks, and to avoid blocks. An incorporated wired/wireless result allows one to use the positive features of both technologies by refining performances and simply manages the managing problems.

System Design:

The system to be organized is made up of numerous green-houses distributed in a field. Each greenhouse is used for the production of numerous types of plants, which can differ according to the time of year and to the needs from the market. Each green- house is armed with numerous sensors and actuators which carry out all the performance demanded for the precise growth of plants.

Sensors are primarily used for the measurement of temperature and humidity, which represent two main parameters inside the greenhouse. Since this is a closed environment, exact dimension and control of parameters, whose value can strongly affect the state of the scheme, are significant. For example, the humidity of the ground is significant for the precise growth of plants, and its size is important in order to measure the amount of water to distribute in the greenhouse. Also, air humidity plays a significant role since a too high value, together with high temperature, can reason the production of shape and the rapid death of few plants. On the other hand, a too low value of air humidity can damage plants which need a tropical-like climate. High humidity would destroy the development of crops. High temperature leads to have an emotional impact on the crop yields.

Actuators are mainly used to alter the ecological conditions through the initiation of irrigation valves, air humidifiers, chilling fans, and water pump. Actuators are put in action by commands directed by the control system which incorporates all the ecological information through appropriate control algorithms.

The control system is a significant point to consider. While, in the past, control approaches in greenhouses were very simple and mostly based on the use of timers, presently, more refined approaches which exploit the same procedures used in industrial mechanization are used. For example, the use of SCADA systems which, too practice control, afford also other functionalities that are very beneficial in greenhouse management.

1) Graphical user interface: The graphical user interface permits one to signify the whole system and to display the position of all or part of the field. This permits the human operator to evaluate how the system is working and to get well rapidly from asymmetrical conditions.

2) Historian module: The historian module permits one to record all important parameters and to display them as appropriate graphs. This can be very beneficial to learn the reasons of certain problems which happened in the field. For example, in the case an infection that arises on particular plants, an examination of the previous values of some flexible can be useful to discover the reason which has activated such a disease.

However, the most important part of the SCADA is the controller part, which is built on closed loops and is reliable for the system development. The growth of a plant takes, definitely, an extended time, and control parameters must be unceasingly modified during the numerous phases. Moreover, controlling the growth of a plant is not a meticulous science; thus, numerous randomness can arise. This implies that the procedure cannot be fully automated and that an operator must interact with the system when essential.

The chief ecological parameters are temperature, humidity, moisture, light in the greenhouse would be measured by the by means of sensors. The output of these parameters affords the daily set points. Sensors outputs will be demonstrated in analog form, so for our simple measurement we need to transform analog data into digital form. This is done using analog to digital converter in PIC.

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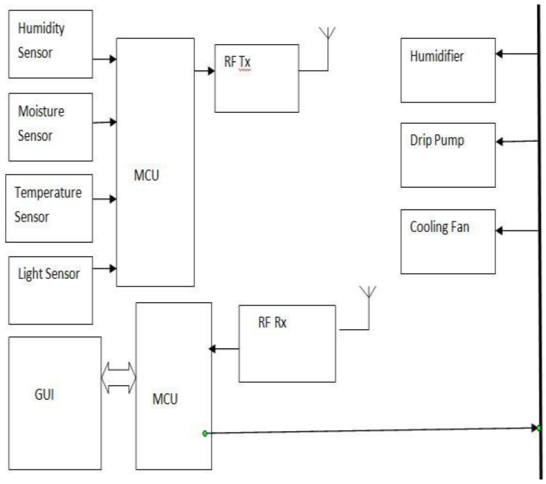

Fig. 1: Architecture of the control system.

The detected data transmitted to control unit through wireless link, i.e., Zigbee. Received data will be saved in the SCADA. This SCADA will monitor the sensor value, if it is in irregular then it run the actuators using PIC IC.

Can Based Back Bone:

The CAN bus was initially designed to be used within road vehicles to resolve wiring problems arising from the growing use of microprocessor-based machineries in vehicles. Owed to the low price of CAN bus and its capability to support real- time communication, CAN is at the present time widely used as an embedded control network to associate numerous control units, sensors, and actuators in a discrete manipulate system. In the greenhouse application, CAN is used as a low-speed purpose for the addition of all the data present in the system.

One of the explanations which justify the success of the CAN lies in the useful precedence based bus compromise mechanism it equips. Any letter conflict on a CAN bus is deterministically defined on the basis of the priority of the objects exchanged, which is fixed in the identifier field of the frame. Thus, the priority of a message is the priority of the entity it contains, indicated by the identifier, which signifies the important part of the CAN frame.

The arbitration mechanism present in CAN necessitates a small length of the bus in order to permit all nodes to sense the similar bit. This way, the system can perform as a form of huge AND gate, with every single point able to check the outcome of the gate. The identifier with the lowest arithmetical value has the highest priority and a nondestructive bitwise negotiation mechanism affords the collision resolution. The priority of a CAN message is fixed and system wide common, and it is connected to a variable. This means that each edge can convey only a variable each time, so that different variables need different structures. For this cause, each structure has a small dimension, comprises of only a few data bytes and is very grip for applications at the field level.

The maximum attainable bus line length in a CAN network is restricted chiefly by the delay of the bus line if associated with the bit period: The bus length must be abridged as the bit period decreases (i.e., the bit rate upsurges).

The small length of the bus may signify a strong restriction for applications different from the motorized ones. For example, in greenhouse control applications, the period of the bus can be up to 200 m. In order to accomplish with this length, the bit rate should be reduced: 250 kb/s can be measured a correct value, but in the greenhouse, the flex speed has been limited to 100 kb/s in order to afford some additional noise protection. Yet, a low bit rate is not a problem for the application deliberated here since all procedures are featured by a very low dynamics and exchanges only minute information. Even with a high amount of plans, the traffic created is limited and does not necessitate a large bandwidth.

Wireless Network:

The wireless network uses hybrid data gathering protocol. The essential elements of the hybrid data-gathering protocol recommended in this paper are that: 1) it changes dynamically between the event-driven data-reporting scheme and the time-driven data-reporting scheme, and 2) sensor nodes that will sense the events in the near future, which characteristically are in close vicinity to those nodes sensing the events, are also involved in the time-driven data-reporting process. Under normal conditions, sensor nodes reply only when the measured temperature is above 100 °C.

To accomplish these requirements, there must be a mechanism to define in an appropriate manner when to change between the two data-reporting schemes and which sensor nodes to comprise in the time-driven data-reporting process. Depending on these responses, numerous policies can exist. In this paper, we present two algorithms: the parameter-based event detection (PED) algorithm and the parameter-based area detection (PAD) algorithm.

A. PED Algorithm:

As portrayed in (Akyildiz *et al*., 2002), the PED algorithm is given a starting point value, a threshold variable, and two counter-variables governing the forcefulness for changes in data-reporting schemes. The threshold value decides the occurrence of an occasion of interest. That is, when the value of the sensed individual is beyond the threshold value, a sensor node needs to report it to a base station. The threshold variable is the average of the values of the sensed individual over a time interval. The two counter-variables, p and q, are defined as follows:

The PED algorithm works as follows. Assume that the current data-reporting scheme of a sensor node is event-driven. A sensor node occasionally computes the norm of the sensed characteristic over a current time window and updates the two counter-variables, p and q, accordingly. If ($p \geq P_{\text{start}}$) or ($q \geq Q_{\text{start}}$), a sensor node switches to the time-driven data-reporting scheme and reports the sensed characteristic incessantly over time. To eradicate the risk of a temporary response, the two counter-variables are rearranged change due to, e.g., sensor out of order. If the test on P fails, the test on $Q$is applied. Therefore, Q allows some variation of measurements and is more conventional. On the whole, smaller values of P and Q lead to more destructive action.

B. PAD Algorithm:

Once a sensor node switches to the time-driven data-reporting scheme, it broadcasts its variation to involve neighboring sensor nodes in the incessant data distribution. The variety of the neighborhood is determined by the PAD algorithm, which is based on two configurable parameters: time-to-live (TTL) and valid time (VT).

TTL signifies the amount of hops within which sensor nodes must switch to the time-driven data-reporting scheme. The use of TTL in the PAD algorithm is analogous to that in computer network technology, where TTL identifies the number of hops that a message can travel to before it should be rejected. When a sensor node obtains a broadcast message enclosing a TTL value that is greater than zero, it changes to the time-driven data-reporting scheme and rebroadcasts a TTL value decremented by one. This process endures until the TTL value becomes zero. This approach is based on the dispute that the nearer a sensor node is situated to the sensor nodes that detect an event, the more probable it is that the sensor node will be relevant to that event in the near future since sensor nodes are formed permitting to proximity.

For example, the current temperature measured by sensor nodes positioned close to the fire may not be high enough to trigger an event, but it would be much higher than those of nodes tens of heaps away from the fire. Therefore, the probability that the closely located sensor nodes will detect an event in the near coming upsurges.

VT is the former important parameter of the PAD algorithm, and it stipulates how long a sensor node should use the time-driven data-reporting scheme irrespective of the result of its PED algorithm. Note that VT is used only for those sensor nodes that are swapped to the time-driven data-reporting scheme by TTL. The requirement of VT arises from the fact that sensor nodes in the neighborhood of the area where an event happens may not yet detect the event. Therefore, without VT, they could instantaneously shift back to the event-driven data-reporting scheme, losing the chance to acquire important information in advance.

We be certain of that our method behaves well in several event-detection environments, in which sensor nodes are skillful of sensing different qualities through simple alteration of the PAD algorithm. For example, a sensor node performs the PED algorithm for each sensed characteristic and broadcasts it’s switching to the time-driven data- reporting scheme to neighboring nodes consequently. By sending not only TTL and VT but also the type of characteristic that produced the switching, the sensor node permits neighboring nodes to determine what type of data they must collect in a time-driven manner.

Experimental section

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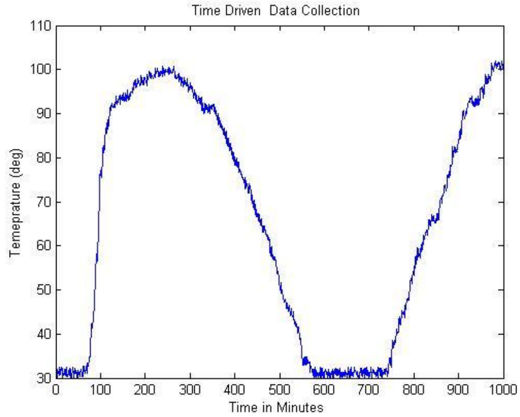

Fig. 2: Time data collection progress

The Fig shown above represents the graphical result of the time driven data collection process. The graph is plotted between the temperatures and the time taken for the time driven process. The temperature is represented in Y axis and the time consumed for time driven process is denoted in X axis.

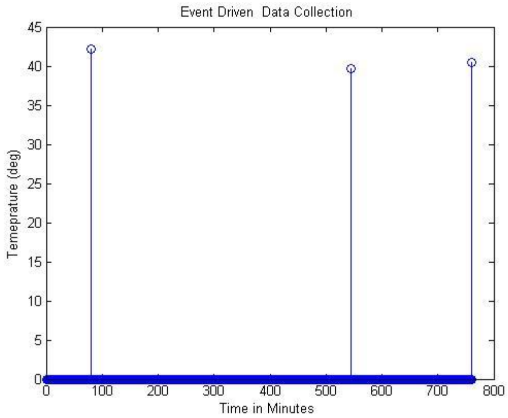

Fig. 3: Event driven data collection

The figure shown above represents the graphical result of the event driven data collection process. The graph is plotted between the temperatures and the time taken for the event driven process. The temperature is represented in Y axis and the time consumed for event driven process is denoted in X axis.

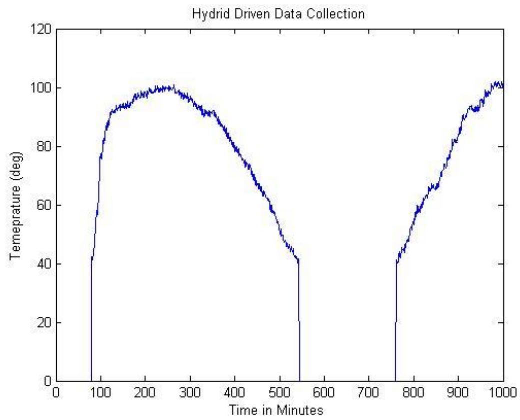

Fig. 4: Hybrid data driven collection

The Fig shown above represents the graphical result of the Hybrid data driven collection process. The graph is plotted between the temperatures and the time taken for the Hybrid data driven process. The temperature is represented in Y axis and the time consumed for Hybrid data driven process is denoted in X axis. In Hybrid data gathering there are no indications before an event occurs, after the occurrence of the event the data is sent unceasingly until the event fades. That representation is shown in the above figure.

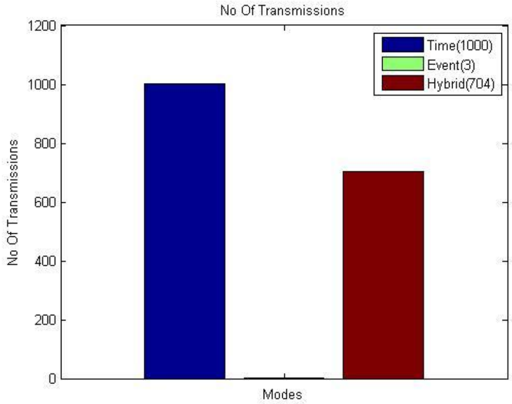

Fig. 5: Modes vs no of transmission

The Fig shown above represents the number of transmissions taking place during different modes. The graph represents Modes in the X axis and No. of transmission in the Y axis. There are thousand transmissions during time driven mode. During event driven mode there is no transmission. There are less than eight hundred transmissions during hybrid data gathering mode.

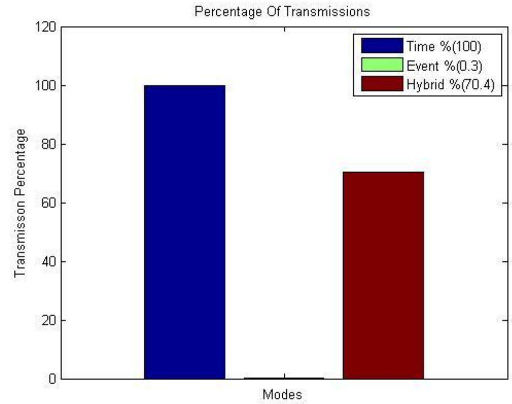

Fig. 6: Percentage of transmission vs modes

The Fig shown above represents the percentage of transmissions taking place during different modes. The graph represents Modes in the X axis and No. of transmission in the Y axis. The time driven mode transmits a whole of 100% during the time drive mode. As there is no transmission during event driven mode it remains in the initial level as 0%. 70% of data is transmitted during Hybrid data transmission mode.

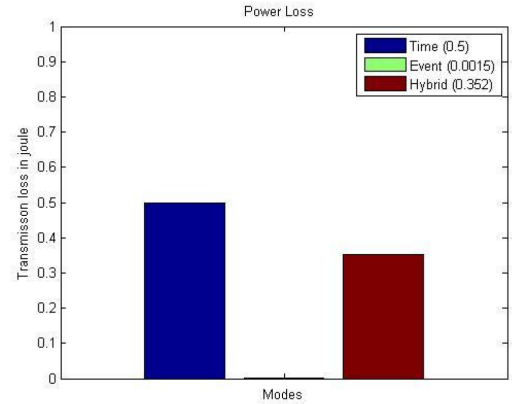

Fig. 7: Power loss vs modes

The Fig shown above represents the Power loss occurring during different modes. The graph is plotted between number of transmission loss in joules and the modes, representing the modes in X axis and the number of transmission in joules in Y axis. There is 0.5 joule loss during time driven. Event driven remains in the initial stage with no loss. There is 0.35 joule loss in the Hybrid data gathering mode.

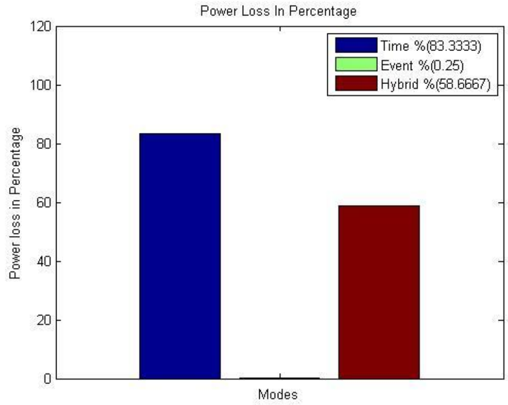

Fig. 8: Power loss in percentage

The above Fig represents the power loss in percentage, where modes are represented in X axis and the power percentage is represented in Y axis.

The power percentage for time driven mode is 80%. As the event driven is maintained in its initial position there is no change in event driven mode. The power percentage of the Hybrid data gathering mode is around 70%.

Conclusion:

The proposed work has improved the performance of greenhouse control system using a hybrid wired/wireless network. The approach saves considerable amount of bandwidth while improving the reliability of the system. The system achieves the advantages of both wired network and wireless network and avoids the issues of both the types of network. The finite energy source is the major bottleneck of WSN, which is tackled by combining event driven and time driven reporting schemes. The proposed system has been evaluated with amount of transmission (Wang, Q., *et al*., 2006), energy distribution and percentage power loss. In all the aspects, the proposed system outperformed the conventional systems. The future work involves improving the wireless system with clustered aggregation schemes, so that more greenhouses can be connected over a single network.

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