Natural Evaporation Type Salt Manufacturing Process Resource Management using Distributed Embedded System

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ABSTRACT
The conventional salt production a system in India is based on sea water solar evaporation method with huge human intervenes. The Advance Control Decision Support system can manage environmental problems efficiently and increase salt product quality at low cost solution. The proposed system is a model for the parameter readings, environmental conditions monitoring and controlling and reporting to the Expert system. This system monitors level measuring, water pH, humidity in environment, temperature of the field, wind/air circulation speed, etc, These data continuously acquired through field bus and wireless network communication. Then controlling system analyzes acquired data and activates different actuators automatically. In this paper Controller Area Network field bus and Zigbee wireless network communication is proposed for automatic controlled distributed embedded system in natural solar evaporation salt production process.

Keywords
Distributed embedded system, Controller Area Network, Salt Evaporation Process, Zigbee

1. INTRODUCTION
Salt is used as raw material in chemical industries for the production of chlorine (Cl) and caustic soda (sodium hydroxide, NaOH)[1]. Salt plays an important role in various fields in industries like Metal processing, ceramic, petrochemical, textile industries, etc.[1]. human body /animal require right intake of Salt to ensure their growth, strong immune and reproductive systems. Human body cannot produce salt itself. Human salt requirements ensure through various sources of salt in food for daily intake. The salt making procedures is varied by geographic region and depends on locally availability of resources [2]. India long seashore provides see water and suitable environment for natural solar evaporation for salt production, main salt manufacturing states are Gujarat, Maharashtra, Tamilnadu, Kerala, Andhra Pradesh, Karnataka, Orissa and West Bengal in India. Solar evaporation of brine to form salt works best in environment where sunlight available up to long time duration with high intensity and low relative humidity [2]. Solar evaporation is the best when fuel resources are limited and boiling of brine is not viable. Solar evaporation also useful at many inland saline where highly concentrated brine available which require less total evaporation time[2].This technique is common and commercially viable in coastal areas [2]. In Gujarat specifically Kuchh- runn(small white send desert) Area make salt from inland brine through traditional solar evaporation method in which most of the operations are handle by Salt workers manually[16]. In this area Due to high temperature and pure water shortage salt workers migrate at different place during summer which creates social problems. salt workers work normally 10 to 12 hours/day in a field and because of pure water shortage they take bath at 3 to 4 day interval which creates physical and medical problems like skin diesis, lung related diesis, Eye burning diesis, etc.[16]. In traditional salt manufacturing process all operations like water filling in the pond, water level maintenance, water salinity level, fresh water injection schedule, etc handle manually on the basis of human experience which may degrade product quality. Now a days advanced technology also available for salt production but its plant installation and equipment cost is very high. Different industrial applications essentially require a reliable communication without data loss for smooth functioning and better control performance [11]. Distributed system Control efficiency depends on task Performance and reliable communication between measurement nodes and actuators [13]. Advanced Technology adoption in industrial field can improve productivity and quality of crop with less effort [14]. Proposed system can provide solution to manage automatic field parameter reading and control the actuator devices. Hybrid network establish between different microcontrollers based embedded system module through twisted pair wired Controller Area Network (CAN) field bus and Zigbee wireless communication channel. Proposed system approach is implementation of embedded system technology in existing system to control various operations automatically from remote location at low cost with less human interference.

2. INTRODUCTION OF SALT PRODUCTION PROCESS AND PROTOCOL

2.1 Introduction of Solar evaporation process:

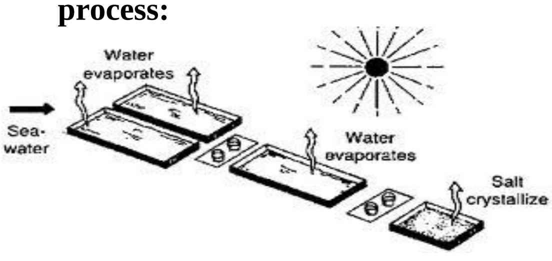

Figure 1 Solar Evaporation System Flow diagram, source:http://www.nzdl.org/

Figure 1 shows Solar Evaporation system diagram for Salt production process. Salt producers find suitable saltpan land for Salt production during nine month season from September to May. Once land is finalize they digging well up to 6 to 9 meter depth with 3 meter diameter and install pump. Normally well kept close to saltpan, but in case suitable quality brine not available near then well digging at distance near about 1 to 1.5 kilometer. In such a condition the supervision work needs more concentration. Once well digging finished then prepares land for laying salt pans and condensers. Normally in 10 acre land salt pan require 8 to 10 condensers in which improved brine concentration by gradual evaporation process and brine flow from one condenser to another through small outlet. During this process step by step brine density increase and when brine density reach of 24 BC brine transfer to saltpans. Saltpan works as crystallizer where brine filled depth *of* about 4-5 inches for evaporation and deposition of salt. When salt clusters are formed of stanch then lower concentrated brine charged in pan and maintain 6 inch brine level up to 15 days and prepare first salt crystals layer. After another 10 days, crystal layer breaks by wooden rack and on the next day make surface flatter for better salt crystal growth. These processes repeat up to 45 days and brine water supply stopped. Once water concentration reaches up to 30 BC all liquid is drained and collect salt crystals production for market.

2.2 Introduction of CAN:

Start of frame	Arbitration field	Control field	Data field	CRC field	ACK field	End of frame

Figure 1: CAN Data Frame Format

CAN-2.0-A Data Frame Specification format of CAN bus data transmission shown in Figure 2, start of frame field use to synchronize receiver nodes of CAN bus. Arbitration field contain identifier for frame identification and control field for data length and frame type information. Next (8-byte) data field carry Data/information as a payload. Followed Cyclic Redundancy Check (CRC) field use to check received data sequence same as transmitted data or not. Next field about acknowledgment field and End Of Frame (EOF) field [12]. CAN protocol field bus based features like collision avoidance, multi-master transmission, message filtering, variable communication speed support, stability control, etc…are more preferable in automobile, robotics and in different industrial applications [4, 9, 10]. CAN Protocol use Non Return Zero Coding for information transmission [3, 5]. CAN bus communication is asynchronous type transmission which not require to transmit clock pulses along with information. Multi -master policy of CAN allows multiple nodes can be a master at the same time it can start communication but only one node can do transmission on a serial field bus at a time. When multiple nodes are ready to transmit frame at a time, the Carrier Sense Multi Access with deterministic collision resolution (CSMA) policy activates to decide priority between nodes [7]. CSMA policy assigns highest priority to node with lowest identifier field value (arbitration field) and then it allots CAN bus to the node [7, 8]. CAN communication is multi node multi master based communication on Twisted pair physical link

2.3 Introduction of Zigbee:

Frame control	Sequence number	Address information	Payload Data	Frame Check Sequence (FCS)

Figure 3: Zig BEE Data Frame Format

Zig Bee Data Frame Format shown in Figure 3 which useful to share data between different nodes. Zigbee is reliable "hand shacked" data transfer protocol suitable for stat, mesh and pear to pear network topologies [15]. It follows IEEE 802.15.4 standard specifications for wireless communication on three license-free ISM frequency bands: 2.4-2.4835 GHz, 868-870 MHz and 902-928 MHz For non commercial purpose [15]. zigbee devices use Carrier Sense Multiple Access with Collision Avoidance (CSMA - CA) policy during communication channel access allocation at different data rates, Maximum data rates allowed for each of these frequency bands are fixed as 250 kbps @2.4 GHz, 40 kbps @ 915 MHz, and 20 kbps @868 MHz[6]. The data frame provides a payload of up to 104 bytes. The frame is numbered to ensure a track that all packets are received. A frame-check sequence ensures that packets are received without error. This frame structure improves reliability in difficult Conditions [6].

3. PROPOSED SYSTEM ARCHITECTURE

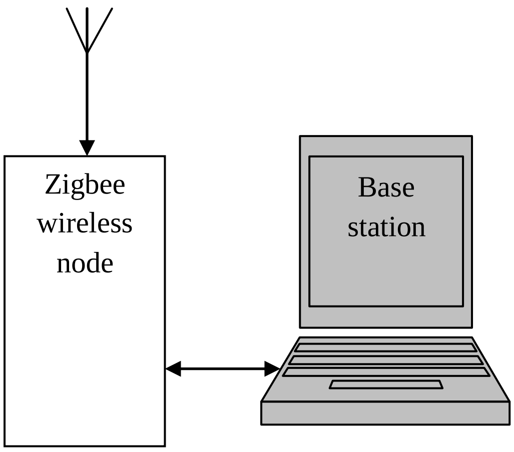

Figure. 4(a) Transmitter Block diagram

Proposed system architecture is shown in Figure 4(a) and Figure 4(b). In system Figure 4(b) can be implement at solar pond where sensor nodes sense different parameter values like temperature, humidity, pond water level, wind speed, pH level of water, etc. and it to send measurement control unit. Measurement control unit manages different sensor measurement schedule and send measured parameters report Message at regular time interval to Field Control Unit (FCU) using CAN bus. FCU function work as CAN bus Gateway where individual CAN bus from different pond fields are connected with FCU. CAN frame payload data is 8-byte and Zigbee payload capacity is up to 104 byte, which is several times greater than CAN payload capacity.

FCU work as bridge device to create agreement between two protocols during conversion of CAN frame formatted message to Zigbee frame message format.FCU assembles different CAN frame payload sequentially and send it to zigbee module connected with Base station.

Zigbee protocol based Wireless communication is used between FCU and Base station for message transfer. Once Zigbee module received data payload transfer it to Base station. Then Base station defragment payload and arrange received parameter value as per the parameter type. Sequence arranged in Zigbee frame must be according to predefined Sequence which is same at FCU and BASE station. Once Base station/ personal computer receive data, it performs complex calculation to prepare best suitable schedule / control and commands which send back to FCU. Field Control Unit (FCU) defragment and extract Zigbee message and send relevant controlling /scheduling information to actuators control unit. Actuator control unit controls different actuator devices like water pump, leveling machine, cultivating mechanisms, etc. as according to default schedule or according to received commands from Base station. Measurement and controlling units perform Measurement of parameter and on the bases of measured value immediately controlling appropriate actuator unit i.e. it perform two operations simultaneously Measurement and controlling. As an example ponds water fidelity process require first water salinity level measurement by taking small sample of water there after based on measurement value water flow diversion actuators activates .if water salinity higher then required level then open valves divert water flow direct to the salt ponds. If salinity below then required level then pond valves are close and open valves for condenser ponds where water evaporation process continue and configure water salinity level measurement schedules. Once water salinity level reach up to required level then actuator become active and transfer high salinity water in salt pond.

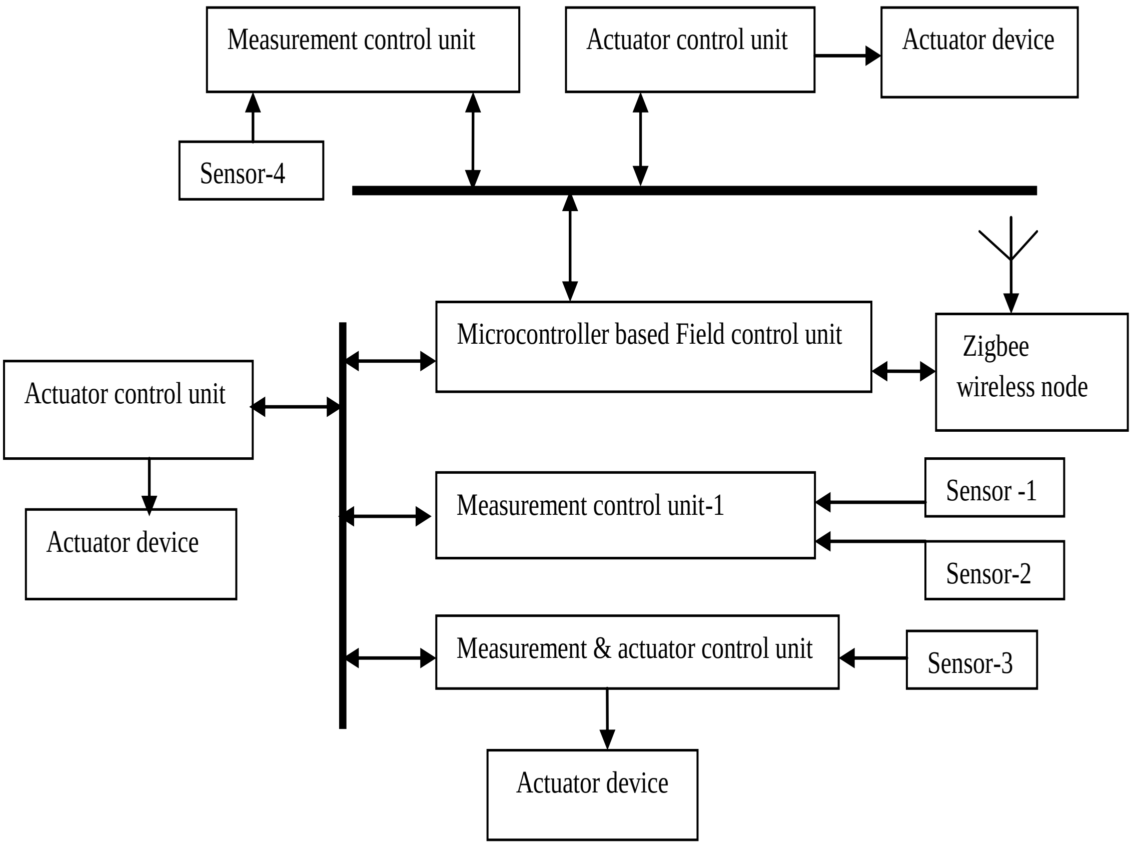

Figure 4(b) Proposed System diagram of Field Control Unit

4. EXPERIMENTAL WORK

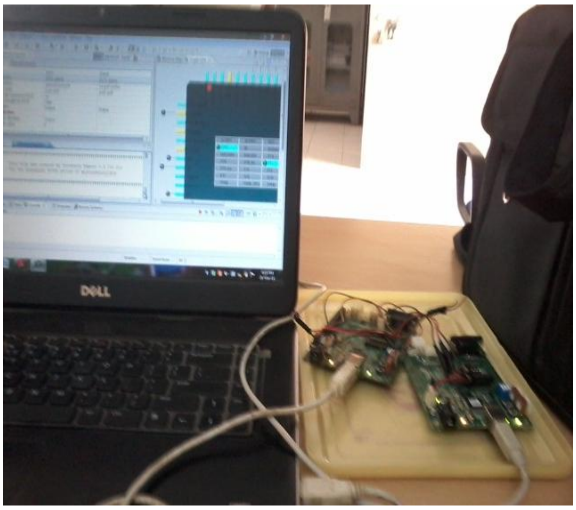

Figure 5 Experimental Setup

Free scale code-worrier software has debug facility with simulator and emulator which provides great support. In the Emulator, transmitter program loaded in one Demo board with microcontroller MCS9sDZ60 and receiver program in another Demo board with microcontroller MCS9S08DZ128 to form test bench as shown in Figure 5 for distributed embedded system. Implemented program use to scan value from two different 12 bit Analog To Digital Convertor (ADC) channels. One channel connect with internal temperature sensor another channel connect with variable resistor (POT resistance range value 1Kohm to 5 Kohm) which perform task of sensor and provide dc voltage from 0v to 5v voltage range. These DC voltage consider as parameter measured value and send it on CAN bus using MC9s0860 microcontroller.

AT receiver part of CAN bus, MCS9S08DZ128 microcontroller used with Two LEDs and one 5v Dc motor as actuator device. Program tested for set upper threshold values equal to digital values of 4.5 v port voltage and lower threshold values equal to digital value of 3v port voltage. received value in CAN frame for port voltage goes above the set up high threshold values then automatically dc motor and LED will ON and if less than the lower threshold value then DC motor and LED is OFF.

5. CONCLUSION:

In this paper researchers have tested proposed approach on test bench by using Code worrier Simulator and Emulator facility, data acquisition and actuator control coding tested with the help of the two Free scale Demo-boards. Long distance Data transmission tested successfully in real time environment and observed reliable results on code worrier Emulator. The system Temperature data acquisition and Actuator control units schedule and controlling process response found satisfactory. This system has advantages of low cost, long distance communication, easy extension and other parameters as shown in Table 1. It could provide reference for other system design and has good application prospects.

Table 1 Comparison of Traditional system and Proposed system

	Traditional system	Proposed system
Parameter measurement schedule	At 2 to 3 hours interval	Continuous at every minutes interval
Measurement policy	manual	Automatic by electronic sensor system
Decision and Control policy	Based on human experience and judgment	Based on measured parameters with scientific approach
Remote access	Not possible	Possible
production	As tradition	Should be improve
Manpower requirements	More	Less
System Operation cost	High	Less
Time and Resource management	Less efficient	Possibly efficient
System cost	Moderate	High
Health related issues of workers	Considerable	Less
Energy Consumption for the system	High	Considerably low

In future work, researchers will improve utility of proposed approach by implementing Zigbee wireless communication network with implemented CAN bus system. Reserachers ongoing research includes formalization of utilization bounds as well as simulation studies to evaluate the effectiveness of the proposed system.

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