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Development of a Hybrid Embedded Real-Time Operating System for Wireless Sensor Networks

Associate Professor P.Murugesan, K.Senthil
Department of Communication Engg.
Annai Mathammal Sheela Engineering College,
Namakkal
murugesan.p20@gmail.com, sent333@gmail.com

Abstract- Real-time operating system plays a key role for embedded system even more for WSN due to resource constraints. So designing an energy efficient operating system dedicated to WSN which meets the requirements of all the real-time applications is still an open problem and a challenge. Due to resource constraints of WSN node and its diverse application domains, the key features of WSN operating systems (WSNOS) should be resource-aware and be configurable to adapt to each situation. Note that most of traditional embedded Real Time Operating Systems (RTOS) are resource consuming. On the other hand, the eventdriven operating systems are essentially single task systems. Consequently, they are not met the requirement of complex hard real-time applications, e.g.. Therefore, our objective is to design a configurable realtime dedicated WSNOS, which enables to adapt to an application to minimize resource consuming (memory footprint and power). Arduino based RTOS is used to design the WSN. WSN for agriculture monitoring and control system is proposed. Because of Agriculture is the back bone of India and nearly 70% of people in our country depend on agriculture. The yield of agriculture should be increased rapidly to fulfill the food requirements of population throughout the world. Now days Wireless Sensor Network (WSN) used for solving many real time problems. WSN plays vital role in many field like transport, medical, military, mobile phones, home appliances and so on. Agriculture is one of the important sources for all living things. But nowadays agriculture crops are affected due to many environmental changes. To overcome this WSN takes important role in the field of agriculture. In agriculture WSN used for monitoring, measuring temperature, irrigation system, measuring water supply and so on. WSN helps the farmer to produce the crop with high quantity and reduce the cost of yield. Agriculture gets affected by climatic change, environmental change, and natural disaster.Using WSN the soil and water management can be done. Here wireless sensors are used so the cost of implementation is very low. In this project wireless sensor nodes are used to monitor the crops. The temperature, humidity and some other theft detection can be made using sensors. This helps to increase the productivity of agriculture. The human effort is reduced by automatic process and it encourages the farmer to develop the farm land. Some components like sensor, Zigbee and some other devices are used to make the agriculture as smart. All the information's are monitored through Personal Computer. Graphical User Interface (GUI) is developed for monitor the environment.

Keywords- WSN, GUI, RTOS, WSNOS.

I. INTRODUCTION

A clever technique that is utilized to obtain real-time reporting of weather conditions is the real-time weather forecasting system. With the use of recent weather data, the status of the atmosphere might be forecast in the future. The primary methods for making weather predictions include observing the current weather, following the movement of air and clouds in the sky, looking for past weather patterns that reflect the present one, observing changes in air pressure and using computer models.

In this paper to despite the immense potential of such systems to enhance health care quality and experience while lowering costs, the technology has not been extensively embraced, in part due to an inadequate knowledge of user expectations, requirements, and preferences [1].

In this paper to the entire system is self-contained. A GSM module has been added to this project, which will warn the doctor in the event that the optimal data is not received, making this project a smart e-healthcare solution for hospital [2].

In this paper to Simulation testing has proven that Adaptive Multi-Objective Routing can accomplish WSN objectives while requiring little communication and energy overhead while meeting QoS and congestion requirements [3].

This paper describes a robust healthcare monitoring system that incorporates wireless sensor network technology and code division multiple assessments with an extended feature of locally standalone diagnosis algorithms that are implemented in cell phones [4].

This paper's originality stems from the deployment of a monitoring strategy with no watchdog nodes. Furthermore, this approach has not been implemented on the Contiki OS to the best of the authors' knowledge [5]. The basic proof of concept developed in this study to validate the proposed SHS has highlighted a number of critical capabilities and features of innovation, which represent a considerable step forward compared to the current state of the art [6].

II. HARDWARE DESCRIPTION

A Power supply unit supplies Direct Current (DC) power to the other components in a circuit. It converts general-purpose Alternating Current (AC) electric power from the mains (230 V at 50 Hz) to low-voltage (for microcontroller, Display unit and driver IC's 5 V (Regulated). Relays and Buzzer 12 V (Unregulated) DC power for the internal components of the Project.

1. Step Down Transformer:
A step-down transformer is an electrical device that decreases the voltage of an alternating current (AC) power source. It is made up of a primary winding, a secondary winding, and an iron core. When an alternating current voltage is given to the primary winding, it generates a fluctuating magnetic field in the iron core.

2. Rectifier Unit:
A rectifier is an electrical device that transforms alternating current (AC), which occasionally reverses direction, to direct current (DC), which flows in just one direction.

3. Voltage Regulator:
A voltage regulator is a power supply unit component that maintains a consistent voltage supply under all operating conditions. It controls voltage during power fluctuations and load variations. It is capable of regulating both AC and DC voltages.

III. ADAPTIVE REAL-TIME WEATHER FORECASTING SYSTEM

1. USE OF ATMEGA328P:
The ATmega chip is a microcontroller that forms the core of many Arduino boards. The ATmega chip contains a central processing unit (CPU) that can execute instructions, volatile and non-volatile memory, and various peripherals such as timers, communication interfaces, and analog-to-digital converters.

2. DHT11 sensor:
DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi.

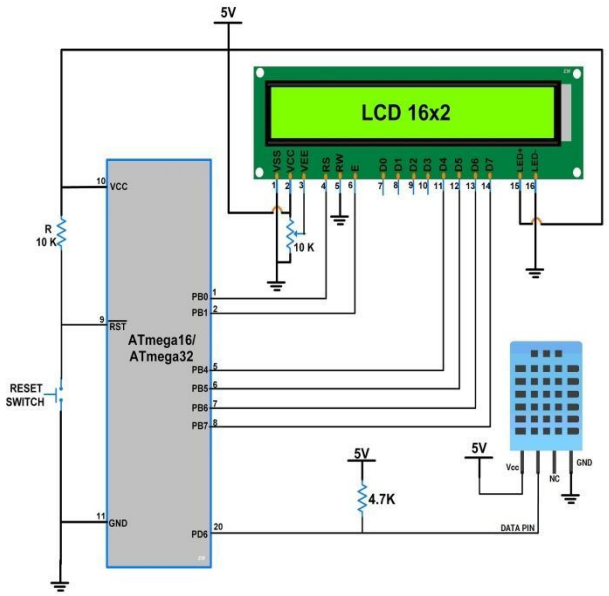

Fig 1. Sensor.

3. ATMEGA328P producer:
- List the functions to be executed by controller.
- Write the functions in programming language in IDE programs. You can download the IDE program for free in company websites. IDE program for AVR controllers is 'ATMEL STUDIO'. Link for ATMEL STUDIO is given below.
- ATMEGA328P programming can also be done in ARDUINO IDE.
- After writing the program, compile it to eliminate errors. Make the IDE generate HEX file for the written program after compiling.
- This HEX file contains the machine code which should be written in controller flash memory.
- Choose the programming device (usually SPI programmer made for AVR controllers) which establishes communication between PC and ATMEGA328P. You can also program ATMEGA328P using ARDUINO UNO board.
- Run the programmer software and choose the appropriate hex file.
- Burn the HEX file of written program in ATMEGA328P flash memory using this program.
- Disconnect the programmer, connect the appropriate peripherals for the controller and get the system started.

4. Programming of DHT11:
- First, load the LCD16x2_4bit library.
- Define the pin number to interface with the DHT11 sensor; in our software, we define PD6 (Pin no. 20).

- Send the initial pulse to the DHT11 sensor, causing it to go from low to high.
- Obtain the DHT11 sensor's response pulse.
- After receiving the response, serially receive 40-bit data from the DHT11 sensor.
- Display the received data on LCD16x2 along with an error message.

5. Zigbee ProtocolL:
The IEEE 802.15.4 physical and MAC layers are used by ZigBee to provide standard-based, dependable wireless data transfer [7]. ZigBee completes the communication suite by adding network structure, routing, and security. On top of this wireless engine, ZigBee profiles give target applications the interoperability and intercompatibility they need to allow similar products from various manufacturers to work together seamlessly.

6. Collision Avoidance:
A collision avoidance system is a safety system that warns, alerts, or assists drivers in avoiding impending crashes and lowering the chance of an event. Radar, lasers, cameras, GPS, and artificial intelligence are among the technology and sensors used in collision avoidance systems.

7. Serial UART Interface:
The UART bridges the gap between parallel and serial interfaces. On one end of the UART, there is a bus of eight or so data lines (plus some control pins), and on the other, there are two serial wires - RX and TX. UART interface that has been overly simplified. Parallel at one end, serial at the other.

IV. CONCLUSION

We presented an RTOS-based architecture for IWSN protocol stacks with multi-processor capability. A case study of a Wireless HART stack constructed on a low-cost two-processor platform demonstrated the benefits. Another potential concern is power consumption. The suggested architecture's RTOS and IPC may require additional energy. However, the core mechanisms of the protocol (e.g., TDMA and security algorithms) may be the principal impediment to low power design.

So, in the future, it is projected to be more effective to optimize power consumption in a larger context, such as not only examining stack implementation but also jointly looking into protocols and complete system integration architectures such as field buses. The system has been validated using agricultural WSN. Agriculture can be done in the current world using numerous cutting-edge technologies. WSN are employed here to produce crops with great yield and minimal cost. Humans are no longer involved in agriculture. Wireless sensor networks are utilized to reduce human effort. Sensor nodes collect data and relay it to farmers and agricultural specialists. Data is sent to smart phones through the use of additional hardware and software.

The farmer can use mobile phones from anywhere at any time. This application can include both farmers and specialists. This is more appropriate for agriculture-dependent countries like India. The system is constructed as a two-node zigbee wireless network.

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BIOGRAPH

Mr. P.Murugesan
Received the B.Engineering Degree from Pavendar bharathidasan college of Engg tech, Trichy in 2005. The M.E Degree from Pavendar bharathidasan college of Engg tech, Trichy in 2012. He has been working as an

Associate professor in Annai Mathammal Sheela Engineering College, Erumapatty, Tamilnadu, India. His research interest includes Communication Engg.
Email:murugesan.p20@gmail.com

Mr. K.Senthil
He is doing his ME degree of EST at Annai mathammal sheela Engg college, Erumapatty in 2023 . He obtained his B.E degree from GCT, Coimbatore in 2015. His research interest include “Embedded system".
Email:sent333@gmail.com