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Implementation of Smart Home System Based on Internet of Things Using Wireless Sensor Networks

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ABSTRACT

In this paper, we have reported an effective implementation for Internet of Things used for monitoring regular domestic conditions by means of low cost sensing system. The description about the integrated network architecture and the interconnecting mechanisms for the reliable measurement of parameters by smart sensors and transmission of data via internet is being presented. The framework of the monitoring system is based on a combination of pervasive distributed sensing units, information system for data aggregation, and reasoning and context awareness. The prototype was tested to generate real-time graphical information for the smart home implementation of IoT using wireless sensor networks.

Keywords: WSN, IoT, Temperature Sensor (LM35) Arduino Kit, Environment Monitoring (Temperature Monitoring).

1. INTRODUCTION

It's a hot summer and you want to switch on the AC of your room through your mobile while you're on the way to office. In this case, the mobile will send the data to a central system, which, in turn, will send the command to the AC to switch ON. Nowadays, Wireless sensor networks play a crucial role as contributors of very large amounts of data. The modern deployment of wireless sensor networks in Smart City infrastructures has influenced to innumerable data being generated each and every day across a variety of domains, with applications including environmental(temperature, rainfall, earthquake, etc.,) monitoring, healthcare monitoring, and transport monitoring, communication monitoring, etc., To utilize the increasing amounts of data we need innovative methods and techniques for efficient data management and analysis to generate information that can help in managing the utilization of resources intelligently and optimistically.

To make WSN to become an basic part of the IoT, it is unavoidable to consider various challenges and difficulties from the adaptation of existing Internet standards to the creation of interoperable protocols and the development of supporting mechanisms for compostable services [2] Clearly, a particular issue that must be considered while connecting a WSN to the Internet is the following that it should sensor nodes which provide their services either directly (e.g. an equipment with a sensor node provides a web service interface), or using base station? In most scenarios a thing should be ''locatable, addressable [...] via the Internet'' [1], which particular configuration might not be suitable for certain other scenarios. There have been various studies that analyze this particular issue [2]. Their conclusion is the following: in some specific scenarios (e.g. SCADA systems [4]) an indirect service provider sensor node and there are other scenarios (e.g. first responders)in which a sensor node should be completely integrated into the Internet. these challenges to WSN are also commonly applicable to other relevant technologies of the IoT (e.g. Embedded systems, Mobile phones, RFID).

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Wireless sensor networks (WSN) are well suited for long term environmental data acquisition for IoT representation. This paper presents the functional design and implementation of a complete WSN platform that can be used for a range of long-term environmental monitoring IoT applications. The application requirements for low cost, high number of sensors, fast deployment, long lifetime, low maintenance, and high quality of service are considered in the specification and design of the platform and of all its components. Low-effort platform reuse is also considered starting from the specifications and at all design levels for a wide array of related monitoring applications.

2. INTERNET OF THINGS (IOT)

The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity—that enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

Sensor nodes associated with different Smart City applications generate large amounts of data that are currently significantly under-used. Using existing ICT infrastructure, generated heterogeneous information can be brought together. Some of the existing wireless communication technologies that can be exploited to achieve this information Aggregations are 3G, LTE Wi-Fi and Li-Fi. In the context of usage of embedded devices and existing internet infrastructure the Internet of things (IoT) encompasses PC’s and other surrounding electronic devices. The Smart City vision is dependent on operating billions of IoT devices from a common place. The recent emergence of low power wireless network standards for sensors and actuators has enabled administrators to manage and control wide ranges of sensor networks and actuators remotely. In order to facilitate the interaction between wireless sensor networks and information and communication technologies, Smart home architecture is proposed in this paper. The proposal is to deploy the architecture on a service platform. Through this platform, sensor applications can be connected and utilized by different web applications for an intelligent operating condition[3].

3. SENSING UNITS

We have used three different types of sensing units as for effective data management on the IoT networks. ity, etc.,. Thus, the fabrication of different types of sensing units enabled in remote monitoring and controlling of household appliances through IoT gateway and IoT application.

Depicts the fabricated sensing units used in the IoT application. The power supplies for sensing unit’s type #1 and type #2 are from electrical outlets, whereas for type #3 the power is supplied from a battery. Type #1 and type #2 radio units are continuously on, therefore consume 40 mA. Type #3 radio units’ uses a duty cycling method in which, it is on for 30 ms for every 5 secs, therefore current consumption is 0.24 mAh. The wireless sensing units with internal sensors to measure temperature, light, humidity, electrical parameters, etc., are deployed at the house as shown in Fig. 3. Electrical sensing units are fabricated in such a way that they can be easily plugged into power points and can operate according to their functional characteristics within an indoor range of about70-80 meters provided an XBee S2 Pro module is used. We considered Xbee-S2 modules in the present setup as they provide sufficient indoor range (i.e. up to 40 meters).

4. TEMPERATURE SENSORS

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor[6]. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air.

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every °C rise/fall in ambient temperature, *i.e.,* its scale factor is 0.01V/ °C.

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01ÚC of the surface temperature. This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature. This is especially true for the TO-92 plastic package, where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature. To minimize this problem, be sure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the LM35 die's temperature will not be affected by the air temperature[5]. The TO-46 metal package can also be soldered to a metal surface or pipe without damage. Of course, in that case the V" terminal of the circuit will be grounded to that metal. Alternatively, the LM35 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM35 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Hum seal and epoxy paints or dips are often used to insure that

Figure 1: Temperature Sensor

moisture cannot corrode the LM35 or its connections. These devices are sometimes soldered to a small light-weight heat fin, to decrease the thermal time constant and speed up the response in slowly-moving air. On the other hand, a small thermal mass may be added to the sensor, to give the steadiest reading despite small deviation.

The LM35 is a low voltage IC which uses approximately +5VDC of power. This is ideal because the arduino's power pin gives out 5V of power. The IC has just 3 pins, 2 for the power supply and one for the analog output.

The output pin provides an analog voltage output that is linearly proportional to the Celsius (centigrade) temperature. Pin 2 gives an output of 1 millivolt per 0.1°C (10mV per degree). So to get the degree value in

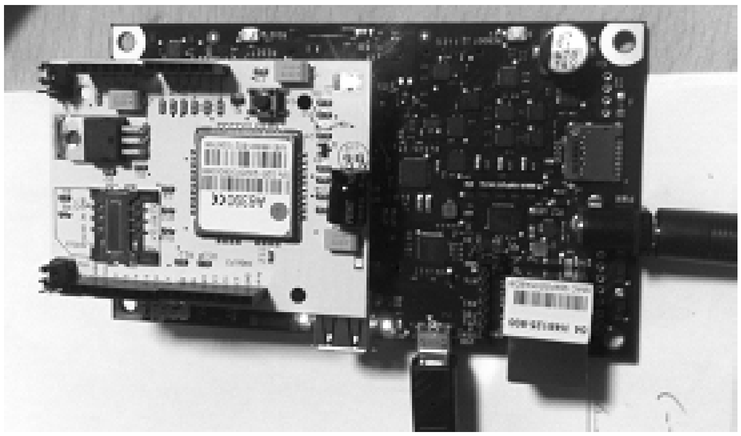


Figure 2: Arduino Kit

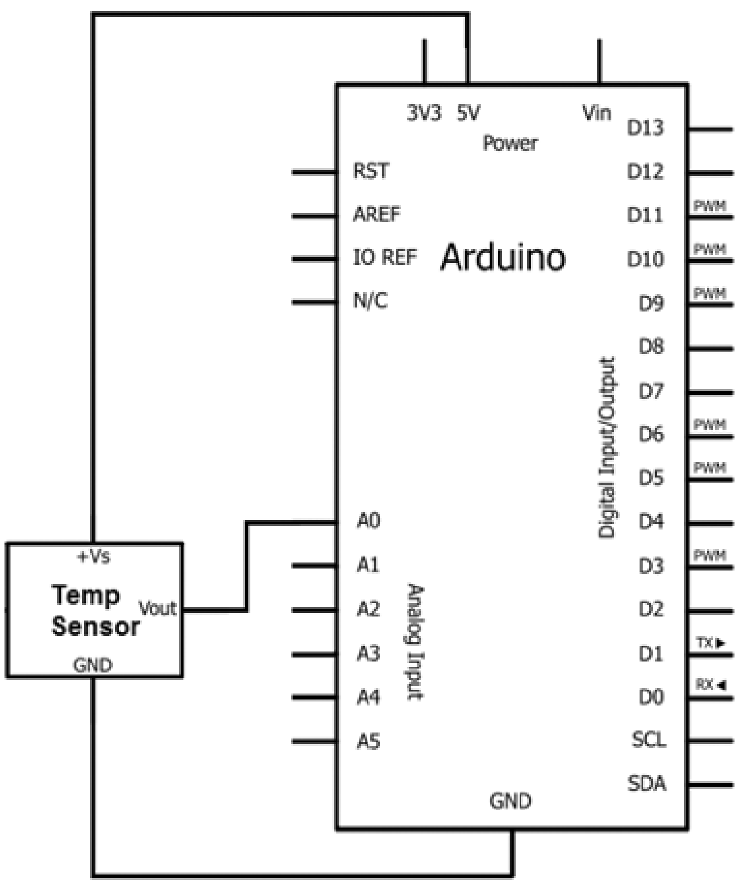


Figure 3: Circuit Diagram of Temperature Control System

Celsius, all that must be done is to take the voltage output and divide it by 10-this give out the value degrees in Celsius[8]. So, for example, if the output pin, pin 2, gives out a value of 315mV (0.315V), this is equivalent to a temperature of 31.5°C. We can then easily convert this Celsius value into Fahrenheit by plugging in the appropriate conversion equation. All we must do is write this code and upload it to the Arduino to convert this Celsius temperature into Fahrenheit.

Pin 1 of the LM35 goes into +5V of the arduino. Pin 2 of the LM35 goes into analog pin A0 of the arduino. Pin 3 of the LM35 goes into ground (GND) of the arduino. Now that we have this circuit setup, we now connect the USB cable from the arduino to the computer. The type B side of the connector goes into the arduino and the type A side into the USB port of the computer. Now the computer is connected to the arduino. We can now write code in the processing software to give instructions to the arduino.

Before we can get a Celsius reading of the temperature, the analog output voltage must first be read. This will be the raw value divided by 1024 times 5000. It is divided by 1024 because a span of 1024 occupies 5V. We get the ratio of the raw value to the full span of 1024 and then multiply it by 5000 to get the millivolt value. Since the output pin can give out a maximum of 5 volts (1024), 1024 represents the possible range it can give out. The raw voltage over this 1024 (value) therefore represents the ratio of how much power the output pin is outputting against this full range. Once we have this ratio, we then multiply it by 5000 to give the mill volt value. This is because there is 5000 mill volts in 5 volts.

Once this analog voltage in mill volts is calculated, we then can find the temperature in Fahrenheit by the equation[7]:

Temperature in Fahrenheit = ((Celsius * 9) /5 + 32)

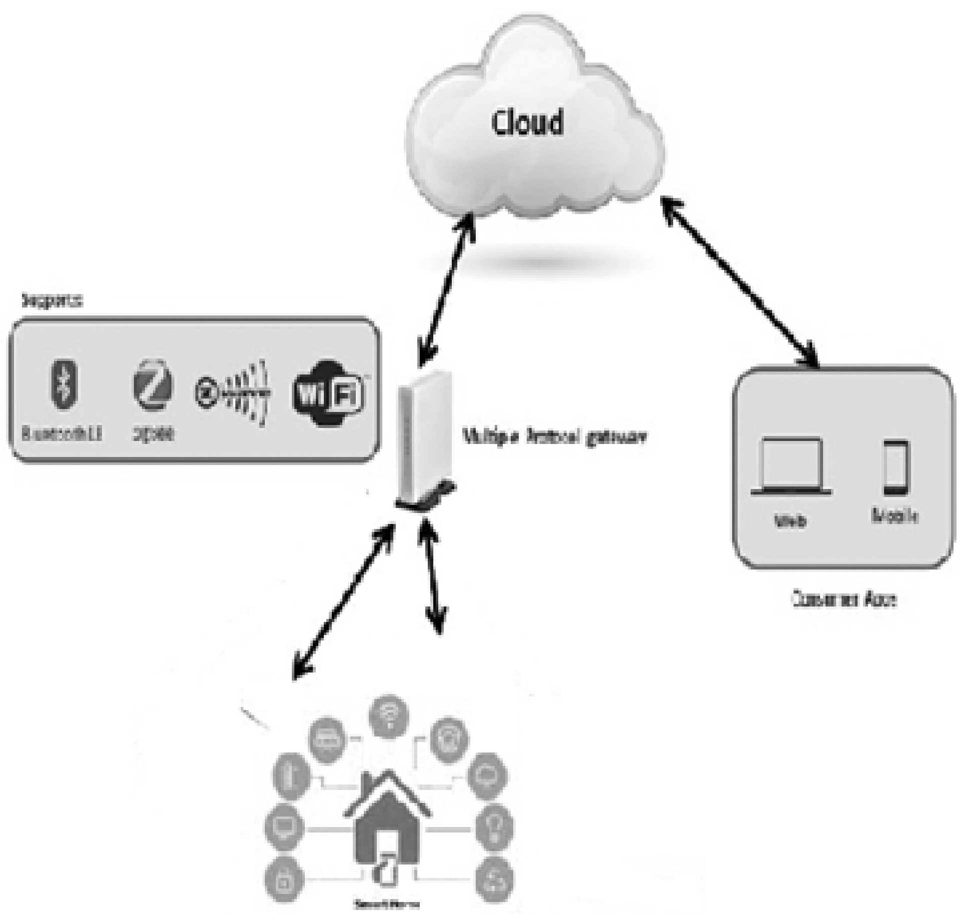


Figure 4: Temperature Monitoring in Smart Home

At the end of the program, a delay of 5000ms applied to take the temperature reading every 5 seconds[9]. To meet the personal preference or program needs we can adjust the value.

The temperature sensor circuit is shown below:

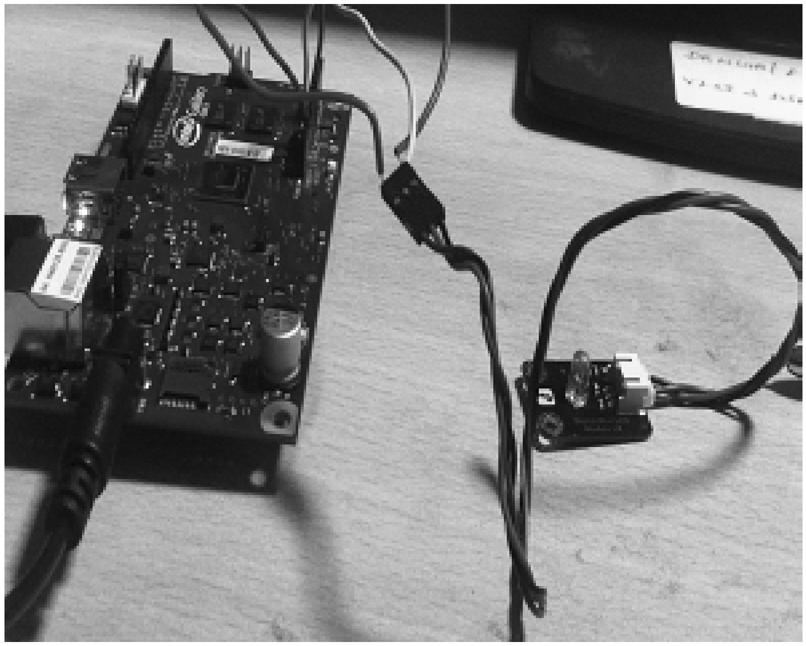
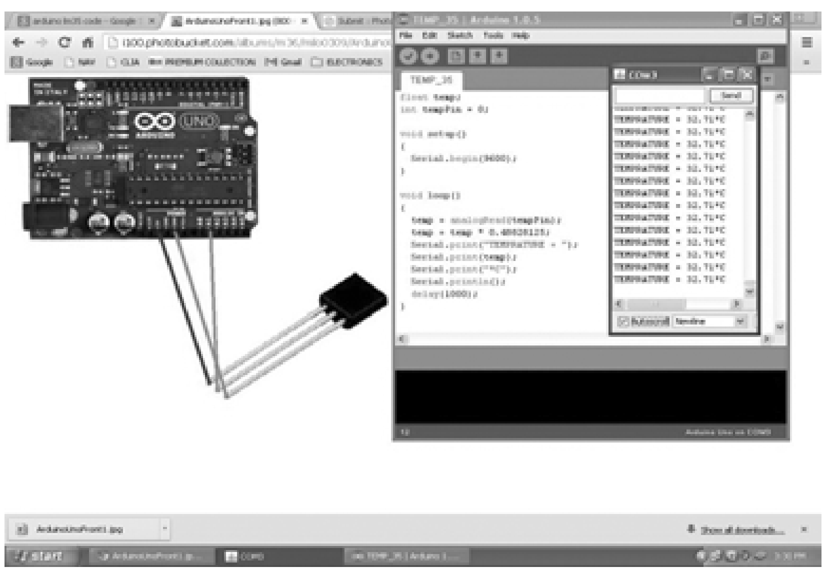


Figure 5: Temperature Sensor Circuit

5. SIMULATION OUTPUT



6. CONCLUSION

The WSNs are traditionally considered key enablers for the IoT paradigm. However, due to the widening variety of applications, it is increasingly difficult to define common requirements for the WSN nodes and platforms. This paper addresses all phases of the practical development from scratch of a full custom WSN platform for environmental monitoring IoT applications. It starts by analyzing the application requirements and defining a set of specifications for the platform. A real-life, demanding application is selected as reference to guide most of node and platform solution exploration and the implementation decisions. All aspects of the WSN platform are considered: platform structure, flexibility and reusability, optimization of the sensor and gateway nodes, optimization of the communication protocols for both in-field and long range, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. Of particular importance are IoT requirements for low cost, fast deployment, and long unattended service time[10]. All platform components are implemented and support the operation of a broad range of indoor and outdoor field deployments with several types of nodes built using the generic node platforms presented. This demonstrates the flexibility of the platform and of the solutions proposed. The flow presented in this paper can be used to guide the specification, optimization and development of WSN platforms for other IoT application domains.

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