Embedded Networking

Internet of Things

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Abstract— **In the past Ethernet communication was a tough task as a lot of processing and memory was required, thus now there are microchips that do the processing for us, so we can use a low power microcontroller to communicate through Ethernet. The internet nowadays contains people and users but does not contain things which work on their own without human intervention, this is a term coined "Internet of Things".**

We can thus use a micro-controller Arduino to communicate to the computer or android device. The microcontroller is interfaced with various sensors and thus the readings of the sensors are sent to the device using UDP packets over the Ethernet. The computer side software is C# which is used to receive the readings from the micro-controller, and then it creates a graphical view of the readings. The graph shows the readings that are taken by the sensors per second.

Ethernet networking thus provides with an automated humidity, light and temperature detecting mechanism by which we can keep getting updates of the surrounding area. This removes the need for human intervention, making work easier and it is now possible to get reports from places where physical barriers made it difficult to get data from.

Keywords—Internet of things; Ethernet; Arduino;

I. INTRODUCTION

Humans have limited time, accuracy and attention, which means that they are not very good at capturing data about things in the real world due to some limitations. If we had computers that knew everything there was to know about things by using data they gathered without any help from us, then we would be able to track and count everything and greatly reduce the loss and cost. We could also know when things needed replacing or repairing and whether they were fresh or not.

Most of us want to be connected in terms of computers, tablets and smartphones. Internet of Things describes a world where just about anything can be connected in an intelligent manner. With the Internet of Things, the physical world is becoming one big information system. The increase of objects that connect themselves to the internet right from cars to heart monitors to stoplights is unleashing a wave of new possibilities for predictive analytics, data gathering, and IT automation.

For example, we can bring innovation out onto the streets by using sensors on a large scale. A network of sensors which are capable of gathering information such as temperature, humidity or other environmental details can be used in the cities. The data collected by these sensors in a network can be sent directly to the Android smart phones or devices running Windows OS through an application so that everything can be accessed on the go. The data will be displayed in the form of a graph which displays live updates on the weather information that the sensors collect. This smart network can also be used to implement various applications such as guiding tourists.

II. LITRETURE SURVEY

A. Methodology

The figure 1 explains the basic flow of the system. As we can see multiple sensors, computers and mobile devices are connected to the internet,. that is that they communicate to each other via internet.

The sensors are placed at multiple locations and the sensors will sense the data and upload the data on the internet. The computers and the mobile devices will read that data from the internet and use the data to show the user interactive graphs about the data received. The user will be able to see the data of multiple sensors in a single graph and thus he will keep getting live updates about that location from the sensors.
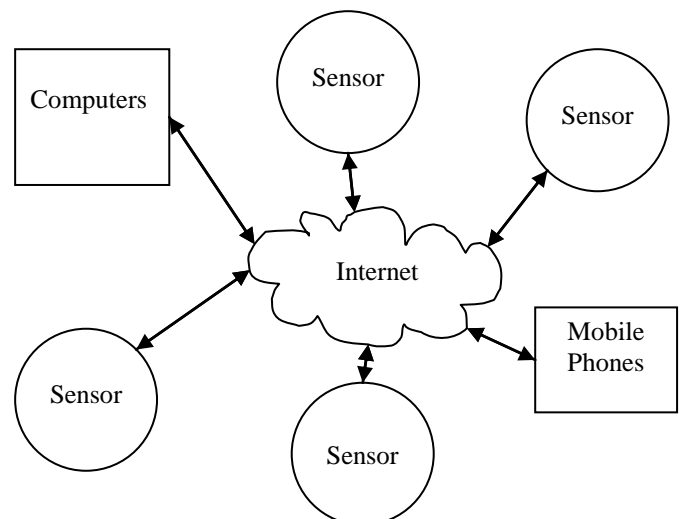

Figure 1

B. Computer Application

Basically C# is used as a program on the computer side that will keep receiving UDP packets from the microcontroller and then its basic function is to plot a graph taking those values. Here, a timer is used by us which continuously receives UDP packets every 100ms. In the start the program sends a start signal to the particular IP address and port and when stop is selected it sends a stop signal to the socket.

All the data that is received will contain humidity, light intensity and temperature information using which the program will project the readings and plot a graph. The graph is made using the chart component in which we just give the x-y coordinates and the graph is plot. It is a combined graph to temperature, humidity and light readings and is plotted every second as it gets the reading from the microcontroller.

C. Microcontroller

Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of an open source hardware board designed around an 8-bit Atmel AVR microcontroller. The software consists of a programming language compiler and a boot loader that executes on the microcontroller.

The Arduino Uno microcontroller board is based on the ATmega328.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a 16 MHz ceramic resonator, a power jack, an ICSP header, and a reset button. It contains everything that is required to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

D. Ethernet Communication

The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 Ethernet chip. The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Its library can be used to write sketches which connect to the internet using the shield. The Ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top. The Ethernet Shield has a RJ-45 connection, with an integrated line transformer and Power over Ethernet enabled. It also has an onboard micro-SD card slot, which can be used to store files for serving over the network. It is compatible with the Arduino Uno and Mega (using the Ethernet library). The onboard micro-SD card reader is accessible through the SD Library. When working with this library, SS is on Pin 4. The original revision of the shield contained a full-size SD card slot; which is not supported. The shield also includes a reset controller, to ensure that the W5100 Ethernet module is properly reset on power-up. Previous revisions of the shield were not compatible with the Mega and need to be manually reset after power-up. The shield basically takes the packets from the microcontroller and sends it to the receiver using UDP.

E. Mobile Application

The user has to install the application on his Smartphone , after which he will be able to use the application. When the system initializes it will first send initialization packets to the sensors. When the start button is pressed the application will send a data packet which will consist of a header and data which will initiate the transmission. Once the board receives this package, it will start sending UDP packets to the various sensors and will receive information from them. As the board receives the packets from the sensors, it then forwards the packets to the device. The device then converts the integer data and into a graphical format which will display the received data. This is how the user receives live data from each of the sensors and the data is graphically displayed for better understanding.

The whole idea of having data available on the mobile device is done so that the constraints of time get nullified. Moreover, another advantage is that the user has his data readily available all the time. It is a huge advantage for the user as he can access the data anytime from anywhere.

F. Communication Protocol

The communication between the applications, sensors and microcontroller is done using User Datagram Protocol (UDP). It is one of the core members of the Internet protocol suite. UDP uses a simple connectionless transmission model with minimum protocol mechanism. It has no handshaking dialogues, thus exposing any unreliability of the underlying network protocol to the user's program. There is no guarantee of delivery, duplicate protection or ordering.

It does provide checksums for data integrity and port numbers for addressing different functions at the source and destination of the datagram. With UDP, computer applications can send messages, which in this case is referred to as datagrams, to other hosts on an Internet Protocol (IP) network without prior communications to set up special transmission channels or data paths. Its suitable for purposes where error checking and error correction is not necessary, thus avoiding the overhead of such processing at the network interface level. The application is time-sensitive, thus uses UDP as dropping packets is preferable to waiting for delayed packets, which is not an option as the system is a real-time system.

III. USER INTERFACE

The main aim of the computer software is to collect data from various sensors and display it in either graphical or numerical form. When the application starts, the graph is shown with live updates as shown in the figure (Figure 2). There is a zoom button added at the bottom. Using the zoom feature one can zoom in to the graph thus increasing the time interval, to see the changes correctly.
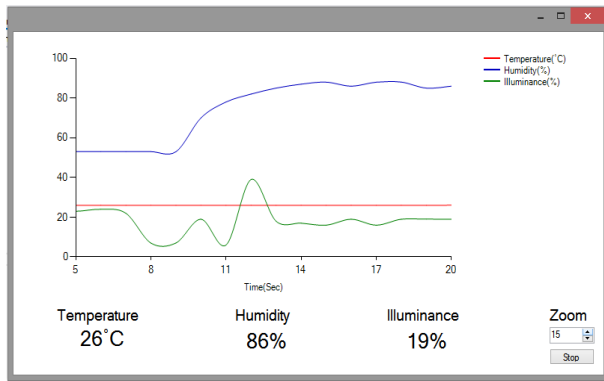
Figure 2

III. CONCLUSION

The entire system is one step closer to the mission of having an internet of things. As of now we have been able to interface and run the sensors and Ethernet shield. We have also interfaced multiple sensors and have displayed accurate values as the output. Also, the UDP protocol is implemented which is used to send packets. In the near future we can make this system communicate using different protocols for more reliability like TCP/IP. We can also make an iOS application to make the system work with multiple platforms. Multiple devices can be placed all over the world connected to the internet and data from the devices can be monitored simultaneously. We can interface more sensors and the device can be made smaller and in a single board. We can also make use of better sensors to handle extreme conditions.

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