Cloud Integrated Sensor Node Enabling Internet of Things Ecosystem

[1]Vivek Shah, [2]Rohit Bhattar
[1,2]Dept. Electronics and Communication, Institute of Engineering & Management, Kolkata, India

Abstract
With the advent of technology human mind has always vouched for easier ways of doing difficult tasks, and automation of any task is considered a task easily done. Any cumbersome task which require your constant approval appears to be monotonous can easily managed if automation is achieved. With time remaining constant and work in hands getting exponentially increased full automation is the only way out. In this paper we have tried to automate and process our surrounding activities. We have used Arduino UNO as our development board. With the help of Ethernet shield and cloud service XOBXOB we have tried it to connect it with internet. In this paper we have shown that not only we have power to access the data involved but also we can use the data and take proper actions.

Keywords
Internet of Things; Arduino UNO; Ethernet Shield; Cloud Service; Automation.

I. Introduction

The Internet of Things (IoT) refers to a broad vision whereby 'things' such as everyday objects, places and environments are interconnected with one another via the Internet. An example of a simple IoT object now available in some homes is a thermostat which can determine when people occupy certain rooms and alter levels of heating, lighting and other functions in the house accordingly. By widening the Internet from "a network of interconnected computers to a network of interconnected objects" (Commission of the European Communities 2009), the IoT will include a vast and intricate network of devices. These devices will include sensors to measure the environment around them, actuators which physically act back into their environment such as opening a door, processors to handle and store the vast data generated, nodes to relay the information and coordinators to help manage sets of these components. Through this, it has the potential to significantly extend, enrich and even shift the relationship between people and the world around them.

The Internet of Things (IoT) refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. Radio-frequency identification (RFID) was seen as a prerequisite for the Internet of Things in the early days. If all objects and people in daily life were equipped with identifiers, they could be managed and inventoried by computers. Besides using RFID, the tagging of things may be achieved through such technologies as near field communication, barcodes, QR codes and digital watermarking. This basic service of interconnecting different set of things and object to get the controls at tip of your fingertip makes huge difference how we see the automated world, with full automation you not only get an easy but also a very proven and accurate method of keeping track of the things.

II. Boards & Sensors Involved

A sensor is a device, which responds to an input quantity by generating a functionally related output usually in the form of an electrical or optical signal. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1°C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Sensors that measure very small changes must have very high sensitivities. Sensors also have an impact on what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages.

A. Proximity Sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.

The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance.

Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

Proximity sensors are commonly used on smartphones to detect (and skip) accidental touchscreen taps when held to the ear during a call. They are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings.

B. Temperature Sensor

Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of environmental temperature.

Because these sensors have no moving parts, they are precise, never wear out, don't need calibration, work under many environmental conditions, and are consistent between sensors and readings. Moreover they are very inexpensive and quite easy to use. We have used LM35 temperature sensor.

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ºC). 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. It also possess low self-heating and does not cause more than 0.1oC 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 ºC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ºC.

C. Photo Detector

A photo resistor or Light-Dependent Resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photo resistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits.

A photo resistor is made of a high resistance semiconductor. In the dark, a photo resistor can have a resistance as high as a few mega ohms (MΩ), while in the light, a photo resistor can have a resistance as low as a few hundred ohms. If incident light on a photo resistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their whole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photo resistor can substantially differ among dissimilar devices. Moreover, unique photo resistors may react substantially differently to photons within certain wavelength bands.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities, also called dopants, and added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

D. Arduino UNO

The Arduino philosophy is based on making designs rather than talking about them. It is a constant search for faster and more powerful ways to build better prototypes. We have explored many prototyping techniques and developed ways of thinking with our hands. Classic engineering relies on a strict process for getting from A to B; the Arduino Way delights in the possibility of getting lost on the way and finding C instead.

This is the tinkering process that we are so fond of—playing with the medium in an open-ended way and finding the unexpected. In this search for ways to build better prototypes, we also selected number of software packages that enable the process of constant manipulation of the software and hardware medium. The next few sections present some philosophies, events, and pioneers that have inspired the Arduino Way.

Arduino interface boards provide the engineers, artists, designers, hobbyists and anyone who tinker with technology with a low-cost, easy-to-use technology to create their creative, interactive objects, useful projects etc. A whole new breed of projects can now be built that can be controlled from a computer.

Arduino is an open source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. It's an open-source physical computing platform based on a microcontroller board, and a development environment for writing software for the board.

In simple words, Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones etc. They can either be powered through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently.

E. Arduino Ethernet Shield

The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 Ethernet chip (datasheet). The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library 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 most recent revision of the board exposes the 1.0 pin out on rev 3 of the Arduino UNO board. The Ethernet Shield has a standard RJ-45 connection, with an integrated line transformer and Power over Ethernet enabled.

There is an on-board 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 on-board micro SD card reader is accessible through the SD Library. When working with this library, SS is on Pin 4.

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.

III. Cloud Service XOBXOB

All Cloud computing in general can be portrayed as a synonym for distributed computing over a network, with the ability to run a program or application on many connected computers at the same time. It specifically refers to a computing hardware machine or group of computing hardware machines commonly referred as a server connected through a communication network such as the Internet, an intranet, a Local Area Network (LAN) or wide area network (WAN) and individual users or user who have permission to access the server can use the server's processing power for their individual computing needs like to run an application, store data or any other computing need. Therefore, instead of using a personal computer every-time to run the application, the individual can now run the application from anywhere in the world, as the server provides the processing power to the application and the server is also connected to a network via internet or other connection platforms to be accessed from anywhere. All this has become possible due to increasing computer processing power available to humankind with decrease in cost as stated in Moore's law.

In common usage, the term "the cloud" is essentially a metaphor for the Internet. Marketers have further popularized the phrase "in the cloud" to refer to software, platforms and infrastructure

that are sold "as a service", i.e. remotely through the Internet. Typically, the seller has actual energy-consuming servers which host products and services from a remote location, so end-users don't have to; they can simply log on to the network without installing anything. The major models of cloud computing service are known as software as a service, platform as a service, and infrastructure as a service. These cloud services may be offered in a public, private or hybrid network. Google, Amazon, IBM, Oracle Cloud, Salesforce and Microsoft Azure are some well-known cloud vendors.

Network-based services, which appear to be provided by real server hardware and are in fact served up by virtual hardware simulated by software running on one or more real machines, are often called cloud computing. Such virtual servers do not physically exist and can therefore be moved around and scaled up or down on the fly without affecting the end user, somewhat like a cloud becoming larger or smaller without being a physical object..

XOBXOB is a simple cloud service that makes it easy for your projects to join the Internet of Things. XOBXOB creates small mailboxes (XOBs). Things can send and receive messages through a XOB. By sharing XOBs, things can send messages to each other. Simple!!

An internet-connected light switch that you can turn on/off from your smart phone can be considered as the most basic example of XOBXOB. You need a thing connected to the Internet. The thing can be physical, like an Arduino. Or, virtual, like a web browser on your smart phone or laptop. Even though you only need one thing, XOBXOB is actually more interesting if you have two things, like an Arduino and a smart phone.

Anything that can connect to the Internet can use XOBXOB. If you're experienced, you can use the Restful API. But we're working on libraries and sample projects to make it simple to use platforms like Arduino, Raspberry Pi and BeagleBone.

IV. Project Functioning

In Cloud Integrated Sensor Node enabling Internet of Things ecosystem we tried to Conceptualized the idea and built an integrated application for actuation and monitoring of surrounding conditions using sensors. It had the capability to analyze data streams and actuate different parameter upon violation of pre-defined thresholds. The live data stream was sent to third party public cloud APIs and could be visualized via web-based application. Human mind has always sought out for atomization of the surrounding. And internet of thing is a big leap in this direction. All we have to do is visit a specific IP address and check the status of all the tagged objects. And on your one click of mouse you can access the complete information. Like for example you want to check the status of all your clothes in your closet which normally is a tedious but with the help of IOT (internet of things), a small example like this can elaborate what a bigger magnitude of effect it can have on our practical world.

The major goals of my project were to:

- Control my home lights, electronics devices.
- Monitor room temperature, humidity levels.
- Get Notified by fire alerts, burglary alerts.

More than half of the efforts was taken by software rather than hardware because creating a user interface on web and syncing it with my client controller was more difficult than interfacing devices and sensors.

A. Working

Now, let us go into the hardware and software details of this project. The hardware components used in the prototype of the project were Arduino microcontroller, Wiznet Arduino Ethernet Shield, temperature and IR sensors, LEDs, Resistors, relays, etc.

The software part includes several programming languages and platforms like Arduino SDK, XOBXOB platform, PHP, jQuery, HTML and so on.

There are three basic operating sub-systems in my system. They are:

- Webpage which is a user interface designed to suitable monitor the sensors values as well as control the devices of the room.
- XOBXOB platform which acts as a bridge between user and the home controller. It connects the home Arduino to the webpage as well do all the database handling and manages the data transfer protocols.
- Arduino which collects the sensors values from the room, sent it to XOBXOB server via Ethernet shield and get devices' switch signals from the XOBXOB server and send it to the relays to turn on/off the room devices.

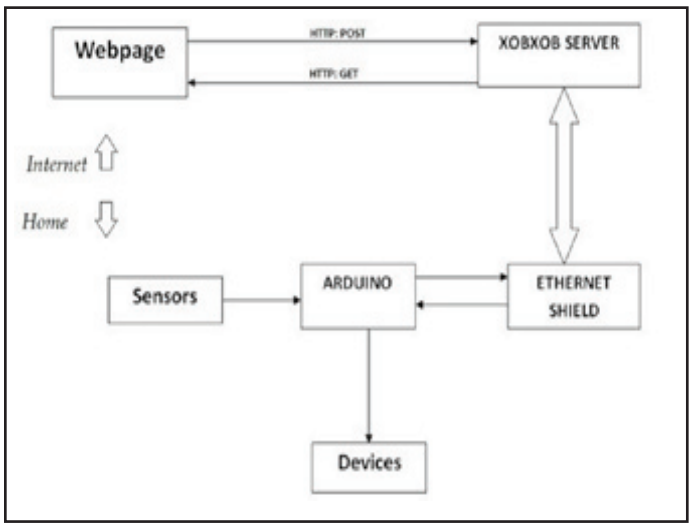

Fig. 1: Working of the Project

The first sub-system of our project is the User Interface. We have made a small webpage that is continuously synced with the XOBXOB server to exchange various data values. Also, the user interface provided by the XOBXOB itself can be used. It is handier in smartphones. For security purposes, both the user interface platforms are well secured by user password so that only the authorized personnel can use this system. Various languages and scripts has been used to design the webpage.

The second sub-system is the XOBXOB platform where I have created an account. I created a XOB named AUTOHOME and many parameters like LIGHT, HEATER, and TEMP, HUMID and so on under it. The XOBXOB provides an API key which is used by controller to track down XOBXOB server and connects to it.

The third and most important sub-system is the Arduino part where an Arduino ethernet shield connected to CAT 6 LAN wire is placed above Arduino microcontroller. The temperature, humidity, fire alarm and burglary sensors as well as relays for switching several devices are connected to the controller. This is the part that actually resides at my room. The controller needs constant 5V DC power supply and internet connection.

Two microcontroller program is divided into two modules. The first one is used to receive the device switch controls from the

webpage via XOBXOB server and another module is used to update the sensor values to the webpage via XOBXOB server. These two programs are kept in a loop with a delay of 30 seconds so that new values are updated and result is reflected every 30 seconds later.

V. Conclusion

In the above experiment we have successfully connected different objects in synchronized manner and obtained useful data. We have achieved full automation of our surrounding with use of different kinds of sensors. Like the temperature sensor used to detect the fire in the vicinity and take suitable actions. The use of temperature sensors is pivotal in fire prevention. As we have connected the temperature sensor with automated pump in which we have made sure that it releases water after reaching a certain temperature. We have also used a proximity sensor that senses any impending object and take necessary action. We have demonstrated it in our project in context of a vehicle as an anti-collision device.

LDR sensors are also used in our project that helps us to detect different intensities of light, like in a drawing room if we want to switch on the tube light after intensity of light hits a certain level can be easily done using this. So we can achieve full automation of our surrounding with help of this project. The only prerequisite is that all the objects to be operated should be tagged. And if we can tag all the objects of this world we can achieve a complete automation and just imagine how much amazing this world be such is the impact of this project.

In the course of this project we faced several difficulties. The major one was that we found it very difficult to connect it with internet. But with the help of DHCP enabled router we were finally able to connect it with the internet.

VI. Acknowledgment

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During the course of the project we realized there is no end to learning in this life. The more inquisitive is your mind, the greater problem you shall face and deeper avenue of knowledge you shall explore. Learning is an aspect of life in which more you share it with others the more you will benefit. All thanks goes to Professor Debadyoti Ghosh our mentor and also to our head of department Professor (Dr) Malay Ganguly. Lastly I would like to thank our esteemed college Institute Of Engineering and Management which has provided us with such an amazing platform and resources which were quite essential in our endeavor of writing this research paper.

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Vivek Shah received his B.Tech degree in Electronics and Communication Engineering, Institute of Engineering and Management, Kolkata, West Bengal, India in 2014. His research interests include Internet of Things (IoT) technology ecosystem integration and deployment for large industries. He is currently working as Systems Engineer with Infosys Ltd. where he works with leading companies in manufacturing sector to provide solutions to complex real-life problems.

Rohit Bhattar received his Bachelor of Technology degree in Electronics and Communication from Institute of Engineering and Management, Kolkata, West Bengal, India, in 2014. His expertise in Internet of Things domain allows him to find suitable and feasible solutions for manufacturing industries. He is currently working with Infosys Ltd in manufacturing vertical, to provide cloud based solutions as Systems Engineer. He is interested in finding suitable business use cases across all domains where Internet of Things technology can be leveraged to solve problems.