SMART HOME SYSTEM APPLICATION BASED ON INTERNET OF THINGS

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ABSTRACT: The Internet of Things (IoT) is an emerging technology that tends to increasingly become part of everyday life. The multiple aspects of IoT, and the increasingly large number of devices, technologies and platforms in the field, led to the development of IoT technology in many areas. The Internet of Things is a technology that will allow the entry into a new economic era for the entire globe. IoT is a concept that defines a world where all the objects (cars, appliances, lighting systems, mobile devices, portable devices etc.) are connected to each other via the Internet. In this paper, there are presented the most important characteristics and major applications of IoT, and the technological challenges that the Internet of Things is facing. IoT is not the result of a single new technology, several complementary technical advances provide capabilities that, together, help to bridge the gap between the virtual world and the physical one. These capabilities support the IoT and the prospects of its development. In conclusion, businesses will need to begin to implement IoT technology if they want to survive over the long term, but they will also have to implement strategies that account for the many risks associated with the Internet of things. This paper describes Frugal Labs IoT Platform (FLIP) for building IoT enabled Smart Home.

KEY WORDS: IoT platform architecture, smart home, sensor, cloud, monitoring

1. INTRODUCTION

The Internet of Things [1, 2, 3] is a concept that defines an area in which all objects (cars, home appliances, lighting, mobile devices, portable devices, etc.) are connected to each other via the Internet. Internet of things does not only rely on computers in order to exist. Every object, even the human body, can become a part of the Internet of things if it is equipped with certain electronic components. These parts will certainly vary depending on what they have to do, but they fall into two major categories:

- The object must be able to capture data, usually through sensors.
- The object must be able to transmit this data elsewhere via the Internet.

A sensor and a connection, therefore, are the two primary electronic parts of an object included in the Internet of Things. However, the Internet of Things will have profound implications for all levels of business operations, regardless of the type of industry [4].

The graphical representation in Figure 1 shows the objects that can be connected to each other via the Internet of Things.

Together with other technological developments such as Cloud computing, smart grids, nanotechnology and robotics, the Internet of Things world provides a huge step forward towards an economy characterized by increased efficiency, productivity, safety and profit [5].

Figure 1. Internet of Things - IoT

2. TECHNOLOGICAL CHALLENGES FOR THE INTERNET OF THINGS

The Internet of Things is confronted with the technological challenges [6] highlighted below:

• **Scalability:** The Internet of Things has a potential global potential beyond conventional internet. Things communicate with each other in a local environment. So, their functioning for communication and service discovery should be equally effective in all environments, both on short and long distance;

• **Acceptance and operation:** smart objects used periodically should not be likened to computers because mobile things need to establish connections unexpectedly and configure to fit the environment in which they are, while computers are usually configured from the start.

• **Interoperability:** As the world of physical things is extremely diverse, in the Internet of Things, each type of smart object has different processing and communication capacities. In order to facilitate communication and cooperation between objects, common practices and standards are needed, which is very important from the stand point of physical addresses and in accordance with the IP standard lines of the conventional Internet.

• **Discovery:** In dynamic environments, services for things have to be automatically identified, which requires adequate semantic means of describing their functionality. Users can get information about the status of an object and use search engines to find them;

• **Software Complexity:** Although intelligent software systems work with minimal resources, a wider network software infrastructure is required to manage smart objects and provide support services and on background servers, as with conventional integrated systems.

• **Data volumes:** Some scenarios involve short, low-frequency communication, while others, such as sensor networks, logistics, and complex real-world awareness scenarios, require large volumes of data on nodes or central network servers;

• **Interpretation of data:** the context determined by sensors at the local level must be as accurate as possible. Data from sensors must be interpreted, resulting in disparate data and then used by service providers to extract their findings.

• **Personal data security and privacy:** In addition to Internet security and protection (such as confidentiality of communications, authenticity and integrity of messages), there are other requirements that are important in the Internet of things such as: selecting objects for access to certain services, communication with other objects at certain moments in time or uncontrolled.

• **Tolerance to errors:** The world of things is more dynamic and mobile than the world of computers, with contexts that change rapidly and in unexpected ways.

• **Power Supply**: Usually, things are not powered by the grid, so their intelligence needs to be powered by an energy source. There are already wireless sensors without batteries that can transmit their information within a few meters. Like RFID systems, they get the energy they need either remotely or from the measurement process itself, for example by using piezoelectric or pyroelectric materials to measure pressure and temperature;

• **Interaction and short-range communication:** Wireless communications over several centimeters are sufficient, for example, when an object is touched by another object. If such short distances are involved, very little energy is needed, the approach is simplified (there is often only one possible destination) and there is usually no risk of interception. NFC is an example of this type of communication. Like RFID, it uses inductive coupling.

During communication, a partner is in active mode and the other can be in passive mode. Active NFC units are small enough to be used in mobile phones; passive units are similar to RFID transponders and are significantly

smaller, cheaper and do not need their own power source;

• **Wireless Communications:** From an energy point of view, wireless technologies such as GSM, UMTS, Wi-Fi and Bluetooth are much less suitable; more recent WPAN standards such as ZigBee and others still in development may have narrower bandwidth, but they use significantly less power.

3. APPLICATION OF THE IoT - SMART HOME

The intelligent house is in terms of space, either a home, office, holiday home that uses modern technologies to automate the systems and the appliances in it. A smart home will ensure comfort, security, safety and economy. FLIP developed by Frugal Labs Bangalore, is an open source IoT platform aimed for developers, Hobbyists, and anyone interested to learn and work on IoT to transform their idea to "Proof of Concept". FLIP is a complete IoT platform and not just collection of devices and sensors or cloud services for building IoT infrastructure. FLIP architecture represented in Figure 2 [7].

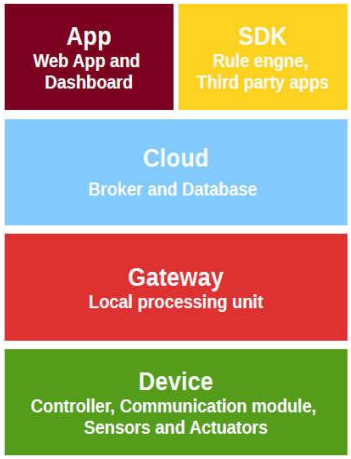

Figure 2. FLIP Architecture

The FLIP architecture has four distinct layers device, gateway, cloud, and app & SDK.
Device layer consists of controller, communication module, sensors and actuators. In this layer FLIP base board is used as controller. FLIP base board is based on Arduino Nano [8]. Gateway layer consists of local processing unit which is based on Linux operating system. FLIP architecture uses Raspberry PI 3 [9] as gateway device. Gateway device has Bluetooth connectivity which allows other devices to connect to it. In the architecture all the devices are connected to gateway and gateway is connected to the Internet. Gateway is connected to Internet through Ethernet or Wi-Fi. Cloud layer consists of broker and the database. Broker connects to all the devices and database stores the data coming from the devices. The top layer is App & SDK layer. The app consists of web app and dashboard and is used for data visualization using widgets and graphs. Using dashboard devices can be monitored and controlled. SDK has rule engine based on python [10]. Python SDK has two scenarios one is to define logic to your device i.e. if temperature is this much then switch on air-conditioner, and second to social media or third party apps. The system has four main application modules smart lighting, smart appliances, intrusion detection, and smoke/gas detection. Figure 3 [7] displays basic device setup diagram for smart home light control including temperature, humidity, light intensity and motion detection sensing capability.

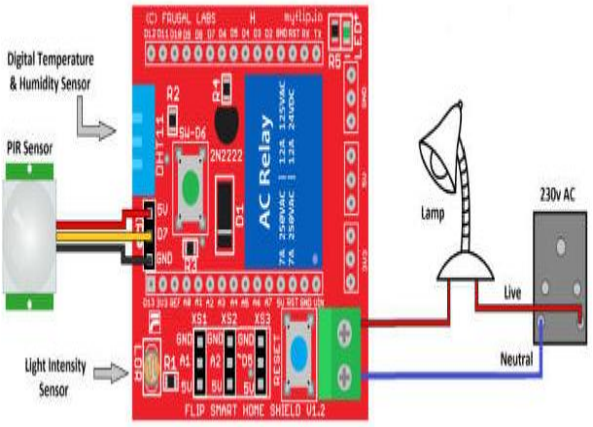

Figure 3. Smart Home Device Setup

The smart home network structure displayed in Figure 4.

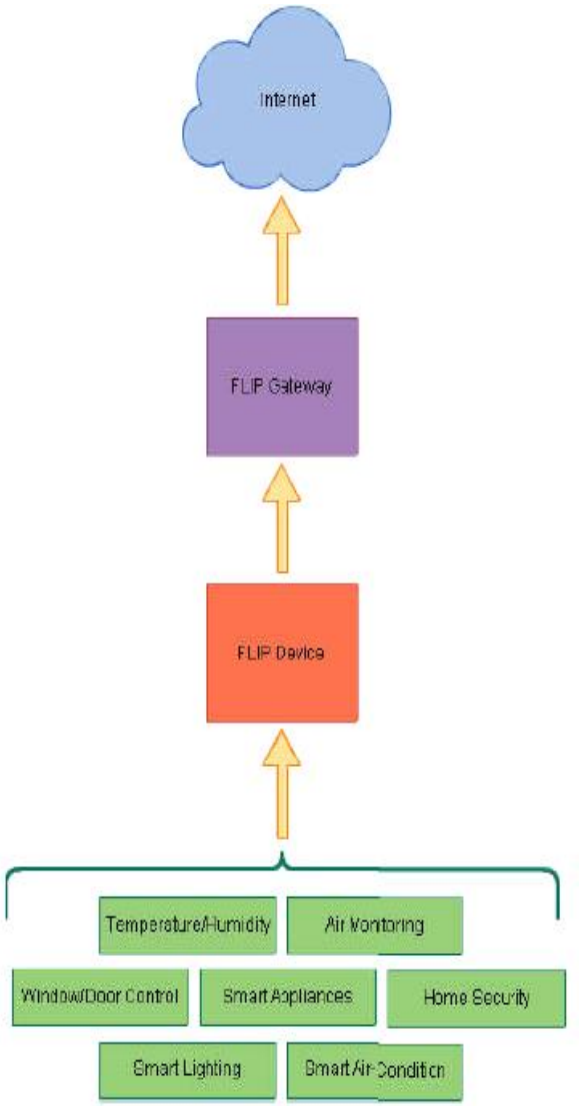

Figure 4. Smart Home Network.

In the proposed smart home system FLIP connected to sensors, lights, air-conditioner, camera, windows and door system, and various appliances. The flip device is connected to the Internet via gateway. Gateway in the proposed smart home network plays an important role as it add an extra security layer to the smart home network thus making the proposed system more secure. The following code segment in C language from proposed smart home system sends temperature, humidity, and light intensity data to server and also allows user to control electric switch remotely.

```
#include <FlipSmartHome.h>
#include <FlipMqtt.h>
FlipSmartHome fsh;
FlipMqtt m;
char* temp_topic ="Home/temp";
char* hum_topic ="Home/hum";
char* ldr_topic =" Home/light";
char* switch_topic="Home/switch";
char* ssid="ssid";
char* pwd="password";
int temp, hum, ldr;
char* s=NULL;
void setup()
{
m.mqttSub(switch_topic);
m.mqttBegin(ssid,pwd);
fsh.relayOff();
}
void loop()
{
s=m.GetSubValue(switch_topic);
if (strcmp(s,"1")==0){
fsh.relayOn();}
else{
fsh.relayOff();}
temp = fsh.readTempC();
m.mqttPub(temp_topic,temp);
hum = fsh.readHum();
m.mqttPub(hum_topic,hum);
ldr = fsh.readLdr();
m.mqttPub(ldr_topic,ldr);
}
```

The proposed system visualize data using widgets and graphs in web app and also provides widgets to set alert conditions and controlling devices such as opening/closing doors and windows, turning on/off lights and other equipments. System also allows users to download all tracking information in excel format and add new logic to the system using python script whenever required thus making system flexible. User can also define the medium for receiving alerts and notifications. The different mediums can be email, text message, and social media. User can choose any one or all. Following python script sends e-mail alert if light intensity in higher.

```
import FlipUtilities as Flip
import FlipMQTT as mq
import time
import getpass
```

```
mqtt = mq.FlipMQTT()
mqtt.sub_topic("Home/light")
mqtt.infy()
service = 'gmail'
Flip.selectService(service)
username = "username"
password = "password"
to = "to-email-address"
frm = "from-email-address"
Flip.emailCredentials(username, password)
print "Logged in successfully!"
received_data = []
check_timestamp = '0'
while True:
received_data =
mqtt.sub_value("Home/light")
if received_data != None and
received_data[1]!=
check_timestamp:
print received_data
if (received_data[0] >= "500") :
check_timestamp = received_data[1]
subject = "Sensor Values"
message = "Light Intensity is "+
received_data[0]+"
Time:"+received_data[1]+""+"
Turning OFF Room Light."+""
Flip.sendMessage(to, frm, subject, message)
print"message sent!"
time.sleep(5)
Flip.closeEmail()
```

The proposed system is very helpful in monitoring and controlling smart home environment. Using this system air quality can be continuously monitored in home and alerts can be sent to user about health risks if any. Proposed system also improves security.

4. CONCLUSIONS

The purpose of a smart home is to improve living standard, security and safety as well as save energy and resources.

The main conclusion of this paper is that the Internet of Object is indeed a revolutionary concept with multiple benefits for the individual as well as for communities and can be implemented in different fields of activity, from the industrial to administrative and housing field.

The common denominator for the use of this technology, regardless of the field in which it is implemented, is to ensure efficiency through superior performance and low resource consumption.

The implementation of the Internet of the Objects involves the use of various technologies, some of them very well developed, from intelligent sensors, speed communication systems, high capacity storage devices to efficient computing algorithms and unbeatable encryption algorithms.

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