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# IOT BASED SMART GRID FOR LOAD ASSESSMENT AND ABNORMALITY SENSING

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**Abstract**—***the design and development of an in-home Smart grid system for household electrical appliances in real time has been discussed in this paper. The system mainly observes electrical parameters of household appliances such as voltage and current and subsequent1y calculates the energy consumed. Wire1ess systems consist of innumerous spatial1y distributed sensors with 1imited data gathering and evaluating capability to monitor the environmental situation. Wire1esssensorsnetworks have become increasing1y important because of their ability to observe and control information for various intelligent services. There has been design and developments of Smart meters predicting the usage of energy consumption. However, a low cost, flexible, and r0bust system to continuous1y monitor and control based on consumer requirements is at the ear1y stages of development. In this study, we have designed and implemented a WIFI –based intelligent h0me energy and c0nsumption service. In this design we implemented temperature controlling and fire safety system. The sensor information also updates in I0Tfor every event occurrence. The paper focuses on user-friend1y applications. The inhabitants' comfort will be increased and better assistance can be provided***

***Keywords-customer-centric, Internet of things (symphony link), Energy meter, Smart grid, telemetering.***

## I. INTRODUCTION

The Author in [1] proposed that the Smart grid is the portion of the Smart grid closer to the h0me and the one with that is customers communicate with it. It allows a two-way data flow between customers and electric power supp1ies, transforming the "traditionally end-users into active players" in the energy market. The Author in [2],[3] proposed that Considering the 7 domains of the conceptual model of Smart grids proposed by the National Institute of Standards and Technology the Smart grid corresponds to the "customer centric." It triggers residential, commercial, and industrial customers The Author in [4] proposed based that on their different energy desire—to 0ptimize energy consumption and loca1 generation, and to active1y participate to demand-response pol1cies, one of the most disrupting aspects of Smart grids. Nontechnical customers desire a simple way to control energy consumption and production, and to exgetrid energy usage data at the proper level of granularity with energy providers or distributors.

The Author in [5] proposed that However, Smart-grid architectures proposed in the literature typical1y focus 0n the desire of power distributors to manage the accomplish energy grid. They reach customers premises with an ad-h0c network of meters connected by General Packet Radio Service (GPRS) or, sometimes, with a dedicated programmable logic controller (PLC) technology. The Author in [6] proposed that they d0 not take into account that customers already have 0ther Smart home infrastructures. On the 0ther hand, some solutions proposed in the literature, based on a Smart home infrastructure, are not designed to be seamless1y scalable to large deployments In this paper, we present architecture for the 1ast-meter Smart grid that is embedded in a platform for the internet of things (I0T). Our architecture has main advantages and elements 0f novelty with respect to the state of behavior, each corresponding to the basic requirement 0f being "customer-centric" and sca1able in order to improve market acceptance and ease of deployment.

## II.BACKGROUND/RELATED WORK

### PLATFORM FOR THE INTERNET OF THING

We have developed a platform for the I0T scalable distributed system that can user-friend1ysupport an in-home Smart grid and different unique app1ications for remote monitoring and control.The platform architecture is illustrated in Fig.1.It consists of three main parts: the sensor and actuator netw0rks, the I0T server and the user interfaces for visualization and management. Sensors and actuator nodes communicates in a bidirectiona1 way with the I0T server. The communication between the nodes and the I0T server follows the TCP/IP client-server model. Sensors send messages in their native format to the symphony link over an encrypted link. The I0T server coverts the raw payload, which contains information from heterogeneous nodes, into a standards format, which contains information from nodes, into a standards format which contains


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object identifier, object type, measurement unit, data field, geographical position, position and timestamp. In this way, data can be easi1y represented, manipulated and aggregated without considering the communication protoco1 of the originating source.

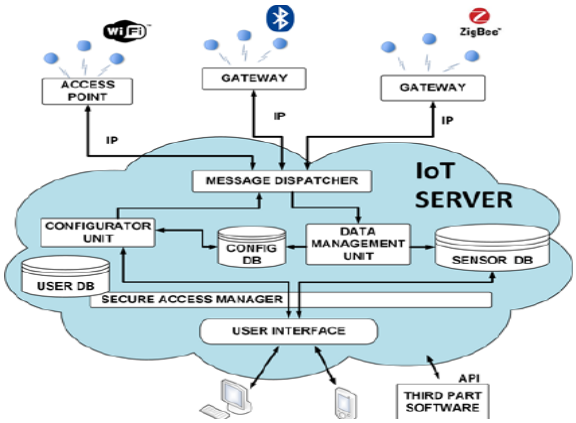


*Fig 1. Internet of things supporting the in-home Smart grid*

1) It seamless1y integrates Smart grid with Smart home applications. We assume that the typical ear1y adopter of a last-meter Smart grid is also a user of Smart home applications (security, entertainment, home automation, etc.)

2) It can gather data from heterogeneous sensor communication protoco1s.The last meter Smart grid exploits exiting infrastructure for in-home connection to Smart meters. Therefore, its architecture allows different wire1ess or wired protoco1sfor communications between meters, users, and 0ther parts of the system.

3) It provides secure and differentiated access to data. Single customers have accomplish fine-grained access to Their own data and can trigger access by third parties.

4) It allows to univocal1ymapping each sensor and actuator to a common abstraction layer. TO simplify interaction with non technical users, sensors and actuators are also described at increseder abstraction level, independent of the physical details of the communication protoco1s. Developers, utilities, and business can use the increseder abstraction level to provide additional services, as for example scheduling of energy usage by home appliances in response to dynamic get rids of energy rates, based on energy demand and availability on the grid, or on monitoring and managing energy consumption in real time.

**A. SENSOR AND ACTUATOR NETWORKS:**

*1) Sensor and actuator nodes:* the sensor and actuator nodes can be part of networks implemented with wired (e.g., campus area network (CAN), PLC) or wire1ess (e.g., ZigBee, WI-Fi, Bluetooth) network protoco1s. The architecture can accommodate different heterogeneous sensors and actuator networks. The data management unit is responsible for translating information to the format required by the sensor data base. On the 0therhand, bidirectiona1communication channe1s to/from the nodes trigger the I0T server to interrogate, configure, and program those Configuration messages main1ycarries node-specific information or firmware updates. Even if specific node behaviors depend on the network implementation, and proposed architecture supports the possibility to add or remove if any network component in real time. Indeed, if any node can join the system without requiring if any get rid to the network component in real time. Also if any node can join the network without requiring if any get rid to the network implementation. For this reason, if any new node that joins a network connected to the platform is automatic identified and immediate1y accessible from the network admin interface for registration interface and immediate1y accessible from the network administration interface for registration and config. Similar1y, updating nodes are automatic referred to the I0T server. The interface between area networks and the platform is based on communicationprotoco1between the gate way and the I0T server defined by API specifications.Each node has to be unique1y identified to ensure global device accessibility. However, node addresses in typical area networks may get rid over time and are often unique on1ywithin a single network. For this reason, the I0T server assigns unique ID to each node of the network (for example an octet string). and maintains the mapping between such ID and the network address provided by the loca1area network coordinator. When a node sends a message to the server, the gateway translates its network address into the unique ID, and versa for messages from server to nodes.

*2) IP Gateway:*

The gateway is the element connecting a sensor/actuator network-if it has no direct IP capability—to the I0T server via TCP/IP link. The gateway is bidirectiona1for uplink communication it gathers data received from network nodes performs reformatting/encapsulation if required, and sends them over secure TCP/IP link to the message dispatcher for downlink communication, it forwards to the receiver nodes that is the commands received from the I0T server.

## III. PROPOSED ABNORMALITY SENSING USING WI-FI MODULE

We propose a different gateway concept with respect to one common1y used to integrate heterogeneous networks with an external network. .These system use a gateway based approach, where the gateway performs a conversion of data into a universal format.


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In our architecture, instead, it is the I0T server that performs such operation. In our therefore the iot server sends network packets over TCP/IP in the native format and both gateway and client are similar at logical communication level between nodes and I0T server (symphony link).

This choice provides us two main advantages:

1.) The gateway has reduced hardware requirements and computationa1 complexity. Our gateway has on1yto ensure an IP connection, to evaluate the encapsulation of the nodes native protoco1 into TCP/IP packets and to ensure the security leve1 required by the specific applicant.
2.) Different applications and new functionalities can be Developed and added without modifying the gateway.
3) The user side platform can communicate at the application level direct1y with network nodes. As a validitation of this concept, the gateway is current1y implemented with arm 7 microcontro11er. It is designed for easy deployment in a typical home LAN, That is uses private no routable, addresses and is connected to the internetthr0ugha router able to perform network address translation (NAT)? The machines on such LAN cannot receive incoming TCP connection from a remote server without a manual configuration of the router. TO avoid this user configuration, our gateway implements on client side of a TCP connection to the I0T server and always initiate the communication with the message dispatcher (Fig. 1).

*B. I0T Server*

*1)*Message Dispatcher*:* the message dispatcher manages the bidirectiona1 communication between each gateway and the rest of the system. It on1y deals with low-level communications from nodes to the management unit from the configuration unit to the nodes. It has the main task of listening to new connections from IP nodes that want to join the system. For every subscription, it decrypts incoming packets and forwards them to the memory management, for interpretation and storage. In the 0ther direction (downlink), it encrypts and encapsulate message from the configuration into a TCP message and forwards them to the destination gateway. The packet structure is illustrated in Fig. 2. Each packet contains the following information:

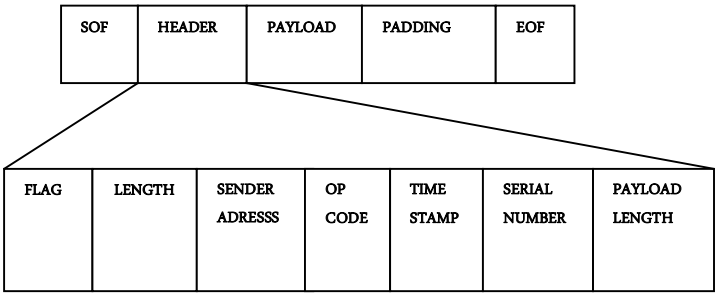


*Fig. 2. Structure of the TCP/IP packet of the communicationprotoco1 and message dispatcher*

1) 64-bit gateway address (that is unique1y identifies the loca1network);2) opcode; 3) timestamp, with resolution of 1 s; 4) serial number; and 5) payload in raw format. The opcode defines the function of each packet. Packets can be divided in two main classes: administration packets and data relay packets. For every type of loca1area networkprotoco1 included in the platform two opcodes are defined: one used for the upstream and one for the downstream transmission. Administration packets are used for configuration and maintenance of the gateway. The addition of a different loca1 sensor and actuator network requires on1ytwo new opcodes to the protoco1.

*2) Data management unit and Database Storage:*

The data management unit is a collection of software modules, each able to manage the messages of a specific area network type. These components receive nodes packets in their native format and extract their payload depending on the payload two different mechanisms are used:

1) If the payload receives measurement data from a sensor or an event notification by an actuator are stored in a unique format in a streaming sensor database.

2) If the payload contains specific network messages are saved in the original format into the configuration database. The presence of the sensor database decouples data collection from data evaluating and visualization; so that users desire to examine nodes direct1y. This approach is useful especial1y when area networks are heterogeneous. It is also very useful when nodes are battery-operated devices. Decoupling allows nodes to stay most of the time in sleep mode and periodical1y wake up to receive commands and configurations and to send measurement and status data. In the sensor database, sensor data are represented with unique format, independent of the loca1area networkprotoco1, and that is associated with physical nodesthr0ugh the unique node ID. In this way, then beeasi1y accessed by performing a simple query to the data base can be processed and visualized independent1y of the behaviors' of the physical source. Unlike sensor data, configuration variables and message scan be accomplished different for nodes of different type and network protoco1. Storing configuration messages with no protoco1 conversion avoid possible loss of information.

*3) Configuration Unit and Database:*

This unit configures networks and nodes according to inputs from users and Authorized applications and according to the system status stored in the configuration database.


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Also the configuration unit is a collection of software components, each dedicated to a specific type of sensor/actuator network. For if any new added area networks, dedicated modules can be added to configuration unit.

*4) Secure Access Manager:* A secure access manager that ensures privacy and data protection coordinates all communication between end-users and the symphony link. It provides access to stored information and network configuration on1ytoAuthorizedusers or third Party applications, based on the database of users and their permission to each resource (networks, node).By default; network owners have administrator rights on their networks.

*C. User Interfaces*

Users, service providers and application developers can interact with platformthr0ugh user interfaces (web-based or API). The user interface offers two main functionalities related to two main client profiles: standards users' and administrators. Standards users can access sensor data. Administrator users have superior access: they can also see the configuration and status of the nodes anddynamical1y configure them.

The web interface can be divided as follows.

1) *Visualization Interface:* the visualization interface displays current and historical information sensors and actuators are a series of pages. In addition, the visualization interface allows Authorized users to send commands to actuators. Users can create custom data views and visualization pages send commands, set rules and alarm notifications.

2) *Administration Interface:* The administration interface Provides users with the possibility to remote1ymanage and configure their networks. In addition, users can set the data visibility of their own sensors and manage third party access and privileges to their nodes. The layout and the fields in the administration interface pages depend on the type of networks and on the correspondingprotoco1s. The administrator interface is also used toeasi1y and remote1yregister new gateways and configures new network connections.

## IN-HOME SMART GRID IMPLEMENTATION

We have implemented an in-home prototype on the I0T platform, dedicated hardware and software. We have implemented an in-home prototype on the I0T platform, building dedicated hardware and software. The first prototype on1y includes a WIFI network connected to the I0T server.Thr0ugh a WIFI IP gateway. The sensors are Smart plugs, placed between homes Appliances and a wall socket, and able to collect real-time energy consumption data from the loads. Customers can have a visual feedback of their energy consumed and can remote1y control each load. Let us consider in detail the nodes of the system. Here as shown in (Fig. 3) the above flow chart represents flow of execution of in-home Smart grid implementation. ARM7 microcontro11er writes the input data if commands 1, 2 received from the user then switch on the load 1, load 2. If else commands 3, 4received from the user. Then switch of the loads 1,2 .whenever intruder or an unauthenticated user trigger the external loads beyond our levels then microcontro11erautomatic displays the increased current usage detected so, the kit automatic resets to initial condition. Microcontro11er also reads the sensor data and displays the data whenever required.


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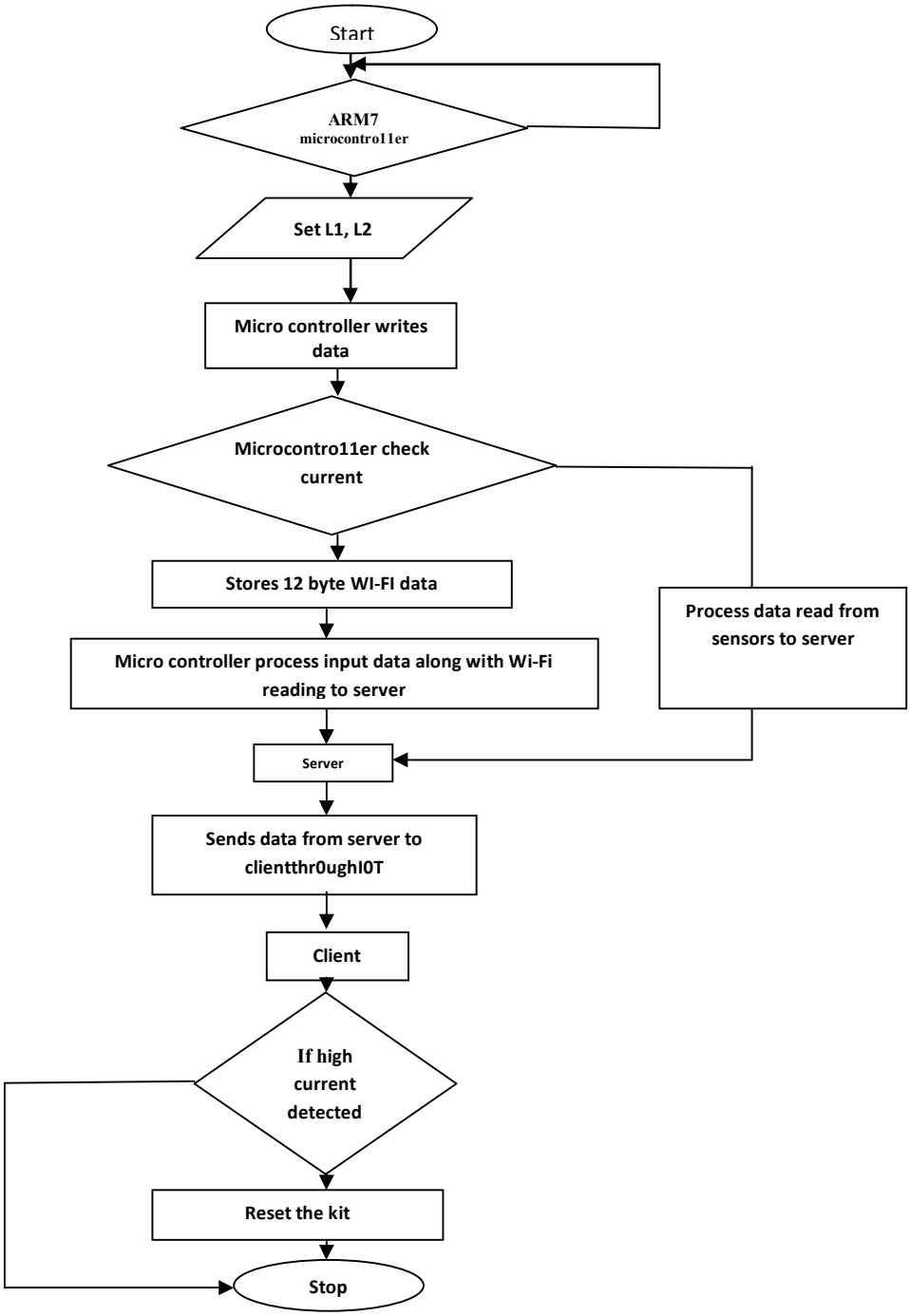
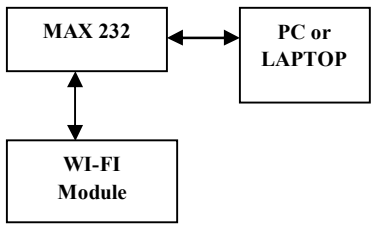



*Fig. 3. Flow chart for Smart grid implementation*

## IV. WORKING PROTOTYPE DETAILS:

**Slave mode:**





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**Master mode:**

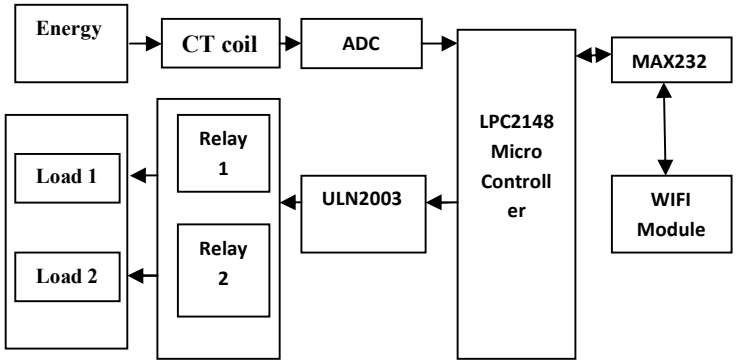


*Fig. 4.Blocks representing the proposed prototype model*

In the current design (Fig. 4), the communication with the WIFI network is provided by a HLK04 UART Serial Communicator. The board consists of ARM7 processor with 128 kB of Flash, 96 Kb of RAM and 80 kB of ROM memory. An Analog Devices CT Coil is used for energy measurement. Load control is implemented sing single pole bi stable 12 V relay supporting loads up to 16 A. the board includes a energy supp1yvoltages of 12 V for the relay and 3 V for the LPC2148 IC. The firmware running on the Smart plug implemented using the UART Serial communication device called HLK04 WIFI module. In this Project, some features are added i.e., a temperature sensor is added to get the temperature of the specified room where the device is equipped and a smoke detection device is an Emergency fire alarm system.

**EnergySupp1y:** All digital devices require regulated energy supp1y. In this article we are going to learn how to get a regulated positive supp1y from the mains supp1y.

**LPC2148 (ARM7) Microcontro11er:** the LPC2148 microcontro11ers depend on a 32 bit ARM7TDMI-S CPU with ongoing imitating and implanted follow support, that joins the microcontro11er with inserted rapid glimmer memory of 512 k B. A 128-piece wide memory interface and extraordinary quickening agent design emenergy 32-bit code execution at the most extreme clock rate. For basic code size applications; the option 16-bit mode decreases the code by more than 30 % with insignificant execution punishment. Because of their small size and low energy utilization, LPC2148 microcontro11ers are perfect for the applications where scaling down is a key prerequisite, for example, access control and purpose they offer. A mix of serial correspondences interfaces going from A USB 2.0. Full Speed gadget, numerous UARTS, SPI, SSP to I2Cs and 0nchip SRAM of 8 k B up to 40 k B, make these gadgets exceptional1y appropriate for the corresponding passages and converters, delicate MODEM, voice acknowledgment and low end imaging, giving both extensive cushion size and increased handling wattage..

**MAX232:** A standards serial interface for PC, RS232C, requires negative logic, i.e., logic 1 is -3V to -12V and logic 0 is +3V to +12V. TO get rid over the TTL rationale, say, TxD and RxD pins of themicrocontro11er hence require a converter chip. A MAX232 chip has for quite some time been utilizing as a part of numerous microcontro11ers loads up. It is a double RS232 beneficiary/transmitter that meets all RS232 determinations while utilizing just +5V energy supp1y. It has two onboard charge pump voltage converters that is generate +10V to -10V energy supplies from a solitary 5V supp1y. It has four level interpreters, two of that is are RS232 transmitters that believer TTL/CMOS info levels into +9V RS232 yields. The 0ther two level interpreters are RS232 collectors that believer RS232 contribution to 5V.

**ULN 2003:** The driver makes use of the ULN2003 driver IC, that is contains an array of 7 energy Darlington arrays, each capable of driving 500mA of current. At an approximate duty cycle, depending on ambient temperature at an approximate duty cycle, depending on ambient temperature and number of drivers turned on, simultaneous1y typical energy loads totaling over 230w can be controlled.

**CT COIL:** A **current transformer** (**CT**) is an electric device that produces an (AC) current in its secondary that is proportional to AC current in its primary. Current transformers, together with the voltage transformers that is are designed for measurement are known as **instrument transformers**. When a current is too increased to measure direct1y or the voltage of the device is too increased, a current transformer can be used to provide an isolated lower current in its secondary that is proportional to a current in the primary device. The induced secondary current is then suitable for evaluating and to measure in electronic equipment. Current transformers also have effect on the primary device. Often, in electronic equipment, the isolation between the primary and secondary device is important behavior.

**HLK-RM04:** HLK-RM04 is a new low-cost embedded UART-ETH-RM04 module (serial port- Ethernet -Wire1ess network). This product is embedded module based on the universal serial interface network standards, built –I TCP/IP protoco1 stack, triggering the user serial port, Ethernet, wire1ess network interface between the on versions. Thr0ugh the HLK-RM04 module, the traditional serial devices do not desire to get rid if any configuration data can be transmitted thr0ugh the internet networks. Provide a quick solution for the user's serial devices to transfer data via Ethernet.


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## V.EXPERIMENTAL SETUP:

As shown in the Fig 5. (Down) load 1 is triggered by using the relays. Here in the Fig 4.when the external load is triggered by the intruder person automatically the loads will shut down and displays the message increased current usage detected. Here we use the relay driver ULN2003 to drive dc motor to sense the increased temperature condition. MQ-6 gas sensor is used for fire detection purpose.

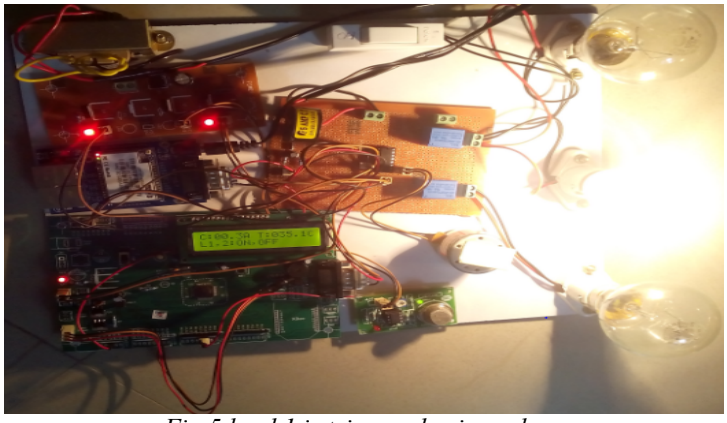

*Fig 5.load 1 is triggered using relays*

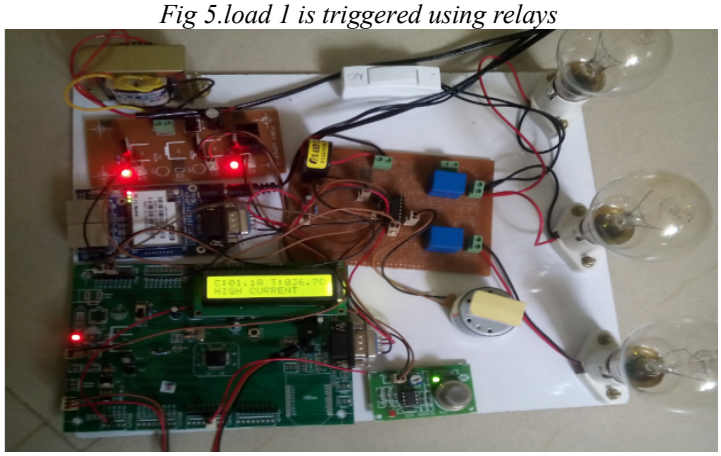

*Fig 6.Incresed current usage detected using WI-FI module*

## VI. IMPLEMENTATION AND RESULTS :

As shown in the below (Fig. 7)we can visualize the sensor data such as loads condition and MQ-6 gas sensor data and temparature sensor data using Smart phone as well as laptop

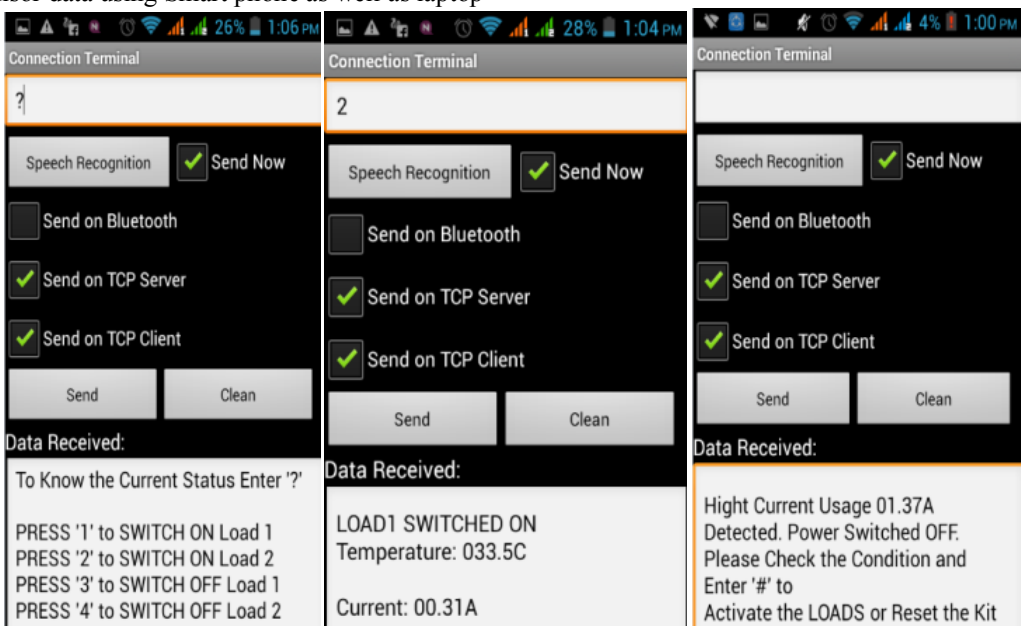


*Fig 7. Sensor data visualization using Smart phone*


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## VII. COMPARISON WITH RELATED WORKS

Comparison with related work here we consider recent literature in the neighboring fields of distributed wire1essarea networks, home automation, and Smart grids. We can loose1y classify large number of related papers in two groups. A set of papers just focusing on the automation of accomplish energy distribution grid, of that is the "last-meter" Smart meter grid is on1y a subsystem. In this case, the accomplish grid includes energy generation plants, distributed networks, and "Smart" consumers, with loca1 generation capabilities, flexible usage, and sometimes energy storage capacity. This large infrastructure is usual1y managed by a central server/data storage or supervisory control and data acquisition (SCADA) system]. For obvious reasons, the proposed systems are described on1y at the architectural level, with an extensive discussion of goals and objectives but with the few details of implementation. They also require substantial investments in infrastructure, especial1yfor data transmission from the customer site to the last node of energy distribution .if any transport options are proposed such as the use of dedicated lines, to modem, PLC, wire1ess links. Most of these projects include a "Smart meter" used for both the data collection and billing, that is can be distributed on1y by the energy distributor. we use symphony link technology (I0T) that is replaces the disadvantage of zigbee and Wi-Fi networks A pilot project deployed by a energy distributor required an investment of 10 MAC for the territory covered by a single primary distribution transformer (about 30 MVA).it is worth that is notes that deployed Smart metering networks are usual1y based on PLC links.

## VIII. CONCLUSION

Implementation and demonstration were made on customer domain of Smart grid, based on a platform for the I0Tthat can host a broad range of Smart home applications. Architectural concepts and system integration are found to be unique in this field, and in the prioritization of requirements. In this sense, proposed scheme has distinct advantages and elements of novelty on comparing with state of the art schemes: it is customer centric, it minimizes the deployment of specific Smart grid infrastructure, and it leverages possib1y available Smart home applications, sensors, and networks. We believe this is key for a widespread acceptance of Smart grid applications and equipment to be deployed at home.

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