IoT Baggage Tracker

A Minor Project Progress Report

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for the Degree of

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IN
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CERTIFICATE

This is to certify that the Mini Project-II Report entitled **“IoT Baggage Tracking”** **s**ubmitted by **DEVANG KHAMAR(13BEC023), DIVYANG GANDHI(13BEC028), PRASHANT GANDHI (13BEC029)** as the partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electronics & Communication Engineering, Institute of Technology, Nirma University is the record of work carried out by him/her under my supervision and guidance. The work submitted in our opinion has reached a level required for being accepted for the examination.

Date: 24/11/2016

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ABSTRACT

SITA, a leading Information technology MNC that provides IT & telecommunication services to air transport industry, reported in 2014 that the passenger count for air travel has risen by 65.6% in the last decade. At the same time the reports of mishandled baggage has cut down to half. Although this may seem like a great improvement, the actual number of lost baggage has risen and is still a cold experience for anyone at the arrivals, stuck at the airlines baggage desk reporting a problem. The same report also states that 81.2% of the mishandled bags were left behind or delayed, 15.5% were damaged & only 3.3% were stolen or lost.

Of the seven reasons SITA listed for why your bags may be delayed, transfer mishandling is number one at 45%. Failure to load comes in second at 16%. Ticketing errors, bag switch, security holds, and other factors account for 15% of all delayed bags worldwide. This problem has started to direct the attention of airlines & airport authorities and has been inviting new solutions & innovation.

Our motivation for this project lies in the concepts of Wireless Sensor Networks (WSN) & the Internet of Things (IoT). A wireless sensor network is a network consisting of a number of nodes laid out in either a random or structured fashion, for the purpose of sensing some physical quantity in their environment. In our case, the sensor & actuator is an antenna. The network 'senses' the presence of the nodes & hence allows us to locate them with reference to the layout of the network.

The Internet of things is an idea where devices can act & react with their surroundings. Every mundane electronic device that was not previously tethered to the internet, is now communicating to a multitude of different devices (either of the same kind or entirely different), to perform a task or action automatically.

We believe that be combining these two concepts we can help generate an optimal solution that allows companies (& by possible extension passengers) to track baggage precisely without having to use costly GPS/GSM modules and yet provide much better accuracy and also range than that offered by RFID tags. Our aim is to develop a wireless sensor network that would allow baggage tracking where it is critically (& almost only) required, inside the premises of an airport. We approach this issue by trying to implement a Local Positioning System (LPS) which would be monitored by a Network Master node that is connected to a PC or A single board computer (like Raspberry Pi or Beagle bone black) that would be connected to the airline database via the internet. This would allow Airlines to uniquely tag & locate the passenger's baggage& would possibly even provide data that could help the airline manage passenger traffic efficiently.

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CHAPTER 1

1.1 Introduction

Our project is based on the concepts of Wireless Sensor Networks (WSN) & Internet Of Things (IOT). Sensor networks are highly distributed networks of small, lightweight wireless nodes, deployed in large numbers to monitor the environment or system by the measurement of physical parameters such as temperature, pressure, or relative humidity. Building sensors has been made possible by the recent advances in micro-electro mechanical systems (MEMS) technology. Each node of the sensor network consists of three subsystems: the sensor subsystem which senses the environment, the processing subsystem which performs local computations on the sensed data, and the communication subsystem which is responsible for message exchange with neighboring sensor nodes. While individual sensors have limited sensing region, processing power, and energy, networking a large number of sensors gives rise to a robust, reliable, and accurate sensor network covering a wider region. The network is fault-tolerant because many nodes are sensing the same events. Further, the nodes cooperate and collaborate on their data, which leads to accurate sensing of events in the environment. The two most important operations in a sensor network are data dissemination, that is, the propagation of data/queries throughout the network, and data gathering, that is, the collection of observed data from the individual sensor nodes to a sink. Sensor nodes can be used in military, health, chemical processing, baggage tracking scenario and disaster relief scenarios.

According to the McKinsey report “Disruptive technologies: Advances that will transform life, business, and the global economy“, the Internet of things (IoT) is one of the top three technological advancements of the next decade (together with the mobile internet and the automation of knowledge work). The report goes on to say that “The Internet of Things is such a sweeping concept that it is a challenge to even imagine all the possible ways in which it will affect business, economies, and society.”

Definitions for the Internet of Things vary. According to McKinsey: “Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet.“ The idea is that not only your computer and your Smartphone can talk to each other, but also all the things around you. From connected homes and cities to connected cars and machines to devices that track an individual’s behavior and use the data collected for new kind of services.“The Internet of things will involve a massive build-out of connected devices and sensors woven into the fabric of our lives and businesses. Devices deeply embedded in public and private places will recognize us and adapt to our requirements for comfort, safety, streamlined commerce, entertainment, education, resource conservation, operational efficiency and persona well-being.”, according to Intel’s report “Rise of the Embedded Internet”.

1.2 Scope of the project

Millions of bags are mishandled by airlines each year, at a cost to the industry of hundreds of millions of dollars and upset customers. Some scenarios involving mishandling are bag is loaded onto the wrong plane, The attendant types in the wrong destination code, forget to pick up the luggage upon landing, the routing label gets damaged and many more. To reduce such scenario and to give customers more satisfaction about the service this smart baggage tracker can be very useful.

1.3 Objective of the project

Objective of this project is to create smart baggage tracking system. We want to create a network in which there will be fixed node which will capture the location of mobile nodes (Bags). The location of the mobile node will be shown on to the GUI and we will come to know about the mobile node (Bag). In this way we will track the bag.

CHAPTER 2

Hardware Sub-system

2.1 Wireless Sensor Network

Advances in the wireless networking, micro fabrication and integration, and embedded microprocessors have enabled a new generation of massive-scale sensor networks suitable for a range of commercial and military applications. Unlike current information services such as those on the Internet where information can easily get stale or be useless because it is too generic, sensor networks promise to couple end users directly to sensor measurements and provide information that is precisely localized in time and/or space, according to the user's needs or demands.

Wireless sensor networks have recently come into prominence because they hold the potential to revolutionize many segments of our economy and life, from environmental monitoring and conservation, to manufacturing and business asset management, to automation in the transportation and health-care industries. The design, implementation, and operation of a sensor network requires the confluence of many disciplines, including signal processing, networking and protocols, embedded systems, information management, and distributed algorithms. Such networks are often deployed in resource- constrained environments, for instance with battery operated nodes running untethered. These constraints dictate that sensor network problems are best approached in a holistic manner, by jointly considering the physical, networking, and application layers and making major design trade-offs across the layers. [3]

2.1.1 Key challenges for WSN

- Scalability of network protocols to large number of nodes
- Design of power-conserving protocols
- Design of data handling techniques including data querying, data mining, data
- fusion and data dissemination
- Localization techniques
- Time synchronization

- Development of exciting new applications that exploit the potential of WSN.

2.1.2 Properties of WSN

- Self-organization: The network should auto-detect newly arrived nodes or removed/stolen/broken nodes and adapt the tree to route messages accordingly. After the deployment, no human interaction should be required anymore during the network lifetime (limited by battery life).
- Scalability: Adding a huge number of nodes should still enable acceptable performance in terms of latency and packet drops.
- Latency: The network should forward messages towards the sink with limited latency. This is not the highest priority for our application though.
- Static/Mobile network: In present case, we are considering a WSN which has a static topology. However, as mentioned before, nodes may be added or removed at different time instants and the topology must adapt automatically.
- Size: Sensor nodes for environmental applications should be as small as possible to be discrete. Indeed, people might be tempted to steal them or to take them home by pure curiosity.
- Price: Since we have a large number of nodes and because our application is agriculture oriented, our nodes must be as cheap as possible. This is of course not the case at this level of research, because we are lacking economies of scale. However, we should keep in mind the financial constraint when choosing each components of the system.
- Robust to physical environment: Nodes must be robust to work long term in a potentially hostile environment: high humidity during monsoon, extreme heat during daytime, strong electromagnetic fields during thunder, sun rays, presence of animals and human curiosity all these aspects make it extremely difficult to provide a reliable system.
- Power consumption: One main challenge is to design low-power hardware components and to develop a software platform that minimizes power consumption. This can be achieved by limiting the time during which the radio chip and the microcontroller are turned on.
- Low data rate: For our application (sending of sensor data), we do not need high transmission rates. A few kbps will be sufficient. This also enables lower power consumption and lower bit error rate while transmitting.

2.2 MSP430

The MSP430™ 16-bit microcontroller platform of ultra-low power RISC mixed signal microprocessors from TI provides the ultimate solution for a wide range of low power and portable applications. TI provides robust design support for the MSP430 16-bit MCU including technical documents, training, tools, and software. Belonging to the world's lowest ultra-low power MCU family, a wide range of development tools has been developed customizable to the application in need.

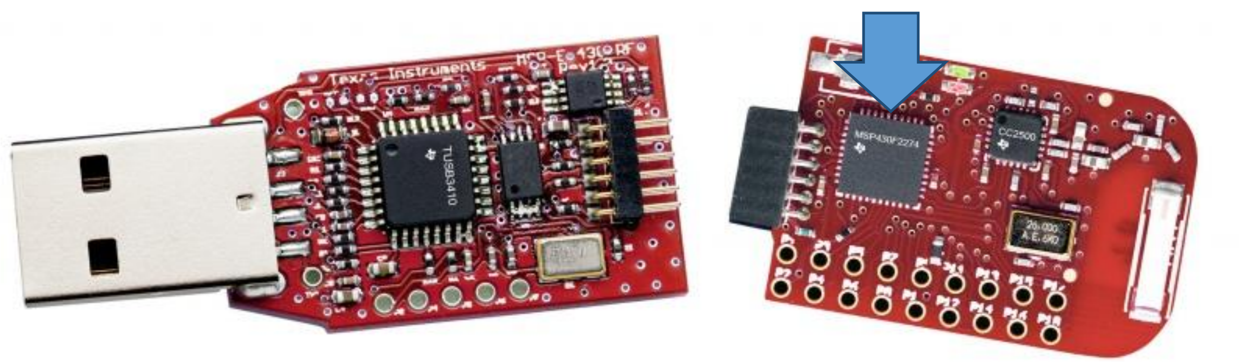

Figure 1 MSP430 Microcontroller (Shown by arrow)

2.3 Radio Chip CC2500

The **CC2500** is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kBaud. CC2500 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication and wake-on-radio. The main operating parameters and the 64-byte transmit/receive FIFOs of **CC2500** can be controlled via an SPI interface. In a typical system, the **CC2500**will be used together with a microcontroller and a few additional passive components. The range you get depends on factor such as output power, sensitivity, antenna gain and the environment in which you operate the radio.

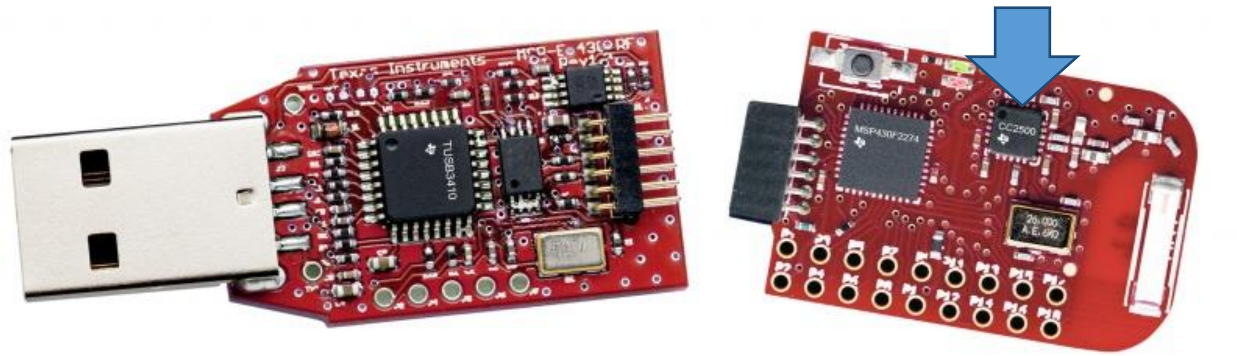

Figure 2 Radio Chip CC2500 (Shown by arrow)

2.4 Wireless Development Tool

The eZ430-RF2500 is a complete wireless development tool for the MSP430 and CC2500 that includes all the hardware and software required for developing an entire wireless project with the MSP430 in a convenient USB stick. The tool includes a USB-powered emulator to program and debug your application in-system and two2.4-GHz wireless target boards featuring the highly integrated MSP430F2274 ultralow- power MCU. The eZ430-RF2500 uses the MSP430F2274 which combines 16 MIPS performance with a 200-ksps 10-bit ADC and 2 op-amps and is paired withtheCC2500 multi-channel RF transceiver designed for low-power wireless applications.

2.5 Sensor Nodes

The eZ430-RF2500T is an additional wireless target board for the eZ430-RF2500 wireless development tool. The eZ430-RF2500T uses the MSP430F2274 which combines 16-MIPS performance with a 200-ksps 10-bit ADC and 2 op-amps and is paired with the CC2500 2.4 GHz multi-channel RF transceiver. A battery pack and 2 AAA batteries is also included.

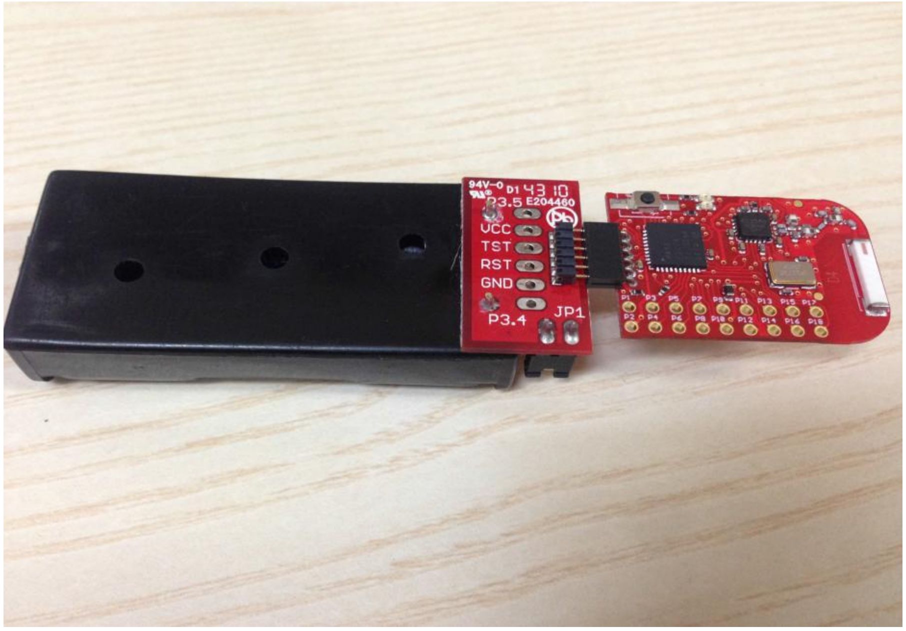

Figure 3. ez430-rf2500t front view

Figure 4. ez430-rf2500t back view

CHAPTER 3

Software Sub-System

3.1 IAR Embedded Workbench IDE

The IDE main window:

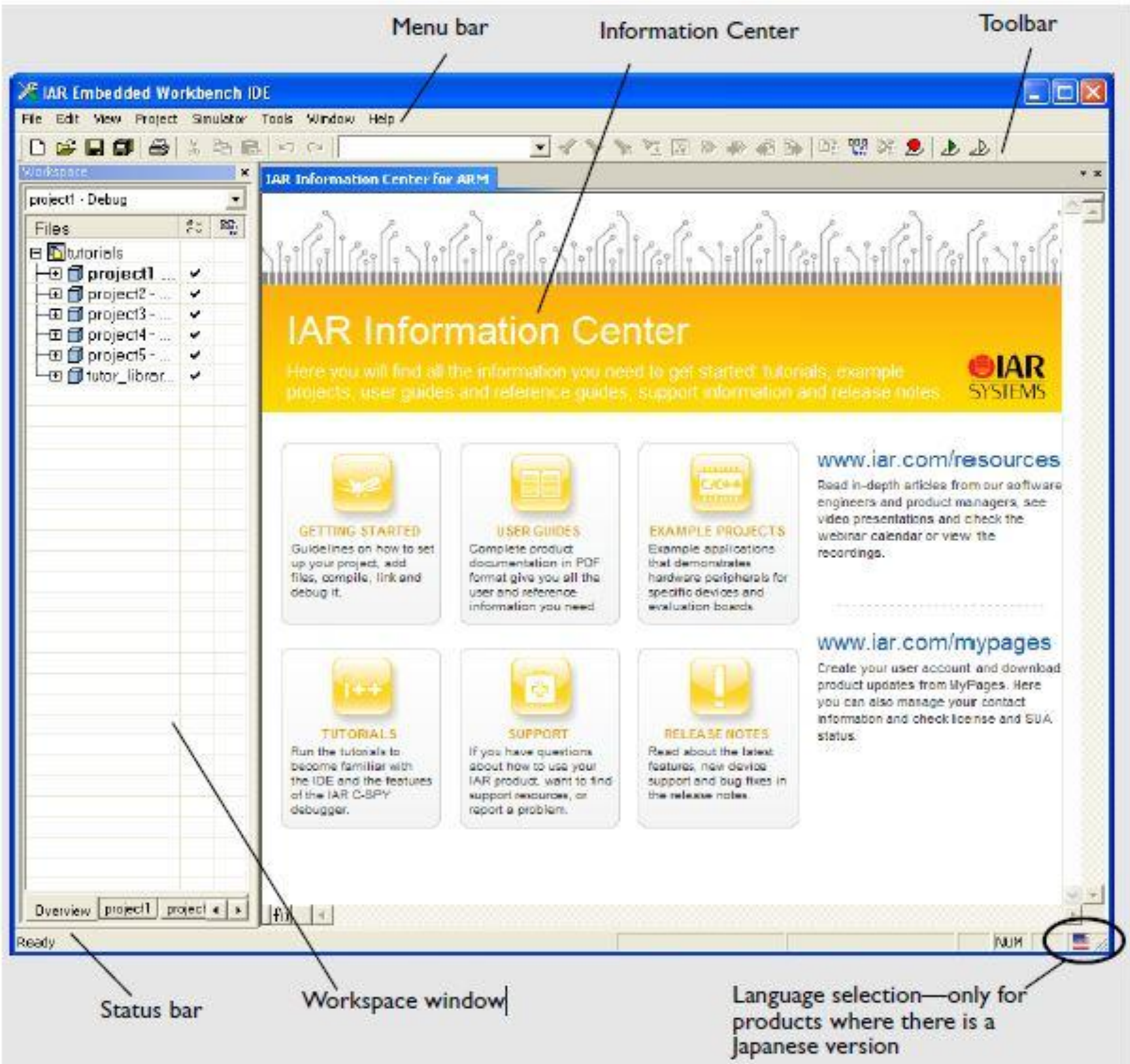

Figure 5. IDE main opening window

IAR C/C++ COMPILER

Programming languages

There are two high-level programming languages you can use with the IAR C/C++ Compiler:

● C, which follows the standard ISO 9899:1990 (commonly known as ANSI C).

● C++ (depends on your product package). IAR Systems supports two levels of the C++ language:

i. Embedded C++ (EC++), a subset of the C++ programming standard. It is defined by an industry consortium, the Embedded C++ Technical committee.

ii. IAR Extended Embedded C++, with additional features such as full template support, multiple inheritance (depending on your product package), namespace support, the new cast operators, as well as the Standard Template Library (STL).

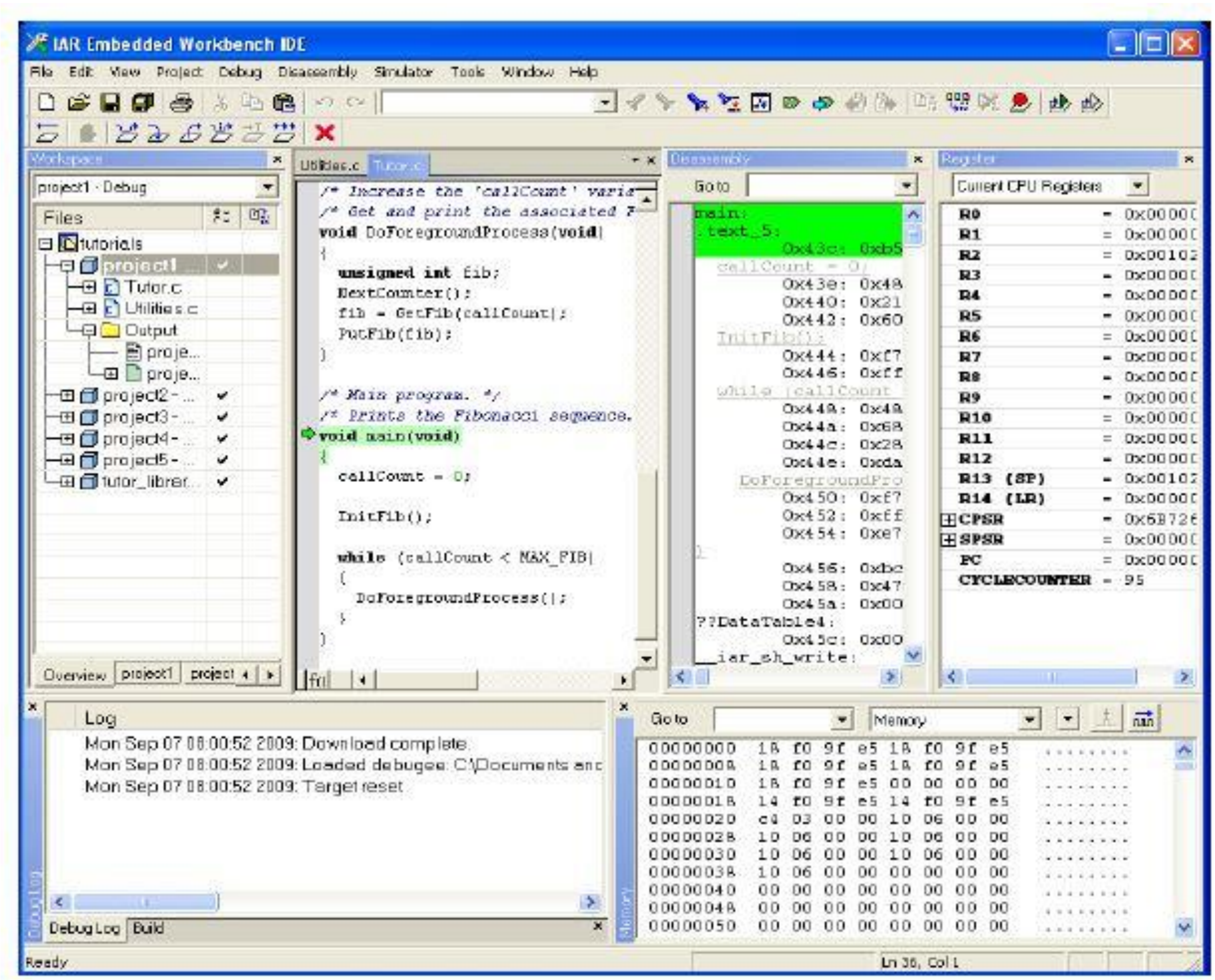

Figure 6. The IDE C-SPY Debugger

3.2 JAVA

Firstly, we created an html file to display the location of our target or baggage. We ran the html file on a local server and for that we used 'apache tomcat server'. For backend coding, we use Java and JavaScript (.jsp) files. Java file was used for implementing an algorithm to fetch data from the computer’s COM port and a JavaScript file used to utilize the data received form the COM port into a Graphical User Interface (GUI).

Here, in our project java files are 'Sample.java' and JavaScript files are 'blink.jsp' which shows the location of baggage. In the coding part, we first created the ‘gui.html’ html file to show baggage location then we create 'Sample.java' Java file to implement the logic part. Then we create 'blink.jsp' JavaScript file to connect the html part and logic part. To run the whole process on server, we use 'Apache Tomcat 8.0' server. We use Eclipse IDE to run the html file, JavaScript and Java file.

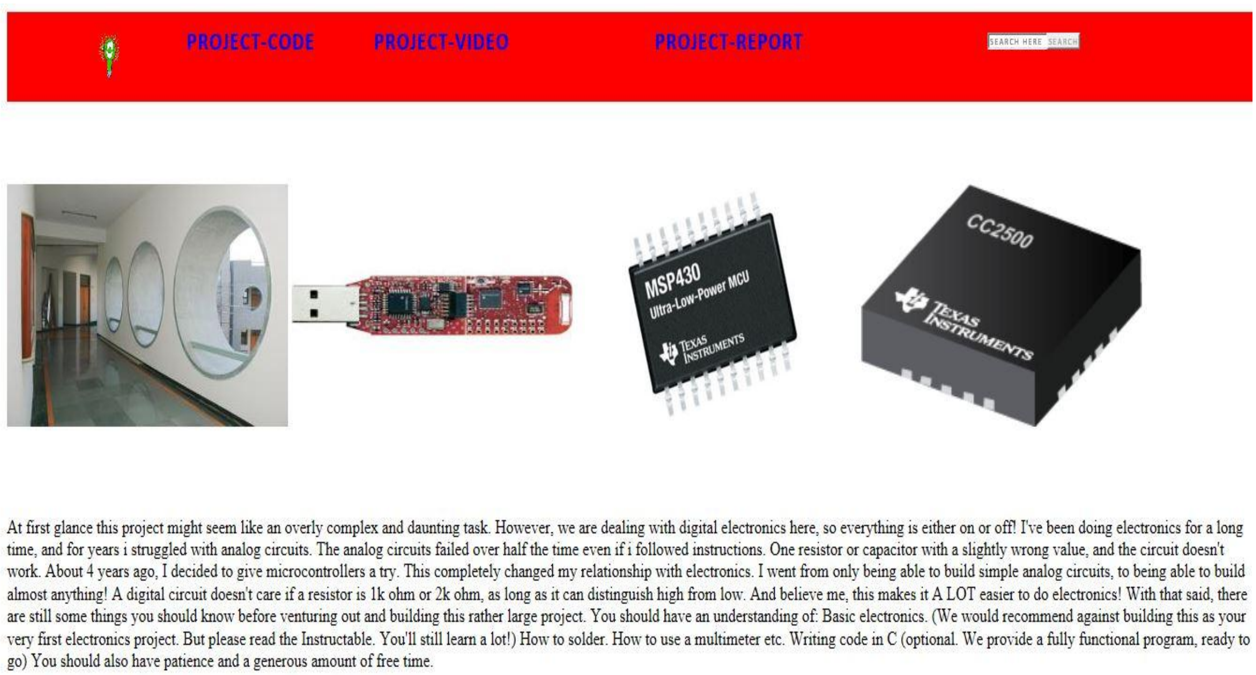

Figure 7 Graphical User Interface home page

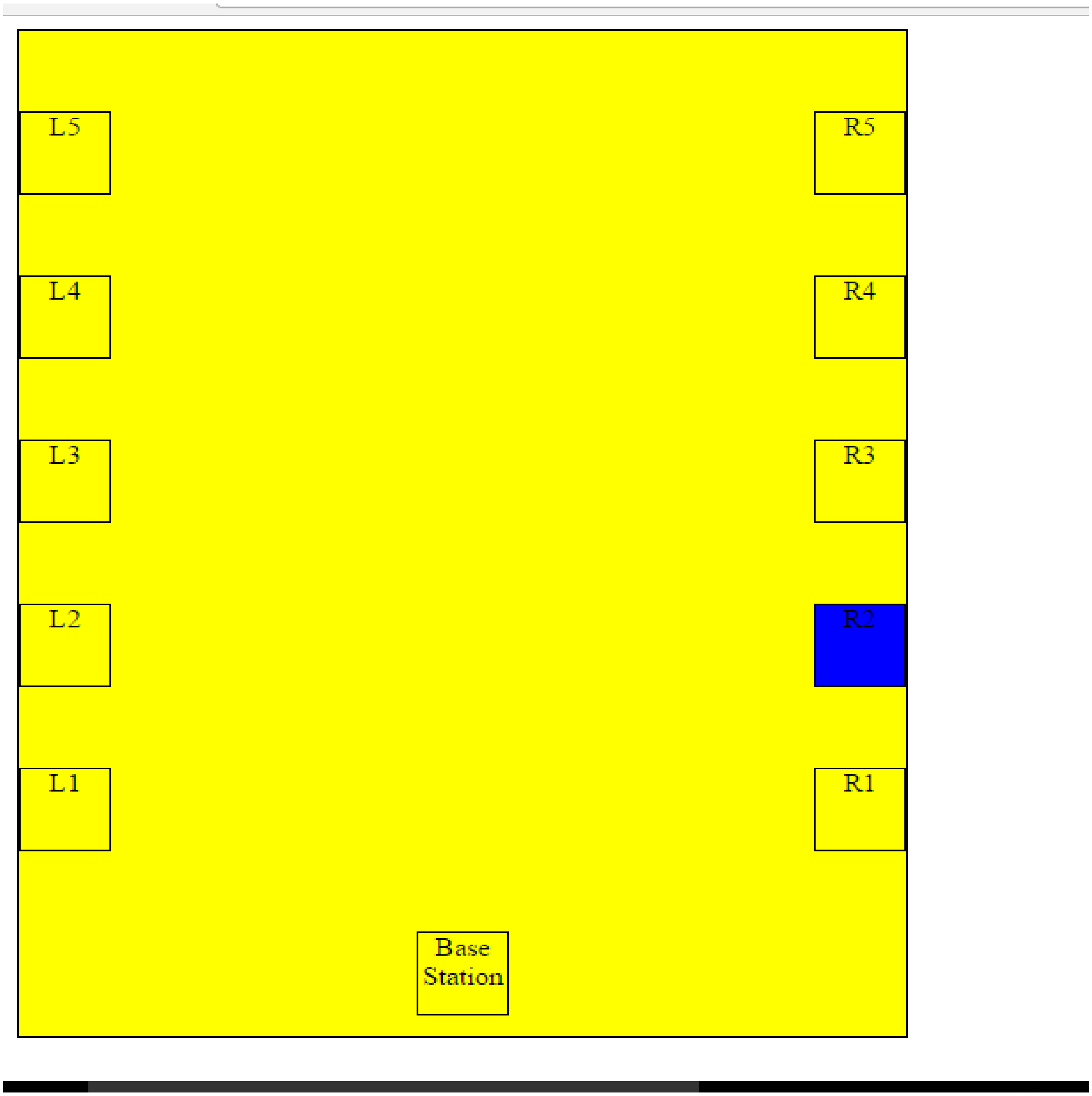

Figure 8 Layout

Chapter 4

Overall Set-up

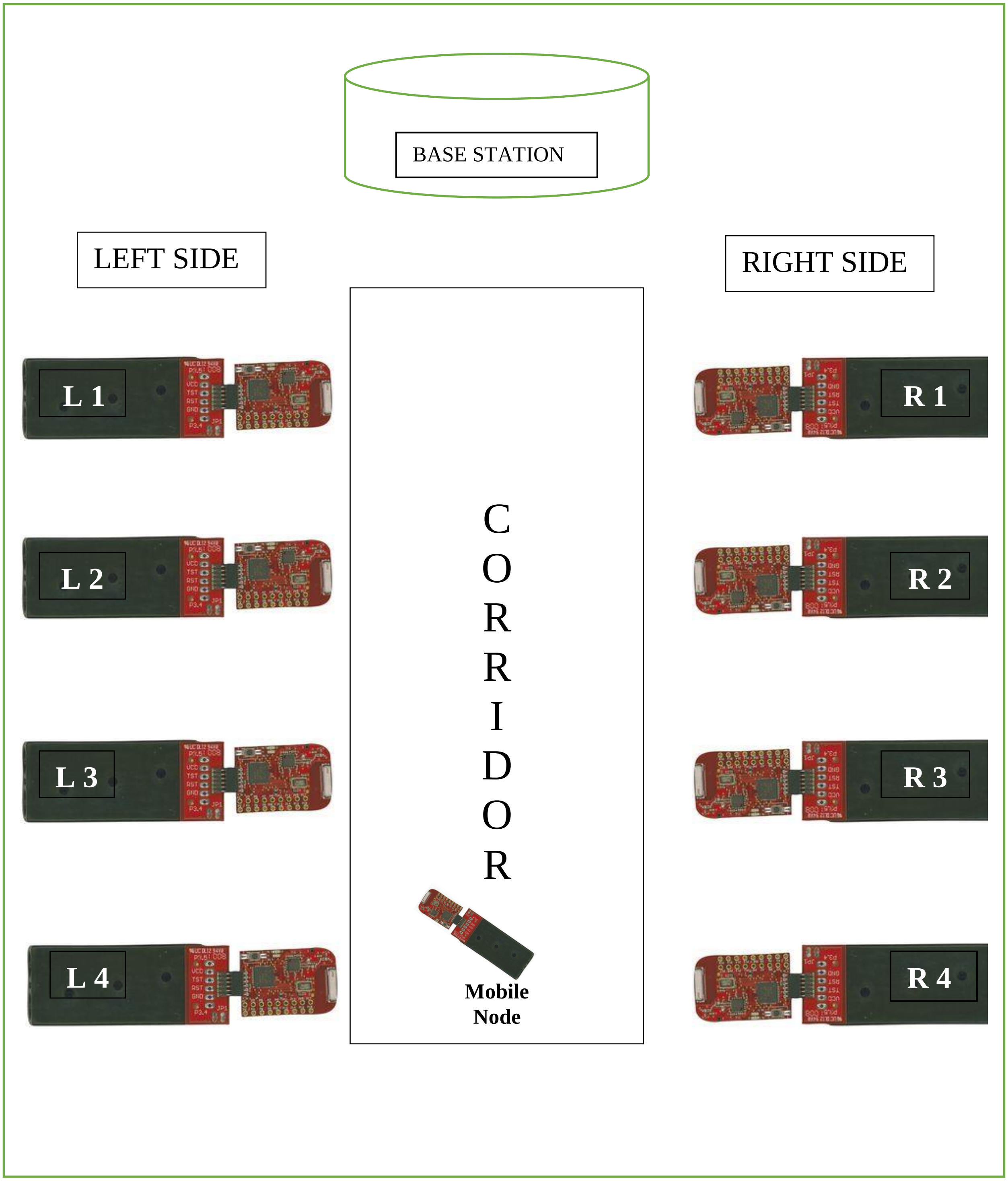

Figure 9. Over all set-up

As shown in figure 7 nodes L1 to L4 and R1 to R4 are fixed in corridor. There is one mobile node which will move in corridor. This mobile node will transmit signal at every 500ms. This signal will be captured by the fixed near to this mobile node. This fixed node then generate new packet which will consist its address and then transmit this packet towards the base station. Through multi hopping we come to know that where our mobile node is and this way we can track this node. Here as a base station we have created GUI using Wampserver. As soon as base station node receive the signal it process and come to know about mobile node and write that fixed node number near to which this mobile node is found into notepad and then GUI process this notepad file and show as graphically on the laptop screen.

Table 1. Node no according to that side

Node Serial No.	Side	Level
0x27	BS	BS
0x20	M	M
0x29	L	1
0x24	L	2
0x30	L	3
0x23	L	4
0x10*	L	5
0x28	R	1
0x35	R	2
0x77	R	3
0x79	R	4
0x04*	R	5

*extra nodes for reducing transmission power; used in actual implementation but can operate with only four nodes per side

Chapter 5

Result

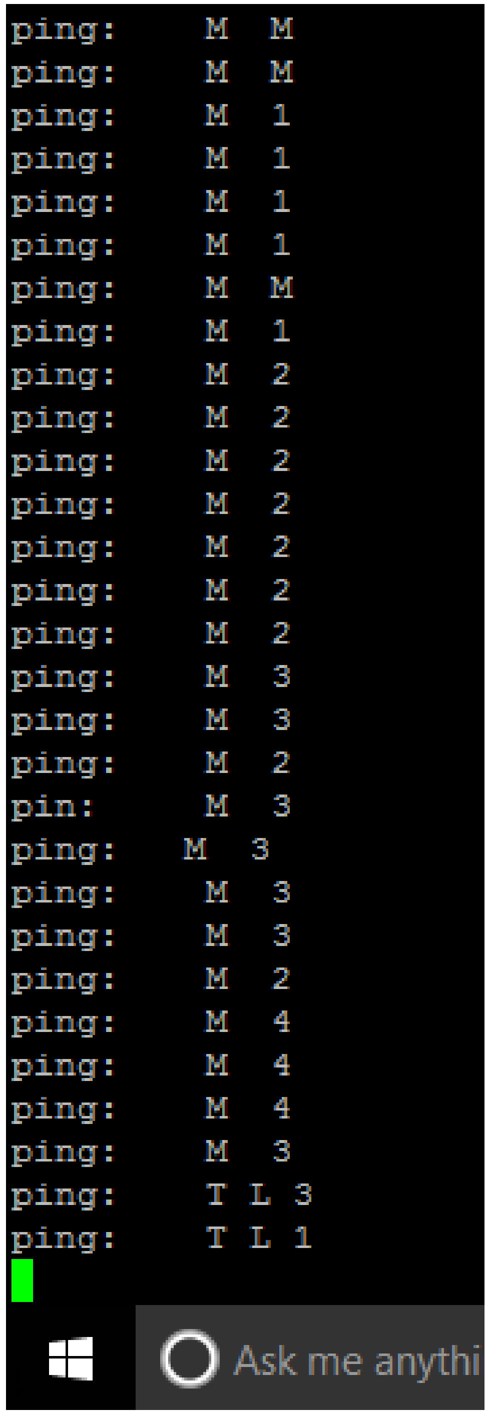

Figure 10 Result

We were successfully able to track the mobile node's position. We have used the USB programmer/Debugger to relay information in the form of a string to the computer. The string was then displayed on an application called putty. The String stated which node had sent a "ping" packet to the base station. The 'M' designates that the cause of transmission was the detection of the mobile node by that node. 'T' designates a test packet that is sent by the nodes in response to an external interrupt, triggered by a button press on the nodes. The 'L' in the test packet string designates the side i.e. left ('L') or right ('R'), from which the test packet was sent, along with the node level.

The network nodes which were responsible for sensing the mobile node's presence were programmed at a transmission power of -12dBm & the mobile node was programmed with a transmission power of -24dBm. The whole network operated on 2.4GHz centre frequency & utilized binary frequency shift keying (BFSK) modulation.

Conclusion

We have obtained a proof of concept that such indoor package tracking is possible. The network consisting of various Texas Instruments ez430-RF2500t nodes can track a baggage in any closed space with no requirement of GPS services. This network would have to be suitably configured to the target area where it is to be deployed. The topology of the network is hence entirely dependent on target area. The only way around this would be to develop a self-configuring network which could be deployed in a pseudo random manner. It would have a initial setup phase wherein it would setup various parameters such as the location of various nodes in the network and optimal transmission power.

The main hindrance we faced was in being unable to account for the multiple reflections that the nodes were receiving. We eventually sorted this out by increasing number of nodes deployed, and reducing the transmission power of the stationery network nodes. We tried to implement stop-and-go automatic repeat request assuming, that the transmitted packets were being lost due to continuous variations in the channel i.e. varying densities of people obstructing the nodes, but we realized that this wasn't the issue. In fact by introducing a need for acknowledgement, the network faced increased delays & at times came to a standstill when one of the nodes missed out on acknowledgements.

This project has immense scope in detecting locations of targets in an indoor environment, and can be further extended by increasing the number of base stations & hence networks for monitoring different floors or levels. Data can then be either sent by base stations to a central server which can process this data & display the location of various mobile nodes, and hence targets, at different locations in the premises.

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