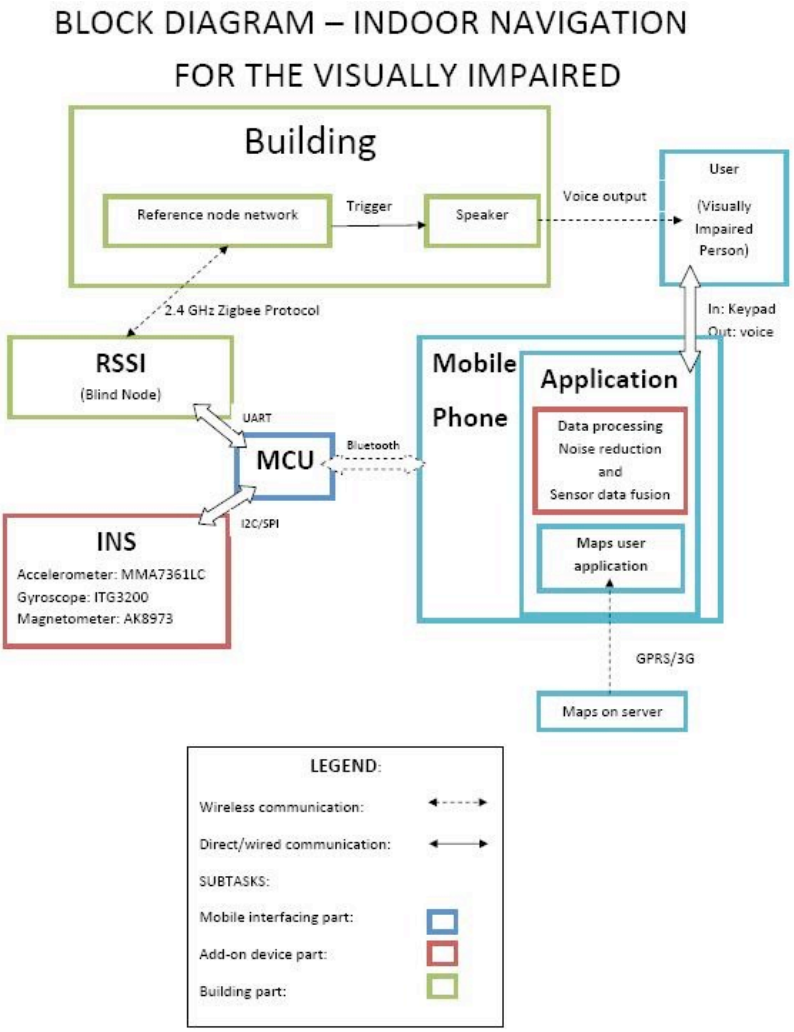
CSP 315 PROJECT REPORT PART I

Indoor Navigation System for Visually Impaired



Anant Jain(2008EE10330), Mridu Atray (2008CS50217)
Manas Paldhe(2008PH10623), Himanshu Gupta (2008EE10342)

Indian Institute of Technology
Hauz Khas, New Delhi - 110016

SPECIFICATIONS

The user experience:

•One of the aims of the project has been to keep the cost of user module low - within $100.

•Upon entering a building, the user module triggers a request for downloading the map for the place.

•Next, the user's mobile reads out the various options that the user has for the particular building, as well as allows the user to do a custom search if he knows where to go.

•Commonly used utilities like lifts/ staircases, restrooms etc. have pre-defined hot keys for all buildings.

•Once the destination is determined, the user gets turn by turn directions to the destination. If the user misses something and takes a wrong path, the system is able to detect the same, let the user know and accordingly guide him/her.

•Also, when the user is very close to the destination, he/she can trigger small buzzers near the door of the room to get the exact location. These buzzers are triggered by the Zigbee sensor network, which is also used in localizing the user, alongwith the Inertial Measurement Unit.

Mobile Application Development:

Mobile Application Part: Designing an application for cheap mobile phones (and hence Symbian OS based) phones to process the data received from the user device on the map, and act as an interface for the user:

•Selecting and using a BT modem to exchange data between mobile with the MCU.
•Voice output and keypad input.
•Loading data from web; and hosting the same on a server
•Looking into the division of processing power between MCU and mobile.
•Running algorithms for processing sensor data on mobile if needed.
•Development of the app on PyS60.

GUI based application: Designing an application to convert an image map to our .map format

•Specify the Data structure for storing maps
•Select the platform for GUI (web based (Ajax etc.) or desktop based)
•Feature detection algorithms from the image (SIFT etc.)
•GUI Development

User Device Development Part:

Hardware part: Designing a custom board carrying the IMU(inertial measurement unit), micro-controller and bluetooth module. This includes:

• Selecting the components(bluetooth to be looked into by Anant/Mridu).
• Procuring the components.
• Designing the PCB, getting it fabricated.

• Getting the components soldered on the PCB
• Testing the PCB and do any iteration that it may require.

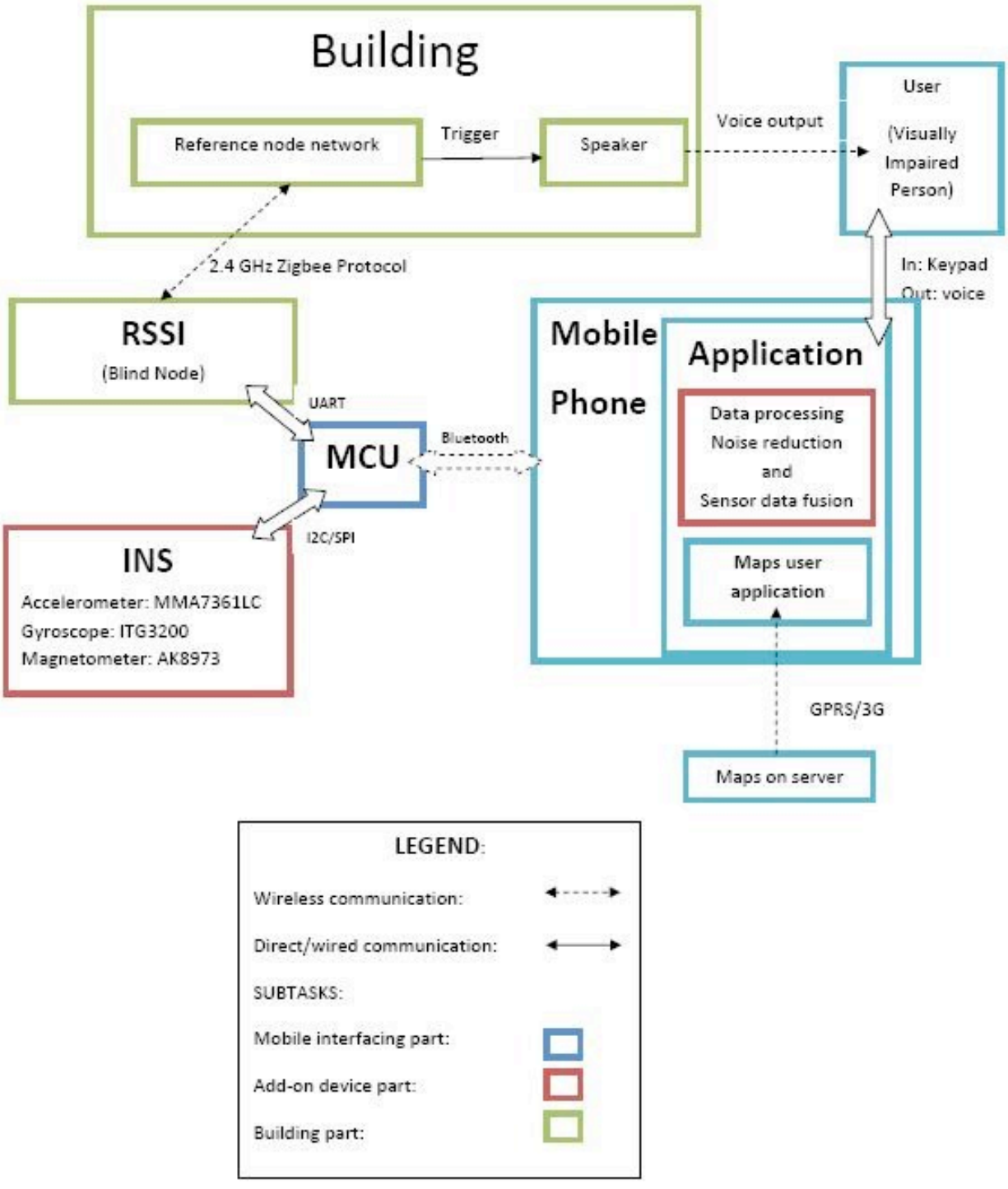
Software part: Developing and testing the algorithms to fuse, refine and interpret the data of inertial sensors and integration of RSSI and INS. This includes:
• Developing the algorithm in matlab to convert the data of inertial sensors into heading and position of user wrt a defined origin
• Implementing Kalman filter to fuse the data of inertial sensors.
• Testing and refining these algorithms to find the position(also figuring out if INS can work standalone to track position)
• Developing the algorithm(if needed) to integrate RSSI and INS in matlab
• Testing the algorithm and refining it
• Converting all the code into C
• Test the entire code on the hardware designed and refine it to work in real time.

ZigBee nodes and buzzers Development Part:

Hardware part:
•Designing an RS232 to TTL converter PCB
•Make the converter and check it
•Test the algorithms using this converter setting blind node,ref. nodes,location Dongle.
•Designing the PCB (if required for buzzers)
•Testing the buzzers

Software part:
•Developing and testing the algorithms to get coordinates from RSSI values:
•Study and change the codes of ref.node ,blind node, location engine to get corrected distance
•Study the code and find out a way to trigger the buzzers using same nodes
•Test the algorithms on the hardware designed and refine it to work in real time.

BLOCK DIAGRAM – INDOOR NAVIGATION FOR THE VISUALLY IMPAIRED



METHODOLOGY

The building enabled for the device shall be equipped with a wireless network of Zigbee nodes. The user device consists of another Zigbee node alongwith an Inertial Measurement Unit (consisting of an accelerometer, gyroscope and compass.) Using the signal strength from various sensor networks and the Inertial Measurement Unit, the user can be localized. The user module is interfaced to the user's mobile over a Bluetooth link, and the user's mobile serves as the interface to the user, giving voice output and taking input through the numeric keypad. The maps for various buildings are stored on a web server which can be downloaded over GPRS to the user's mobile when the user enters a building. Also, these buildings will have small buzzers/ speakers installed near the doors of rooms/places, which can be triggered by the specific user who enquiries for it, upon reaching there.

MAJOR COMPONENTS/ BLOCKS/ KITS TO BE USED

Mobile Development part:

1.Mobile: A loaner Nokia N73 running Symbian OS 3.0 available with Anant and is being used for the project.

2. Bluetooth Modem - to be procured from SparkFun

User Device Development part:

1.Accelerometer :MMA7361LC
2.Magnetometer :AK8973
3.Gyroscope : ITG3200
4.Microcontroller : ARM7
5.Some support components

For now, we are using the IMU Data Logger available in the lab (consisting of the above Accelerometer, Magnetometera and Gyroscope) to test out our algorithms.

ZigBee nodes and Buzzer System Development Part:

1.ZigBee Development Kit CC2431 DK(available but not completely working)
2.MAX3232 and MAX232(available)
3.3.3. to 5 V converter(available)
4.Some support components

MAJOR TASKS

Mobile application and maps application development (Anant, Mridu):

I. Application for Symbian OS:
   - Accessing SPP on BT and interfacing with the MCU
   - Voice output and keypad input
   - Loading data from web; and hosting the same on a server
   - Running functions f and g on mobile if needed.

II. GUI Application for converting image to .map format
   - Specify the Data structure for storing maps
   - Select the platform for GUI (web based (Ajax etc.) or desktop based)
   - Feature detection algorithms from the image (SIFT etc.)
   - GUI Development

III. Division of processing burden between mobile and MCU

User device development (Manas, Himanshu):

I. f(acc_data, gyro_data, compass_data) -> (x,y,orientation). Give f.
   - Given data, find error vs time graph for INS
   - Determine feasibility using the INS error vs time graph and integrate with RSSI.
   - Capture data from custom components into the MCU

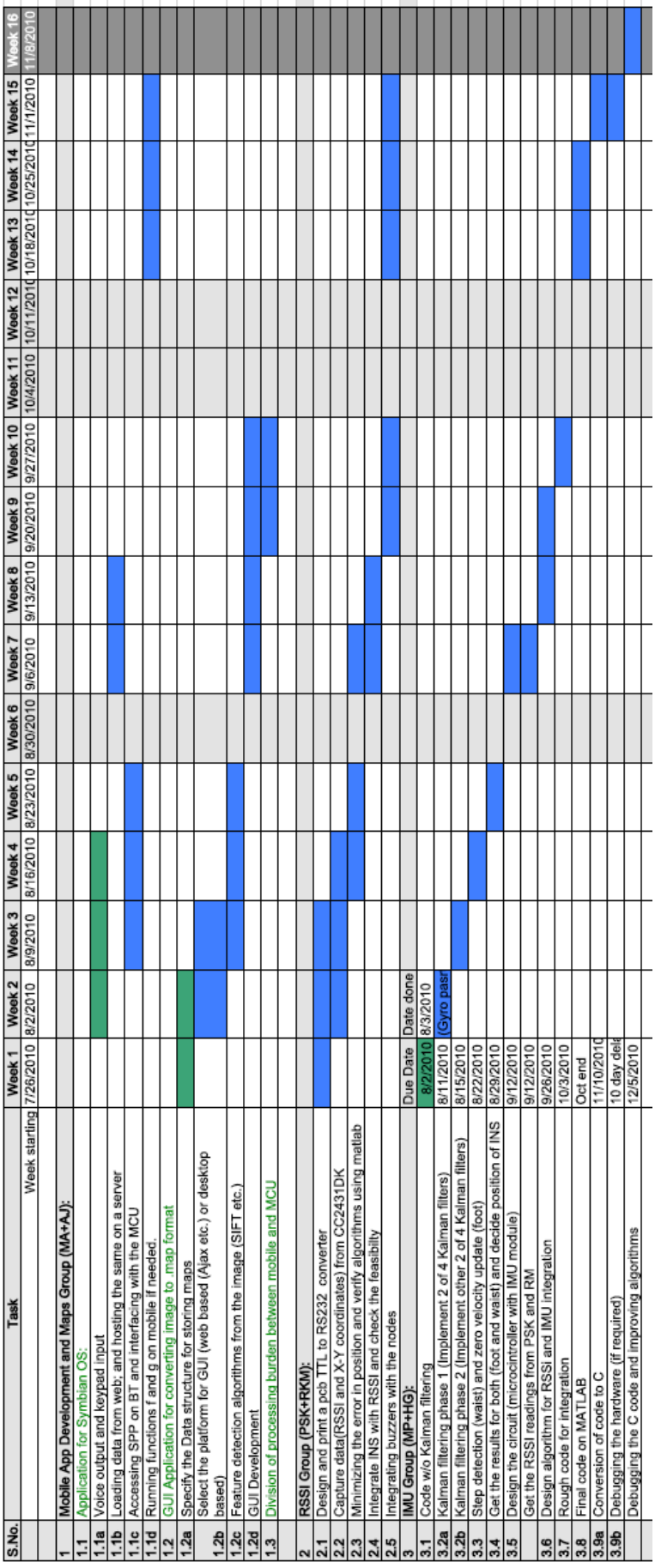
II. User device hardware development:
   - Making PCB for:
     - MCU
     - Acc+Gyro+Compass
     - RSSI unit
     - Bluetooth
   - Printing, soldering and verifying the user module PCB

Building device(s) development (Ravi, Prateek - Left the project !):

I. g(RSSI(i)) -> (x,y). Give g.
   - Capture data through CC2431DK BB to the MCU
   - Minimize error in RSSI using this data.
   - Determine feasibility using the RSSI error vs time graph and integrate with INS

II. Integrating buzzers with the RSSI nodes
   - Protocol for triggering a specific buzzer

GANTT CHART



S.No.	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
	Week starting	7/26/2010	8/2/2010	8/9/2010	8/16/2010	8/23/2010	8/30/2010	9/6/2010	9/13/2010	9/20/2010	9/27/2010	10/4/2010	10/11/2010	10/18/2010	10/25/2010	11/1/2010	11/8/2010
1	**Mobile App Development and Maps Group (MA+AJ):**																
1.1	Application for Symbian OS:																
1.1a	Voice output and keypad input																
1.1b	Loading data from web; and hosting the same on a server																
1.1c	Accessing SPP on BT and interfacing with the MCU																
1.1d	Running functions f and g on mobile if needed.																
1.2	GUI Application for converting image to .map format																
1.2a	Specify the Data structure for storing maps																
1.2b	Select the platform for GUI (web based (Ajax etc.) or desktop based)																
1.2c	Feature detection algorithms from the image (SIFT etc.)																
1.2d	GUI Development																
1.3	Division of processing burden between mobile and MCU																
2	**RSSI Group (PSK+RKM):**																
2.1	Design and print a pcb TTL to RS232 converter																
2.2	Capture data(RSSI and X-Y coordinates) from CC2431DK																
2.3	Minimizing the error in position and verify algorithms using matlab																
2.4	Integrate INS with RSSI and check the feasibility																
2.5	Integrating buzzers with the nodes																
3	**IMU Group (MP+HG):**	Due Date	Date done														
3.1	Code w/o Kalman filtering	8/2/2010	8/3/2010														
3.2a	Kalman filtering phase 1 (Implement 2 of 4 Kalman filters)	8/11/2010	(Gyro pasr														
3.2b	Kalman filtering phase 2 (Implement other 2 of 4 Kalman filters)	8/15/2010															
3.3	Step detection (waist) and zero velocity update (foot)	8/22/2010															
3.4	Get the results for both (foot and waist) and decide position of INS	8/29/2010															
3.5	Design the circuit (microcontroller with IMU module)	9/12/2010															
	Get the RSSI readings from PSK and RM	9/12/2010															
3.6	Design algorithm for RSSI and IMU integration	9/26/2010															
3.7	Rough code for integration	10/3/2010															
3.8	Final code on MATLAB	Oct end															
3.9a	Conversion of code to C	11/10/2010															
3.9b	Debugging the hardware (if required)	10 day dela															
	Debugging the C code and improving algorithms	12/5/2010															

WEB LINK

http://sites.google.com/site/ins4vi

As requested, the site has been kept in the private domain, with TAs, students and mentors given access to view and edit the site.