Indoor Navigation System for the Visually Impaired

Introductory presentation

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Concept

- 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.
- 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 wireless network.
- Commonly used utilities like lifts/ staircases, restrooms etc. have pre-defined hot keys for all buildings.
- Low cost - within ₹4000

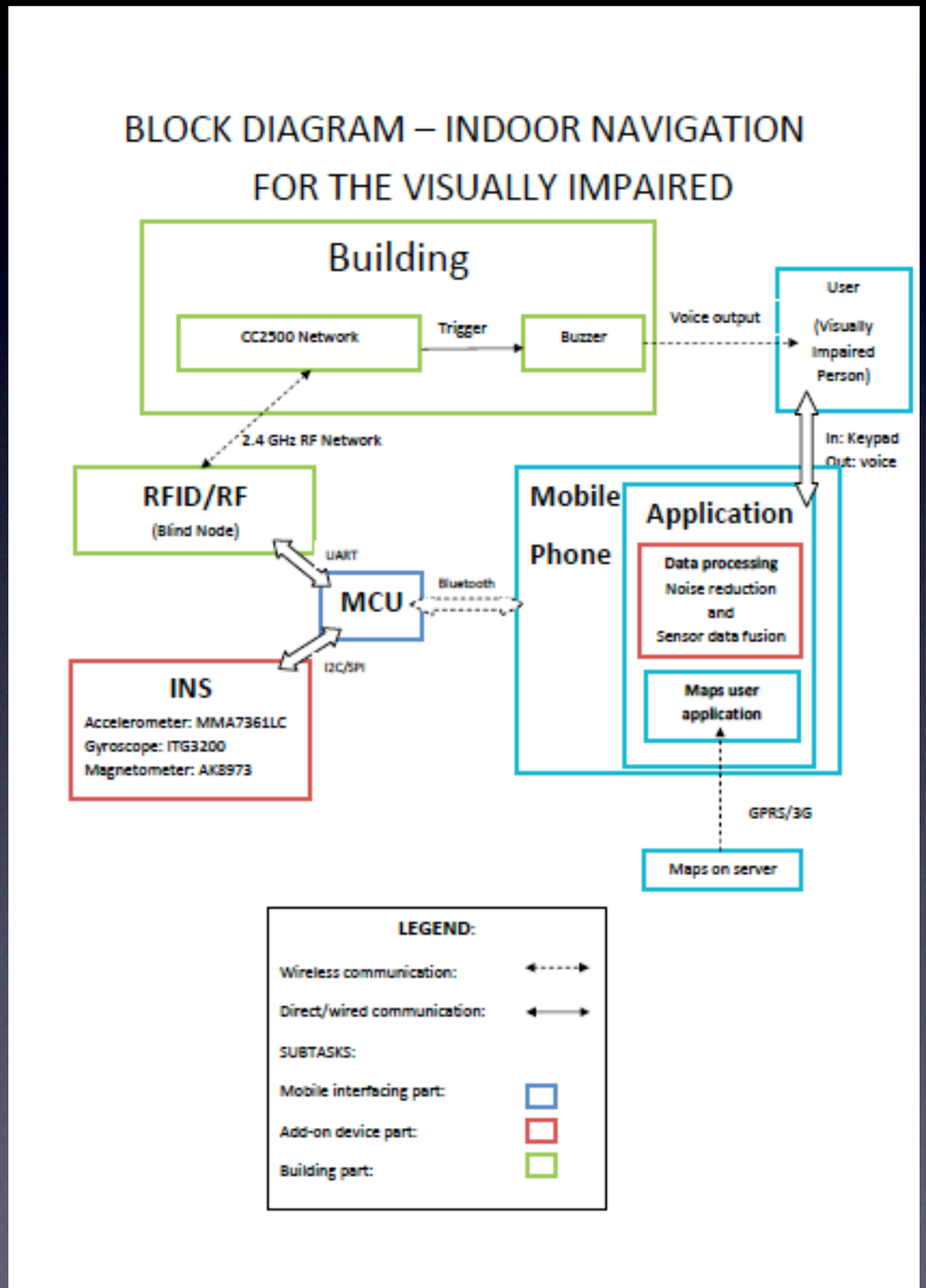
Introduction

- Possible indoor localization systems:
  - GSM
  - GPS
  - RFID
  - Ultrasonic
  - RSSI
  - IMU

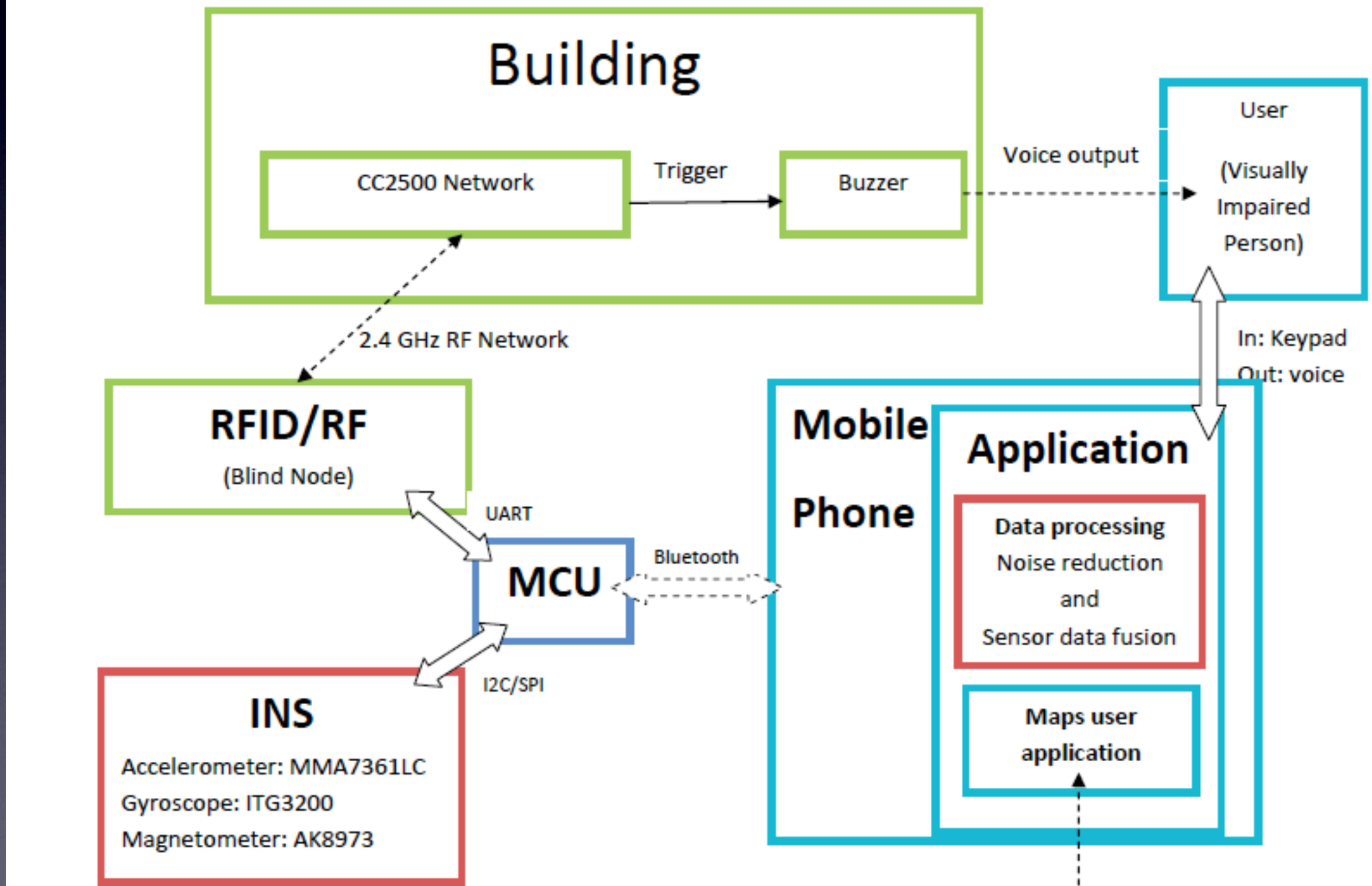
Solution

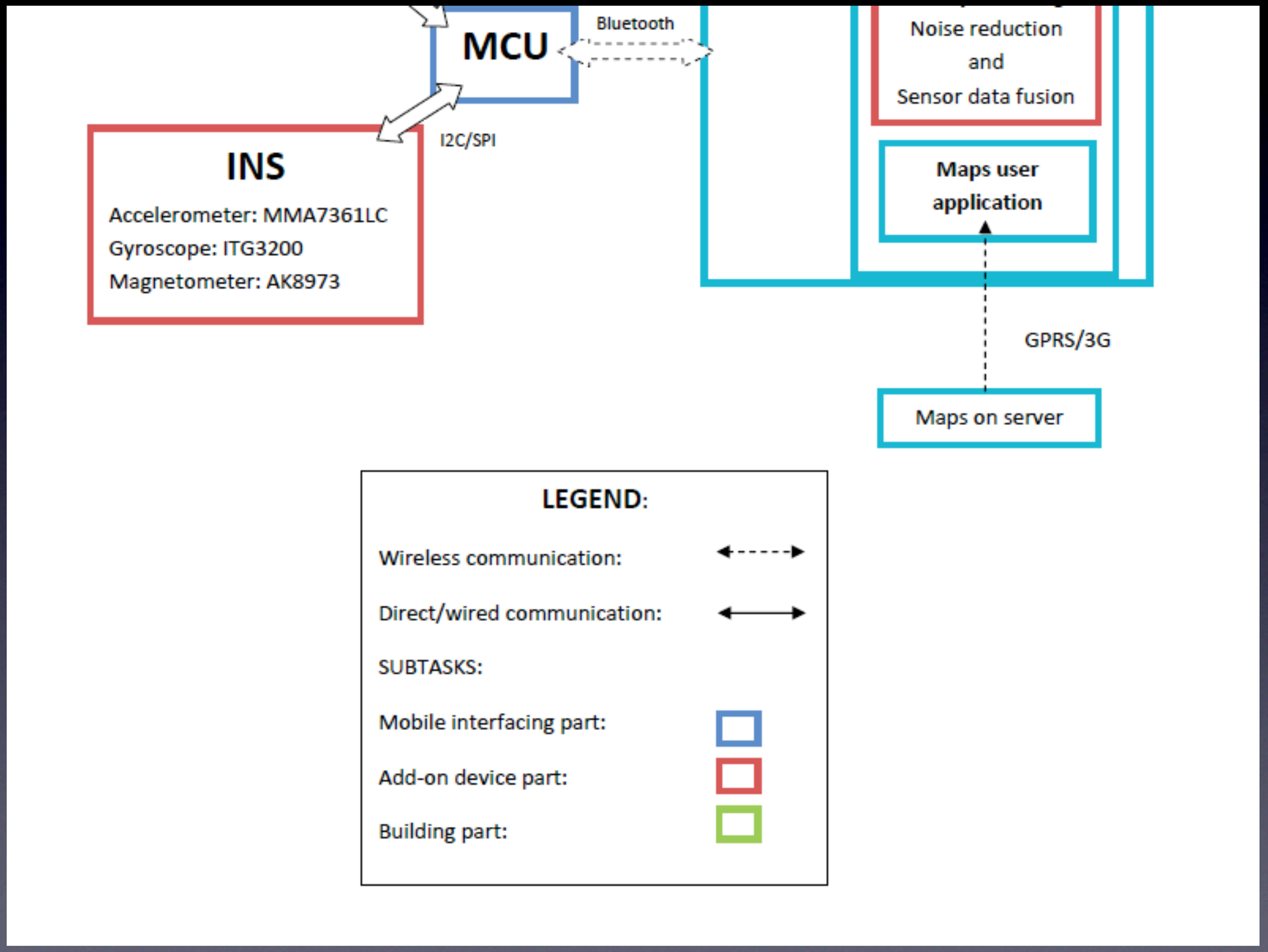
- The user device consists of an Inertial Measurement Unit (consisting of an accelerometer, gyroscope and compass.) and a Bluetooth capability.
- We shall attempt to localize the user through the Inertial Measurement Unit, used in conjunction with map of the building.
- The user module is interfaced 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.

Block Diagram



BLOCK DIAGRAM – INDOOR NAVIGATION FOR THE VISUALLY IMPAIRED




MCU
Bluetooth
I2C/SPI
INS
Accelerometer: MMA7361LC
Gyroscope: ITG3200
Magnetometer: AK8973
Noise reduction
and
Sensor data fusion
Maps user application
GPRS/3G
Maps on server
LEGEND:
Wireless communication:
Direct/wired communication:
SUBTASKS:
Mobile interfacing part:
Add-on device part:
Building part:

Components/ Kits to be used/ ordered

Mobile App development part:

1.Mobile: A loaner Nokia N73 running Symbian OS 3.0 available 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.

Major Tasks:

User device development:

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

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

Mobile application and maps application development:

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

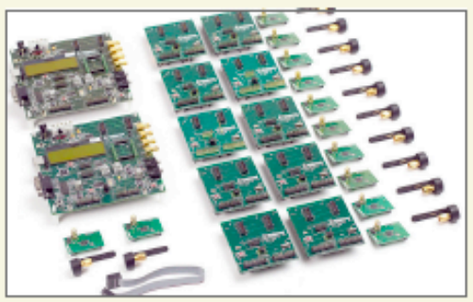
Gantt Chart

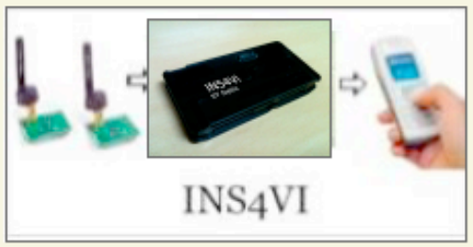
S.No.	Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
	Week starting	7/26/2010	8/2/2010	8/9/2010	8/16/2010	8/23/2010	8/30/2010	9/6/2010	9/13/2010	9/20/2010	9/27/2010	10/4/2010	########	########	########	11/1/2010	11/8/2010
1	**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	**IMU Group (MP+HG):**																
2.1	Hardware																
2.1a	Component selection																
2.1b	Schematic																
2.1c	PCB																
2.1d	Ordering																
2.1e	Soldering																
2.1f	Debugging and new version																
2.1g	New order and soldering																
2.1h	Getting data from the sensors																
2.2	Software																
2.2a	Filtering																
2.2b	Foot mounting and data collection																
2.2c	Step detection in case of foot																
2.2d	Kalman filtering and position correction using foot																
2.2e	Matlab code- complete																
2.2f	Matlab to C conversion(functions)																
2.2g	Improvements																
2.2h	Matlab to C conversion(intelligence part)																

Collaboration

- Prof. Vinay Joseph Ribeiro is looking for students to work on the INS system he is developing for Marvell Technology Group Ltd.
- If possible we'll collaborate with them, as they are willing to provide industry standard hardware design.
- INS based localization is still an area of

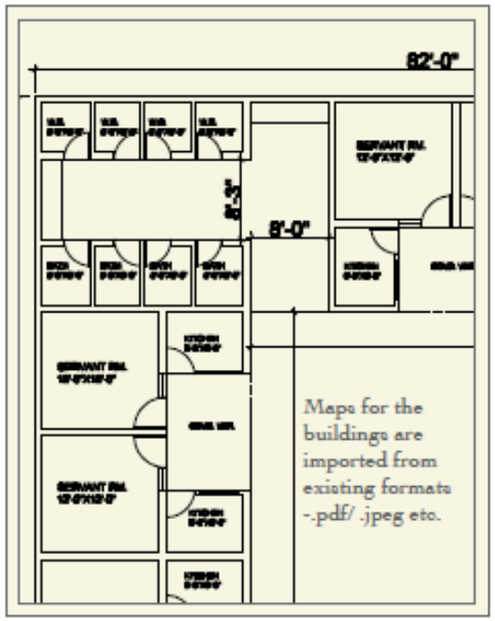
Brochure





Prototype development so far

We have been using Texas Instruments' CC2431DK platform to serve as the wireless node network for simulation and testing purposes. Since it's an open platform, migrating to custom board using CC2431 chip is feasible. To keep the user device highly compatible with most of the mobile phones in the market - specially the non-smart phones, we have been developing the user application for Symbian OS, the most common OS for mobiles. Moreover, the Inertial Measurement Unit's data is currently being analyzed so that exact information about the user's movement can be most meaningfully interpreted from it.



Contact us

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INS4VI

Indoor Navigation System for the Visually Impaired

INS4VI is a low-cost, portable, self contained system that will allow the visually impaired individuals travel through unfamiliar indoor environments without the assistance of guides.

Deptt. of Computer Science and Engg. and Deptt of Electrical Engg.

IIT Delhi

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.

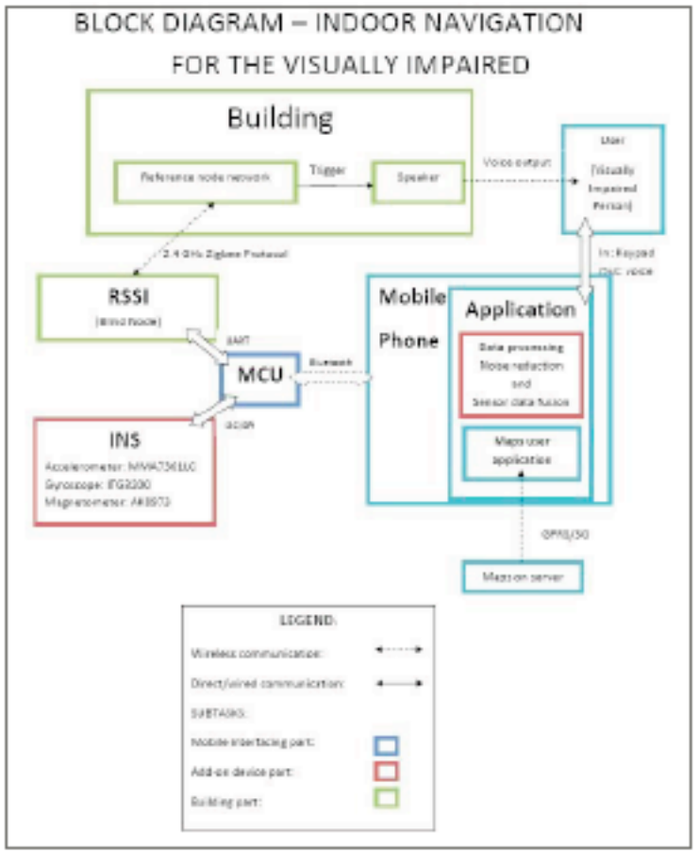
The concept:

Challenges faced by the visually impaired

A visually impaired person faces the problem of knowing the directions to various places he/ she might want to go to in an indoor building - for instance, a room number in a hotel, or a particular shop in a mall, or say finding the correct gate at an airport. Moreover, it is possible that they might wish to know where they are while navigating to their desired location - how far it is, and if they are still travelling the correct route. These problems make the presence of a guide essential, and our project aims at making a visually impaired person completely self-dependent for carrying out these tasks with the help of a user module and his/her mobile phone.

Technology to be used

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. The block diagram is as shown below:



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.