DM – 1000SE

by

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A SENIOR THESIS PROPOSAL

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The accompanying Senior Thesis Proposal, “DM – 1000SE,” is submitted in accordance with the requirements of CEEN 4980, Senior Thesis Proposal. This project is a personal undertaking and as such all funding will be provided by the members of the team.

Respectfully yours,

Quinn Smith

Jonathan Vonk

Brian Walker
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I. **BACKGROUND**

Global Position System (GPS) allows the quick and accurate determination of exact location anywhere on the planet. Using a series of synchronous orbit satellites, a GPS receiver can calculate its latitude, longitude, elevation, and time to an accuracy of better than 3 meters and 200 nanoseconds. However, the correlation between latitude and longitude and actual position remains difficult to determine.
II. THESIS OVERVIEW

This project will correlate the latitude and longitude coordinates from a GPS antenna to correlate position on an aerial photograph. The user’s position will then be displayed on the map using a PDA.

This project will consist of two units that will be interfaced for full functionality. The first device is the GPS unit. The GPS unit will contain a GPS antenna and an electronic compass. The GPS unit will perform two discrete functions. The first function is to display basic positioning data such as latitude, longitude and magnetic north. This function will be standalone and will not require the second unit for functionality. The second function is to process the GPS and compass data for transmission to the second unit. This function serves no purpose without the second unit.

The second unit performs data transformation and display. This unit will be a PDA running proprietary software. The software will input the data from the first unit and transform the latitude and longitude into a position on a map. This map will then be displayed with a “You Are Here” marker to orient the user. Additional functionality will include route mapping, path tracing, heading display, and audible prompts.
II. GENERAL DESCRIPTION

The project will consist of three major subsystems working in unison. The core of the system is the integrated GPS receiver and antenna. The GPS unit will be a 12-channel receiver that will continuously track all the visible satellites. The unit can provide position accuracy of less than three meters. The information that is transmitted by the GPS unit will be processed by the second system of the design.

The information stream from the GPS unit will be processed by a 17C44 PIC micro-controller. The PIC unit will be used to serially transmit the GPS data as well as the information from an electronic compass. The electronic compass will allow the unit to locate magnetic north and provide a graphical output to the user. The PIC unit will allow the second system to display the position and heading information on an LCD screen. The second unit, in tandem with the GPS unit, will create a rudimentary device that can provide usable position information independent of the PDA.

The PDA will receive the information transmitted from the PIC unit and provide the user with a graphical representation of their current position. The PDA will take the information; calculate the unit’s position and display the data on a stored map. This will allow the user to quickly locate businesses and other points of interest that may not have visible addresses or markings. The PDA will have the capability of storing points of interest or headings into the non-volatile memory of the unit. This will allow the user to retrace paths or relocate objects at a later moment in time. A block diagram of the design is listed below.
Figure 1 Block Diagram of Project

GPS Unit

Antenna Unit → Receiver Unit

PIC Unit

PIC Microcontroller

Electronic Compass → LCD Display

PDA Unit

Graphing Software

Graphical Display → Non-Volatile Memory

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IV. COMPONENTS LIST

**GPS Unit**
- Garmin GPS 16 I/O Device $200

**PIC Unit**
- 17C44 PIC Processor $10
- LCD I/O Device $40
- Electronic Compass I/O Device $50

**PDA Unit**
- IPaq PDA Processor $400

**Miscellaneous Items**
- Project board, sockets, connectors $100

**Total Estimated Cost** $800
V. **TIME SCHEDULE**

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Figure 2 Timetable of Project Completion.
VI. ACCEPTANCE TESTING

Note on testing procedures:

Due to the nature of the GPS, most acceptance testing procedures will require a line of sight to a significant proportion of the sky. In addition, the hardware, which comprises this system, is moderately sensitive to water. Therefore, it must be understood that these testing procedures must both a) occur outdoors and b) in the absence of inclement weather.

Furthermore, it must be understood that the sensor components of this system have both systematic and random error associated with their measurements. In the case of the GPS sensor, the systematic error in position measurement may be in excess of three meters and have a random error in excess of one meter. The sensor will also not provide updated measurements in the event of a loss of satellite lock. All test performance is dependent on these conditions, which form a bound on the optimal performance of the system in otherwise ideal conditions.

Features to be tested:

- Ability of the hardware to receive and display geo-location data independent of the PDA.
- Ability of the hardware to communicate geo-location data to the PDA
- Ability of the PDA to analyze and interpret geo-location data
- Ability of the PDA to perform advanced tasks with geo-location data
Test I.

*Intent:*

Verify the ability of the hardware to receive and display geo-location data independent of the PDA.

*Test Module Descriptions:*

3) From an initially powered-off state, the hardware unit (detached from the PDA) will be powered-on and allowed to acquire satellite lock. This state will be clearly indicated by the hardware. Further verification will be seen when the unit is moved to a position without a view of the sky (e.g. indoors) and the indication of subsequent loss of satellite lock.

4) With the hardware operating in the satellite lock state, the unit will display repeatable solutions for the geo-location data (i.e. lat/long, heading) on its display. The display should update the current position readout if the unit is moved beyond the precision tolerance of the GPS antenna while satellite lock is maintained. Returning to the starting position and orientation should return results equivalent to those measured at the beginning of the test module, within the systematic tolerances of the GPS and compass modules.

*Conclusions:*

It may be concluded from module 1 that the hardware unit is capable of standalone operation and that it can correctly initialize its components and communicate with them. Module 2 verifies the correct operation of the hardware components.
Test II.

*Intent:*

Verify the ability of the hardware to communicate geo-location data to the PDA.

*Test Module Description:*

From a powered-off state, the hardware will be connected to the PDA system. The hardware will then be powered-on. Once configured, the PDA should then display the information in numerical format (i.e. lat/long, heading) as received from the data stream from the hardware.

*Conclusions:*

From this test module it may be concluded that the hardware is capable of multiplexing the GPS and compass data stream and communicating it over standard serial link. It may be further concluded that the PDA has been programmed to correctly interpret serial data in the format required and collect this data.
Test III.

*Intent:*
Verify the ability of the PDA to analyze and interpret geo-location data.

*Test Module Description:*
While connected to the hardware in a powered-on state, the PDA will be able to display a location indicator on a map image. This indicator will correspond to the current position and heading of the system. The display should update the current position indicator if the unit is moved beyond the precision tolerance of the GPS antenna while satellite lock is maintained. The indicator should return to the same position indicator location (within component tolerances) if the system is returned to its original position and orientation.

*Conclusions:*
It may be concluded from this test module that the system is capable of analysis and interpretation of the geo-location data (e.g. lat/long, heading vector) and correlating this to a map display in a consistent fashion.
Test IV.

*Intent:*

Verify the ability of the PDA to perform advanced tasks with geo-location data.

*Test Module Descriptions:*

3) While situated in the conditions for Test III, the PDA will be able to extend the functionalities displayed in the module for Test III by displaying a trace on the map display of prior locations of the system. This will effectively cause the map display to show a trace of the path that the system takes over the course of the test (provided the test path is larger than the tolerances of the GPS antenna and given satellite lock is maintained).

4) While situated in the conditions for Test III, the system will be able to record a test path (larger than GPS tolerance, constant satellite lock). Once the recording is terminated, the system will be able to give audible prompts via the PDA’s internal speaker to guide the system back along the test path to the point of origin (within GPS tolerance).

*Conclusions:*

It may be concluded from this test module that the system is functionally capable of performing the listed advanced capabilities.
VII. TEAM MEMBERS

Smith, Quinn  
Vonk, Jonathan  
Walker, Brian

VIII. ASSIGNMENT OF EACH TEAM MEMBER

The project labor has been divided into three parts. These parts are software, hardware, and interfacing. As a whole, each team member will be responsible for documenting the part of the project that they are developing. This documentation will include work performed, modifications made, and difficulties encountered.

Quinn Smith will primarily focus on hardware development. Hardware development requires the development of a prototype board that will allow interfacing between all hardware components. Quinn will also assist with the microcontroller multiplexer.

Jonathan Vonk will primarily focus on software development. The software aspect requires development of a user interface for the PocketPC platform. Development will require accessing a serial link, processing data obtained from the serial link, and using that data to calculate a position on a map, which will be displayed on the PDA.

Brian Walker will focus on interfacing. Interfacing requires the development of a device to sample the asynchronous data from the GPS antenna and electronic compass and multiplex the two data streams over a single RS232 connection. This will be accomplished using a microcontroller. Brian will also serve as the secretary for the team by collecting the individual documentation provided by the other team members and maintaining an up-to-date listing of the
progress and status of each part of the project. Each team member is also expected to provide a
detailed description of their part of the project to Brian who then assemble the final report.

It should be noted that though each team member is responsible for a particular portion of the
project, full interaction is expected and each team member should a have a good understanding
and knowledge of the other parts of the project
IX. **SUMMARY**

In summary, the proposed system is a geo-position locator that will provide advanced data interpretation and output capabilities. This system is to be formed as the conjunction of two subsystems: a hardware system constructed out of specialized hardware and a commercially available PocketPC PDA. To maximize the utility of the subsystem components, the hardware will be designed to operate without the PDA and provide a subset of the full capabilities of the system as a whole.

The hardware subsystem is designed to receive and display geo-location data independent of the PDA. This subsystem is also responsible to communicate this geo-location data to the PDA in a serial format compatible with the PDA. In conjunction with the hardware subsystem, the PDA will be able to analyze and interpret geo-location data and to perform advanced tasks with said data.