Project Proposal

EET-400 Project Management

The GPS Dog Tracking System

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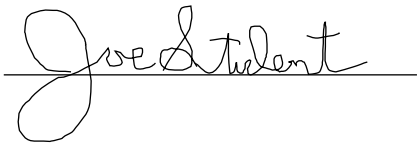
This is the original work of Joe Student



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1.0 Introduction

The GPS Dog Tracking System (DTS) is designed to help hunters and others who use dogs in the field to locate their animals. It consists of two parts, a locator collar worn by the dog and a handheld receiver with information display that will be used by the owner. The dog collar will contain a GPS receiver and a UHF radio transmitter that work together to measure the dog's location and transmit this information over the air. The handheld information display will have a second GPS receiver that measures the owner's location, and a radio receiver that demodulates the incoming data stream from the UHF transmitter on the dog collar. With the two combined data streams, the handheld unit will be able to display bearing and distance data to assist the owner in locating the animal.

There is a general lack of equipment that enables hunters to exactly locate their hunting dog. Therefore, there is a great need for this product, especially for coyote and raccoon hunters who must know the location of their dogs (who are usually out of sight). The Dog Tracking System will eliminate a great deal of time wasted in locating hunting animals, and can give a hunter early indication of dangers to their dogs (such as the dog entering a no-trespassing area, or other hazard.)

2.0 Competitive Products

There are two primary products that can be considered competitive with the Dog Tracking System. These are the Innotek RD-400 RF Tracking System, sold at Gun Dog Supply (http://www.gundogsupply.com/rd-2.html), and the Pointer Dog GPS from Pointer Solutions (http://www.pointersolutions.com/eng/hunting_dog_gps.htm).

2.1 Innotek RD-400 RF Tracking System

Figure 1 shows the Innotek RD-400 RF Tracking System. To use this product a collar is placed on the dog with a small radio transmitter. The owner rotates the directional antenna (with integrated receiver) until the highest "S" meter indication is obtained, thus indicating the most probable line-of-sight bearing to the animal. This system can only indicate the general bearing to the dog, and not the distance; furthermore, considerable hunter skill is needed to operate it successfully in the presence of radio signal reflections from terrain.

Figure 1: Innotek RD-400 System (Image source: http://www.gundogsupply.com/rd-2.html)

2.2 Pointer Dog GPS

The Pointer Dog GPS (Figure 2) is a more sophisticated approach very similar to mine. It uses two GPS receivers, one on the dog and one on the owner's handset; instead of a direct UHF radio transmission, it utilizes the cellular telephone network (GSM required) to transmit the data stream from the dog's collar. The advantage of this approach is nearly unlimited range, since the GSM network carries the traffic. However, the system is unusable out of range of the cellular system, which makes it impractical for use in remote wilderness areas. The operating expense for the Pointer Dog GPS includes the airtime for the cellular telephone system.

Figure 2: Pointer Dog GPS Receiver (Image source: http://www.pointersolutions.com/eng/hunting_dog_gps.htm)

2.3 Comparative Analysis of Systems

Table 1 compares the Dog Tracking System to the nearest competition. The price point of the system has been placed in between the competing items, based on feature set.

System	Advantages	Disadvantages	Purchase Price
Innotek RD-400	Works in any location; no GPS reception required	Only provides bearing to animal; can be fooled by terrain; bulky receiver.	$450.00
Pointer Dog GPS	Simplicity; gives accurate location of dog; can use downloadable terrain maps; long range possible	Most expensive; won't work without cellular infrastructure; requires purchase of cellular air-time	$1,000.00[1]
Dog Tracking System (This proposed product)	Simplicity; gives accurate location of dog; not limited to use within cellular-area; no cellular time charges	Limited range of UHF transmission, 5km or less depending on terrain	$750.00[2]

Table 1: Comparison of DTS to the Competition

From the analysis of competition, it can be concluded that there is a viable market position for this product; there is a gap where this product can easily fit and still provide good per-unit profit. Information not available at the time of this analysis is the size of the market, in terms of units sold per year for each competing device.

[1] Estimated, as of August 2005.
[2] Estimated price point; see Section 4.3, *Estimated Cost to Manufacture the Product*

3.0 System Block Diagram

The Dog Tracking System will consist of two units, the *collar* and the *location display*. The physical configuration of these devices is approximated by Figures 3 and 4.

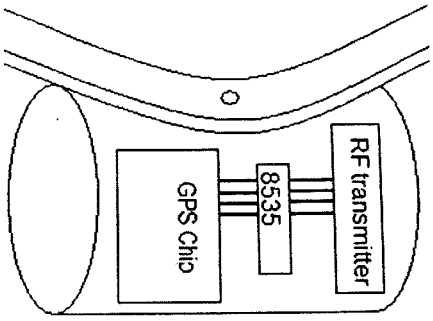

Figure 3: Collar

3.1 Collar

The collar will contain three primary active components, a GPS receiver chip (very likely a Garmin GPS-15 OEM GPS sensor), an Atmel 8535 microcontroller, and a UHF radio transmitter module (possibly a Linx Technology type TXM-418-LR, which operates as a Part 15 unlicensed device in the 418 MHz band with a rated range of 3,000 feet or better). The software in the collar will read the serial data from the GPS chip, extract the GPS positioning data from the stream, and periodically retransmit this data on 418 MHz through the RF transmitter module. The software will periodically "sleep" in order to conserve batteries. Not shown is the required GPS reception antenna, which would be mounted on top of the collar to place it in view of the satellite downstream signals.

3.2 Location Display

The location display will contain an identical GPS receiver and antenna, a second Atmel 8535 microcontroller, a 418 MHz RF data receiver (probably a Linx Technology RXM-418-LR), and an LCD display for output.

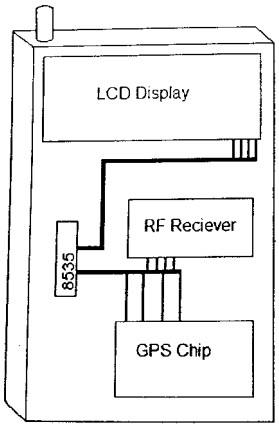

Figure 4: Location Display

The location display will have no user controls except for the power switch, a MODE switch, a SELECT switch, and the LCD display. The display unit will acquire the hunter's bearing by reading the coordinates from its internal GPS receiver, an d comparing these with the coordinate stream being received from the remote collar. The software in the display unit will then convert the two coordinate values into range and bearing information to be displayed on the LCD display. The MODE switch will be included to allow the user to select various options, such as tracking the history of dog location, extrapolating expected future dog location (based on the bearing and speed of the animal), and other functions.

3.3 Electrical Block Diagrams

The proposed electronics for the collar and display unit are shown in Figures 4 and 5. The block diagrams illustrate the following requirements for the system components:

- The supply voltage for the GPS modules must be regulated to 3.3 V.
- The microcontroller in the display unit appears to need two UARTs, since it must decode data from both the GPS and the remote RF collar. A software-derived serial port will be used to satisfy the need for the second serial interface.
- The electronics, especially those in the collar, must be very compact. The RF transmitter and receiver modules are surface-mounted parts. Surface-mount versions of the AtMega8535 are available for deployment in the collar to keep the size down. The bulkiest component in the collar will be the GPS receiver.
- A compact, easily-replaceable battery with high capacity will be needed for the collar.
- Identical 1/4 wave whip antennas will be used for both 418 MHz devices.

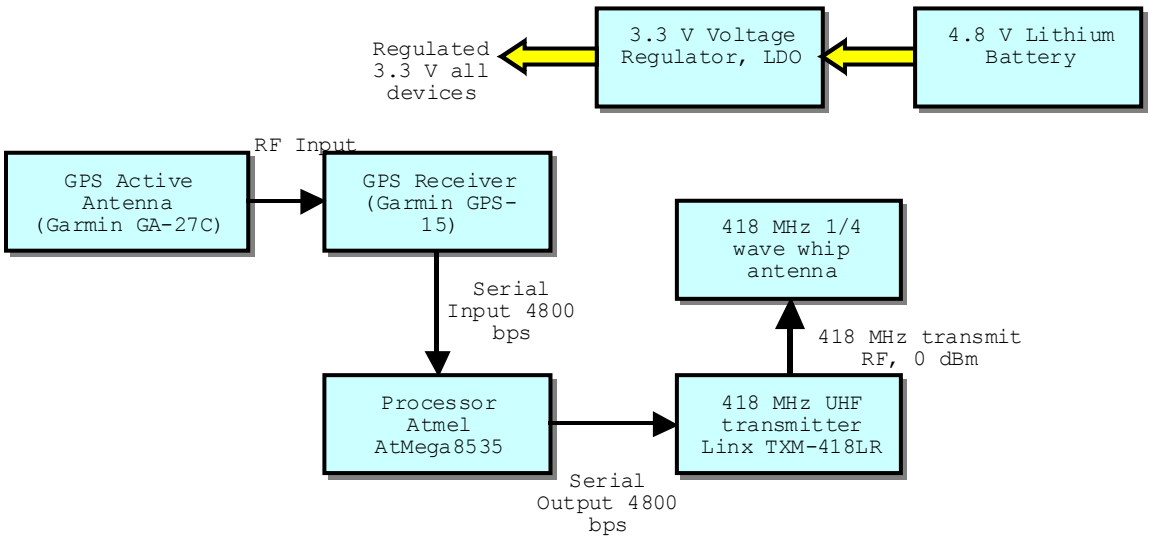

Figure 4: Collar Electronics Block Diagram

The display unit is a little more involved. It will require two levels of voltage regulation since the GPS and RF receiver modules require 3.3 V, and the LCD and microcontroller work from 5 V. Low-drop out, high efficiency regulators are available from National Semiconductor to take care of the necessary voltage regulation. In addition, logic level translation will be needed between the GPS-15 and the processor due to the voltage difference.

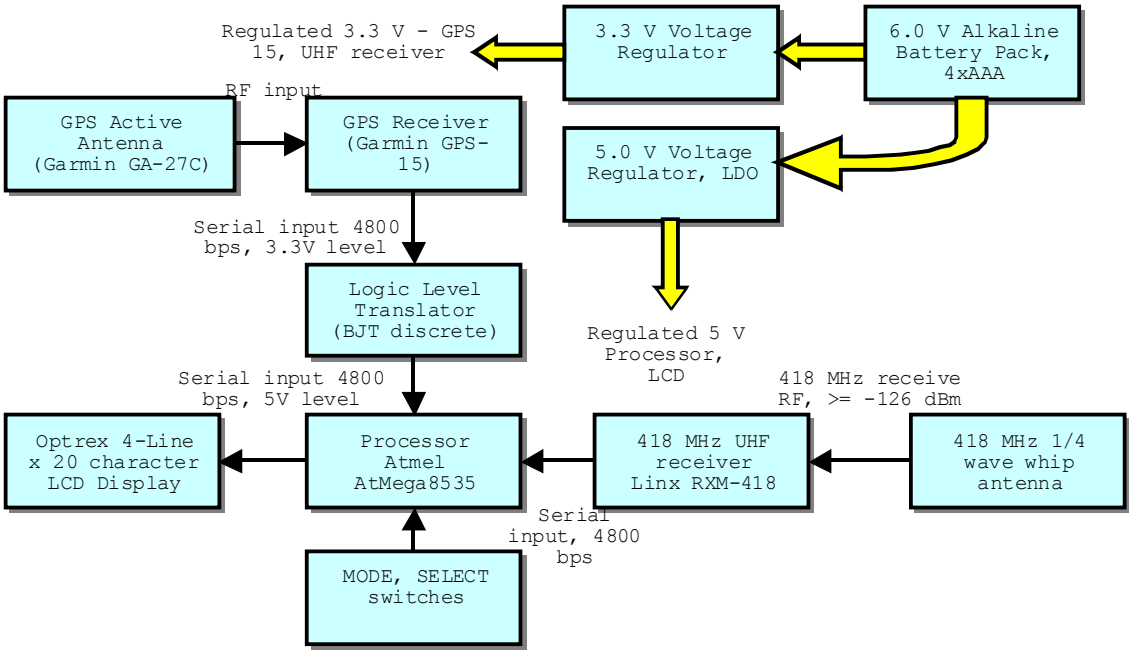

Figure 5: Display Unit Block Diagram

The voltage difference between the LCD display and GPS-15 creates the need for dual supply voltages. Further investigation may reveal an LCD module that is capable of operating directly from the 3.3 volt supply bus, eliminating the level translator and 5 volt regulator circuit, since the AtMega8535 processor can operate directly from the 3.3 V supply.

3.4 Environmental Requirements

The collar and display unit will be used outdoors under a wide variety of conditions. Special packaging will be necessary in the final product to meet these requirements.

3.4.1 Dog Collar

The collar must be able to withstand repeated impacts resulting from the dog's activity (probably 1-2 g continuous, 10 g maximum shock), a temperature range from below freezing to very hot (10 F to 110 F), as well as temporary immersion in water to a depth of no more than 1 meter for periods of less than 5 minutes. Water protection is probably the most important single measure, as the electronic components can easily withstand the temperature and acceleration parameters.

3.4.2 Display Unit

The display unit will also be operated over a wide temperature range (10 F to 110 F), and may experience shock and water splash exposure (but not immersion). Careful attention should be paid during the design of the display unit's enclosure and controls to make it convenient to hold and operate, in order to minimize the chance of being dropped. The LCD display is the most susceptible component in the display unit; it will require a tough, clear plastic window on the enclosure to protect it against mechanical pressure and moisture. The LCD must be backlit to be visible under all lighting conditions.

4.0 Overview

There are many unknowns in this project, and the team will require a wide variety of skills. Some of these unknowns are:

- We have no experience with the RF transmitters and receivers.
- We haven't worked with GPS devices.

We do have most of the knowledge needed to complete this project. The school curriculum has covered the Atmel microcontrollers, LCD displays, interfacing, and enough basic electronics to complete the design.

4.1 Work Task Breakdown, Project Schedule

Two people will be required for this project. A hardware engineer will be needed to complete the analog and digital design, and a software engineer will be needed to design and debug the operating system firmware present in both devices. The services of an independent certification company will be needed to obtain FCC Part 15 certification. Table 2 shows the estimated timing schedule for the project, task by task. It is estimated that 30 weeks will be required to complete this project.

Interval ⇒ **Task** ⇓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Locate GPS Receivers	X														
Locate RF Receiver and transmitter	X														
Software Design						X[3]			X	X	X	X[4]			
Hardware Design		X	X	X	X	X	X								
Software Testing						X			X	X	X	X	X	X[5]	X
Hardware Testing		X	X	X	X	X								X	X
Packaging Design						X	X								
Prototype Construction					X	X	X	X	X						
Technical Manual								X	X[6]					X	X
Environmental, FCC Testing									X[7]						X

Table 2: Estimated Timing Schedule for the Dog Tracking System Development Project. (One Interval = 2 weeks calendar time)

[3] Device drivers completed at this time, verifying hardware functionality.

[4] Final software design complete at this time. All product features functional.

[5] This is the final, complete prototype test.

[6] First draft of technical manual completed here.

[7] FCC certification testing on prototype; final prototype (with final packaging) tested at week 30 to assure conformance with FCC/environmental limits.

4.2 Estimated Costs

Table 3 shows the estimated costs for this project. These values take into account both prototyping components and engineering time.

Item	**Quantity**	**Unit Price**	**Total**
Design, Software and Hardware	50	$100.00	$5,000.00
Research, engineering	60	$100.00	$6,000.00
Prototyping (Technician)	20	$ 30.00	$ 600.00
GPS Devices	2	$ 45.00	$ 90.00
Miscellaneous components, supplies			$ 100.00
Microcontrollers, prototyping	10	$ 12.00	$ 120.00
Atmel JTAG-ICE dev kit	1	$400.00	$ 400.00
LCD, prototyping	2	$ 60.00	$ 120.00
Packaging (design); Ten-Tec Corp. estimate			$2,000.00
RF Modules	4	$ 10.00	$ 40.00
		Total Estimated Cost	$14,470.00

Table 3: Estimated Costs for the Dog Tracking System Development Project

The following are the deliverables for this project:

- Two complete working prototype systems in final molded plastic cabinets.
- Complete technical documentation for the project with theory of operation, schematics, parts lists, software flow diagrams, and software source code (on CD-ROM).
- English-language end-user documentation for the product, printed and electronic form.

4.3 Estimated Cost to Manufacture the Product

Table 4 summarizes the cost structure for the manufacture of this product. From this information the price point of $750 may be a little "soft," since this doesn't leave a very strong markup margin for retailing. Further research needs to be conducted to determine the optimal price point for this product.

Item	**Quantity**	**Unit Price**	**Total**
Electronics, collar	1	$ 70.00	$ 70.00
Electronics, display unit	1	$100.00	$100.00
Packaging (collar)	1	$ 10.00	$ 10.00
Packaging (display)[8]	1	$ 20.00	$ 20.00
Packaging, retail	1	$ 2.00	$ 2.00
Manufacturing Time and Resources per unit	1	$100.00 (estimated @ 50% of electronics cost)	$100.00
		Total Estimated Cost	$302.00

Table 4: Estimated Cost to Manufacture in Lots of 100

[8] Estimate from Ten-Tec Corporation, one potential packaging supplier.

5.0 Summary

The Dog Tracking System is a very practical product idea that is both technically feasible and marketable. The potential for profit is great with this product, and the risks are fairly minimal. Our team can convert this idea into reality in approximately eight months time, given the resources described within this document.