

Embedded Electronic Systems Design and Development Engineer

ACCA6020: Independent Project

Personal GNSS Tracker

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Problem Statement

The ability to know the location of something, or someone is critical to some activities or industries; whether that is for tracking the whereabouts of a child or an elderly person in your life; mountaineers and adventurers tracking their own location as they traverse extreme environments; or global industries tracking the movement of assets.

Many Global Navigation Satellite System (GNSS) trackers exist but many existing commercial devices suffer from limited battery life, high operating costs, and bulky designs or reliance on other devices, especially when including features such as emergency alerting. These limitations restrict widespread adoption of the technology for continuous, long-term personal use, particularly in scenarios where regular charging is inconvenient or unreliable.

A low power GNSS personal tracker could offer a potential solution by combining efficient hardware components with power optimised firmware on a capable microcontroller. Such a device would operate for extended periods of time without charging from a relatively small battery while maintaining an accurate and reliable track.

This project proposes to design and prototype a compact GNSS tracker that maximises battery life without compromising on tracking accuracy or connectivity. The system will integrate a power-efficient microcontroller with an efficient GNSS module and display and utilise a low power communication interface capable on long range comms for remote data transmission.

Project Aims

This project aims to design, build and evaluate a prototype low-power GNSS personal tracking device capable of accurately determining and logging a user's location and transmitting location data over a long range.

Objectives

The project aims to design a compact handheld system integrating a low-power microcontroller, GNSS module, display, battery and power management and communications interface. This will be measured through the following success criteria:

- Functional schematic and PCB layout produced and verified by simulation
- Component selection to maximise power efficiency
- Prototype size, weight and power (SWaP) that is compatible with a handheld device

The project aims to develop embedded firmware to acquire GNSS coordinates and store them in a log, while transmitting location data at user defined intervals. This should take place while minimising energy usage. This will be measured through the following success criteria:

- Able to capture and log GNSS location data
- Able to transmit data with at least a 90% success rate within a test range

- Average power draw of the system should be reduced by at least 40% compared to continuous operation and achieve at least 48 hours of operation

The project aims to implement the PCB design as an initial prototype and evaluate performance in comparative rugged environments. This will be measured through the following success criteria:

- Achieve a positional accuracy of at least 5m in open sky conditions
- Successfully operate the device in at least two different environments

This project will be documented via a 10,000 word report including a review of current commercial offerings and possible technologies to achieve aims, an analysis of the developed device and how it achieves the stated aims.

Resources

The successful execution of this project depends on the availability and effective utilisation of a range of resources, spanning hardware and software design and development tools during the initial development phase to test and evaluation tools once a prototype system has been developed. The use of resources will be accompanied by justifications to support its inclusion in the project and how it supports the project's objectives.

For the initial investigations into component selection, hardware simulation tools such as Labcenter Electronics' Proteus Design Suite will be critical to the testing hardware designs in a modular fashion, validating approaches to take forward into a prototype design. Successful development of individual modules of the system will then be taken forward into an overarching system design, culminating in a functional schematic with specific components justified by literature review and simulation investigations.

The system will require firmware developed for a microprocessor, requiring an Integrated Development Environment to be used. Initial investigations may be possible to be carried out in Labcenter Electronics' Proteus Design Suite depending on the microprocessor selected. As the hardware and firmware matures it will be necessary to transition to an integrated development environment (IDE) that supports the selected microprocessor family and enables the programming and debugging of hardware.

For the design of prototype hardware to validate simulations in Proteus Design Suite, tools such as Number One Systems Easy-PC or Ki-CAD PCB Design Suite will be required to ensure the quick and efficient layout of components on a circuit board prior to sending the design off to a PCB Fabrication Service. On receipt of PCB's and components, a soldering station along with test and evaluation hardware will be required to assemble and test the design for correct assembly and validate performance.

To validate the design's power consumption the use of power profiling tools would enable the design to be validated as achieving low-power status and the expected battery live extrapolated.

To document the work undertaken in this project a work diary will be maintained in Microsoft OneNote, and version control systems such as Git will be utilised to ensure traceability and version management throughout the project lifetime. To support delivery of the project a formal report will be written in Microsoft Word. Diagrams and illustrations will be created using tool such as Draw.io, Inkscape and similar. The final report will be supported by a poster, created in a suitable graphical design or document typesetting tool.

To enable the running of field testing, two distinct locations that represent different environments will need to be identified to allow for the evaluation of GNSS performance, user experience of the display and user interface features.

Throughout the project different people will be required to deliver and support delivery. The lead designer and engineer will be Matthew D Prentice, supported by a project supervisor and mentor who will provide technical guidance, review design decisions and ensure the project remains aligned to academic standards. Throughout the design process peers and colleagues will be utilised to provide feedback and review hardware and software design to ensure high quality delivery. Finally external suppliers such as PCB Fabrication services, electronic component distributors, software development forums and other open-source resources will be utilised where required.

Plan

The project is planned to last between 5 – 6 months with work being carried out on a part-time basis. The initial research and development work is intended to last 2 months. Within that time a literature and market review will be carried out, enabling the system requirements to be defined.

Once system requirements are set the review of possible components can be undertaken, culminating in the selection of components to carry forwards into simulation and schematic designs for individual modules.

With module schematics designed and simulated, over the next 3 months the modules will then be laid out as PCB's and sent off for fabrication before assembling and testing each design.

Upon successful testing the system will be integrated into a single design.

Concurrently to the hardware design, the firmware for each module of the system will be developed ahead of the boards returning from the PCB Fabrication service and ready for flashing onto microcontrollers. Once the testing and evaluation is complete the firmware will be integrated ready for flashing on the final prototype system.

Finally, the testing and evaluation of the system is planed to last 5 weeks, leaving a few weeks to focus on final documentation and preparing for report submission.

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