Project SB3: Data Logger
Package Environment Monitoring
Final Report

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summary: motive, method, key results, conclusions

Contents

1 Introduction

The express delivery industry is one of the fastest growing industries in the world today. In 2003, the industry made a direct contribution of US$64 billion to worldwide GDP, and has been growing by around 8% per year since [3]. However, customers have very little information of the environmental and handling conditions their package has been subject to during its transit. When shipping fragile or sensitive products, the conditions that the parcel is subject to may be critical in the integrity of the product. The two major issues here are:

1. Fragile goods which arrive broken: it is desirable to determine whether the package has been mishandled, and if so by whom.

2. Perishable goods: if they have been subjected to conditions outside of temperature and humidity sensitive limits they will have a shorted shelf life. This may not be obvious upon inspection of the goods, so detailed condition tracking is required.

While products have been around for a while to carry out this type of tracking on shipping containers, the same problem applies to smaller and domestic packages too. In the past six months, a couple of products have been announced to achieve this, but it is clearly an emerging market and a good product launched now could have a great chance of success. FedEx Corporation have recently announced deployment of a similar environmental tracking device, "SenseAware"[1], however this is only available on a select number of carriers and services and is a business level product, not suited for everyday or relatively low value package monitoring. An alternative is the "DropTag" system recently announced by Cambridge Consultants [2], however this system is not yet at the commercial release stage.

With a problem identified and a solution required, as well as a clear business opportunity due to the interest in development from other companies, product development was begun.

2 Overview

In order to effectively track the condition of a parcel during transit, the final product was clearly required to be cheap, low power and physically small and robust. For this project, a simple prototype was to be developed, which if successful could be miniaturised and fabricated for the final product.

2.1 Summary of Design

The first stage of the design process was to evaluate which quantities should be measured and logged. The key environmental variables would be temperature and humidity. Vibration, orientation and shocks would also be required to understand the handling and transport conditions. GPS tracking would also be useful, but it was decided to focus on the other five initially as GPS could be relatively simply included with a dedicated GPS chip communicating over the I^2C protocol, and GPS reception may be limited at many points during transit.

The product would clearly be required to work without being plugged in to a computer, so a standalone mode would be developed. It would be useful for development, debugging and testing to operate with instant feedback from the computer system, so a linked mode was also developed.

To ensure long term operation, on-board memory would be required, so an EEPROM was used for data storage in the standalone mode. This would also require a battery supply.

Some kind of on-board display would also be useful on the board, for monitoring, debugging and status display, so an LCD screen was used along with five LEDs.

The platform choices were specified in the project requirements, so the project was to be developed for the STM32F100 ARM Cortex MCU and a PC running the Windows operating system. The key design areas would therefore be hardware, firmware and software. The budget was generous for the development board so cost was not really an issue, however to achieve a commercial product, the cost and size would need to be reduced. This could be achieved by miniaturising, as surface mount components tend to be cheaper, use of a cheaper MCU (which wouldn't need the development features of the STM).

The project block diagram is shown in figure 1.

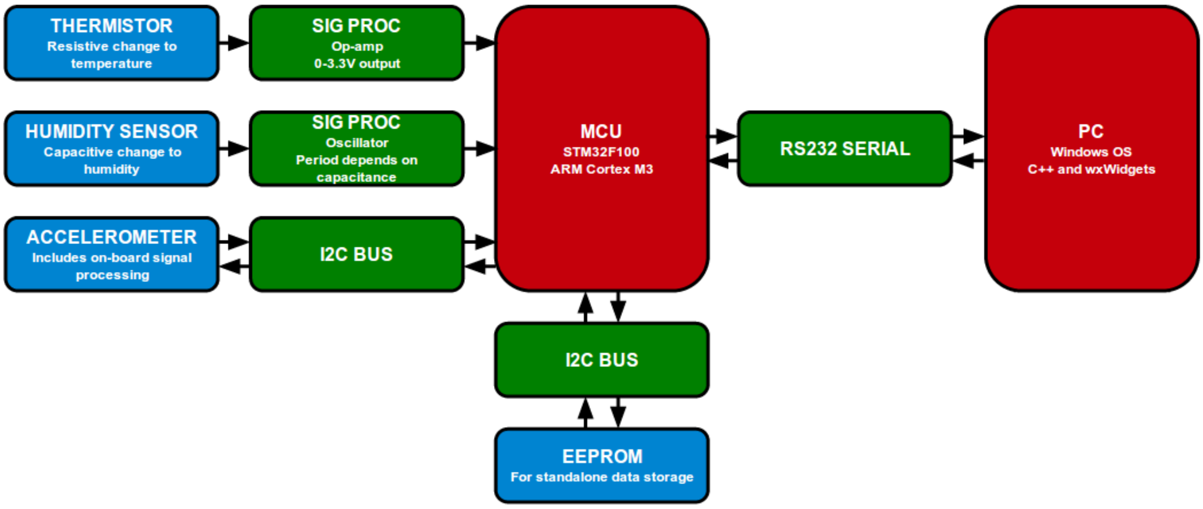

Figure 1: Overall system block diagram

2.2 Project Management

The project was divided between the two team members. It was decided that James would write the firmware for the MCU, Andrew would write the software for the computer and the hardware design was to be shared. The general development plan was to start by making a basic but working system and gradually adding features and complexity upon the existing system. This ensured that we would have a fully operational, if not with every desired feature, by the end of the project, and would also allow the simpler parts to be used in testing more complex parts.

Initally basic hardware circuits were designed and built. The firmware and software were then developed. The hardware circuits were highly useful in testing the firmware, but in writing the firmware, flaws in the circuit designs became apparent, such as the initial plan to use a simple charge-discharge of the humidity sensor. For this reason, the humidity sensor circuit was updated during the project.

3 Design

A brief overview of the design has been given in section 2.1. This section gives technical detail about the parts of the system which I designed. The other parts are detailed in James' report.

3.1 Hardware

3.2 Software

3.3 Communications

4 Problems Encountered and Technical Solutions

5 Test Procedures

6 Conclusions and Next Steps

A Source Code and Circuit Diagrams

B Marketing Datasheet

C First Interim Report

References

[1] http://news.van.fedex.com/SenseAware. Nov 2012. Accessed on 3/6/13.

[2] http://www.cambridgeconsultants.com/news/pr/release/116/en. Feb 2013. Accessed on 3/6/13.

[3] Oxford Economic Forecasting. The impact of the express delivery industry on the global economy. http://eiciindia.org/frontsite/An%20Oxford%20Economic%20Forecasting%20-%20The%20impact%20of%20the%20Express%20Delivery%20Industry%20on%20the%20global%20economy.pdf, 2005. Accessed on 3/6/13.