Industry Involvement in a Senior Design Environment: Circuit Board Optimization

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Abstract

Background: Check fraud is a critical issue in the financial community, costing financial institutions and commercial customers approximately $12 billion per year.
Proposed solution: In order to prevent check fraud, our sponsor created a product to detect the authenticity of a check. It was deemed that the product needed additional features, board modifications, circuitry reduction and power improvement. As part of senior design projects in the Electronics Engineering Technology Program at the University of North Texas, the sponsoring company assigned our group the task of carrying out these improvements by examining the board circuitry and diagrams that integrate the product. These improvements will enable the product to operate using USB technology and to perform successfully with ease. The project involved analog and digital designing, an understanding of electro-optics, software, hardware and business analysis. The project was successfully completed and demonstrated to the satisfaction of our clients.

Introduction

The University of North Texas at Denton is the third largest, single-campus university in Texas. The Department of Engineering Technology is one of the founding departments of the newly established College of Engineering. The department is ABET accredited and is one of 25 in the nation that offer undergraduate and graduate programs in Engineering Technology. The senior design projects class serves as the setting for the final, capstone project. Students work in teams (of 4 or 5 students) to propose, design, implement and successfully demonstrate the working of their project. Final presentations are made to an audience comprising faculty members and invited industry personnel from the area (numbering 20-25). Students are graded individually and in teams for technical content, demonstration and presentation skills.

The project overall goal is to streamline the existing hardware and software used in the Invisible Barcode Reader (IBR) that is used to detect fraudulent checks. As part of the requirement for capstone projects in the Electronics Engineering Technology (ELET) Program, we formed a company (group) of four seniors and set up a hierarchy of management. A representative from the sponsoring company served as the customer. The contributions of the sponsoring company were: a) Providing the project to us, (b) keeping a watch on do's and don'ts on the project, (c) providing specifications for project components and outlining requirements in design, (d) providing financial assistance in parts procurement and implementation (PCB fabrication). Dr. Vaidyanathan was our company CEO – in charge of overall planning and implementation. Student roles were defined as: John Campbell – Project Manager and software engineer; David Clothier – Hardware; Antonio Mendoza – System Engineer and Marketing; Lisa Dildine – Design and Quality Engineer. As per the practice in senior design class we gave our company a name, Blue Collar Technologies. The ELET program has initiated a move to have senior design projects, sponsored by companies or have seniors work on problems for industry that need a solution within a specified time period. This modus operandi enables students to interact with industry personnel and learn the thought processes and work techniques employed in an engineering workplace. A local start-up company specializing in opto-electronics products sponsored Blue Collar Technologies, to streamline the existing hardware and software used in the IBR. The streamlining was to be accomplished through the elimination of unnecessary components and the coordination of multiple software components to work in tandem with the improved hardware design as well as each other. All the tasks were to be accomplished during the course of one semester.

The paper describes

- the collaboration between industry and academia in a capstone project;
- student experiences in the project;
- use of the capstone project in ABET assessment

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Description of the Problem

With the technology in photo processing and printing software advancing, banks and financial institutions are struggling to protect themselves from check fraud. Photo editing software has

allowed thieves and falsifiers to reproduce checks and documents with an astonishing quality that is nearly impossible to distinguish from genuine documents. Check fraud and document falsification is a problem that affects all banks, manufacturing companies and even super markets. In short, anyone who distributes or accepts checks is at risk of becoming an unsuspecting victim. According to Jesse B. McCoy, author of the Bank Fraud Trends and Fraud Awareness journal, check fraud is one of the main leading problems in the financial and social communities in the United States [1]. Check fraud produces losses of several billions of dollars. Just two years ago, it was reported that financial institutions and commercial customers lost an accumulated total of $53 billion due entirely to check fraud and worthless checks.
Over 1.2 million fraudulent checks are produced every day [1]. Banks find it difficult to recognize fraudulent checks as "fraudulent" until money is been withdrawn from an account. At this point goods or money have already been lost, thus the discovery becomes a means of punishment instead of a means of prevention. According to the Internet Fraud Complaint Center (IFCC), fraud complaints tripled between 2001 and 2002 [2] and the average dollar loss per typical complaint in check fraud is $1100.Research has indicated that white-collar crime is not the exclusive realm of top executives [3]. There are corporations that set up questionable businesses that operate on the fringes of the law [4, 5].

Recently, SQN announced the successful completion of a pilot to read seal protected U.S. Treasury checks at a large financial institution [6]. SENTRY: Seal ^{TM} is a robust fraud prevention product providing instantaneous check verification, which supports multiple vendors including Fiserv Secure Seal, the technology used on Treasury Checks to create image-survivable seals. Similarly, Falcon systems introduced the Falcon fraud management solution in 1992. Today, this solution protects more than 450 million active credit and debit cards worldwide. And in the U.S, the Falcon system has helped reduce credit card losses by two-thirds since its introduction [7].

The solution presented in this paper is the IBR. IBR is a fraud identification system that is capable of verifying key information in checks and important documents before the transaction takes place. By implementing IBR, several banks and other affected financial institutions move the discovery process to the point of transaction. The check is never cashed and the bank or retailer never loses a dime. The discovery of a fraudulent check by the vendor rather than his/her financial institution would assist the government as well in cutting down the caseload for local courts by reducing the number of check fraud cases reported. The use of IBR will reduce the overall cost of enforcement and punishment for criminals carried by the average American taxpayer. Financial institutions are the primary focus for IBR's marketing strategy since they are the leading reporters of check fraud [8].

Methods

The technical requirements were stated in the first meeting Blue Collar Technologies held with the sponsoring company. Throughout the semester, a series of meetings (6) were held with the industrial sponsor to keep them informed of the progress. A timeline for these tasks was provided followed by identification of important milestones. The timeline for tasks is shown in Figure 1.

Design of board: This section was accomplished by utilizing the symbol technologies development kit, Symbol Technology manuals and technical support. The most problematic portion of this section was the discovery process of the development board's capabilities and operating hardware. The reduction of the board was accomplished by applying circuit analysis and reduction techniques obtained in courses taken throughout the Electronics Engineering Technology (ELET) curriculum at the University of North Texas.

Prototype fabrication and integration of test services: The fabrication of the board following the initial design was achieved using a development kit and PCB Express software. The hardware and software integration with other aforementioned hardware as well as the testing of the product itself took place within proper time constraints and was successfully demonstrated for the sponsoring company and the University of North Texas.

Additions to the original hardware include:
1) Automatic switching.
- Reduced driver circuit

2) USB compatibility (Changed from serial port to USB)
- Elimination of external power supplies.

3) LED switching component
4) On/Off switch software or hardware activated
5) Creation of GUI

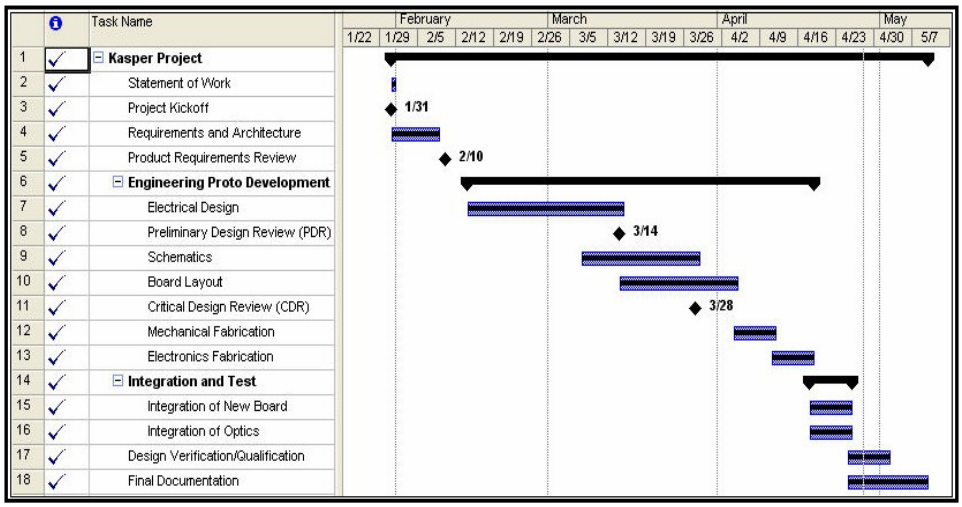

Figure 1: Timeline of tasks that were accomplished as part of the IBR project.

The original circuit board contained unnecessary space and electronic components that were not desired by the customer. There were electronic components that were not used for the primary purpose of this project, which is UV image detection. Therefore, a careful review of components was done and Blue Collar Technologies reduced the number of components in the board and the board size. The original IBR had a physical switch that needed to be pushed whenever the user requested a read. The new IBR has a switch that reacts to the pressure made by sliding a check in

the slot; the device then reads and displays the data independent of the user. The original IBR allowed the end user to utilize the Symbol Native Application Program Interface (SNAPI) to select, alter or even disable sensitive parameters of the reader ultimately affecting the scan engines capability to read and detect information. Blue collar Technologies created a new GUI using C++ code that allows the end user absolutely no access to these features and ensures that an unwitting user cannot program the device incorrectly.

Blue Collar Technologies has conducted a simple market survey in which a group of 50 business managers and employees from different ages and both genders participated. We found that 60% of the people who were surveyed were interested in purchasing a device that can detect documents that have been counterfeited. The people interviewed were given non-security sensitive details about IBR. The group surveyed included 50 % males and 50 % females with an annual income of less than $100,000 and between the ages of 20 and 70. Most of the people interviewed were active professionals who owned a business or belonged to a financial institution. From the results obtained from the survey, we discovered that 23 % of the people interviewed never heard of a device such as IBR and its capabilities of interfacing with an operating system in a computer. Another 17 % percent of the participants said they were satisfied with their existing product. Other interesting data we obtained from this survey is that there are many products like this out in the market. It was also determined that our best target is a business male between the ages of 30 and 45 with an annual income between $50,000 and $80,000. It was surprising to realize how many senior citizens are still actively involved in banks and stock transactions.
The block diagram of the system is shown in Figure 2.

Switch: Detects the presence of the document to be analyzed. Once the document is sensed, the switch is turned on and the 2D detector is activated.

Detector: Obtains the data to be read. A mechanism enables the detector to identify the section of the document to send to the reader.

A.S. Reader: Reads and sends the data obtained by the detector to the decoding section of the system.

Data Transmitter: Once the data has been read, analyzed, and decoded, a transmitter sends all the relevant data to an USB port.

USB: Its primary functions are to enable the system to interface with a computer and to supply power to the entire IBR system. The working of the IBR system can be described as follows: The optical lens reads the data contained on special documents. Special software is used to determine the reading range. The aid of lasers will not be necessary for this system since a special light source is used and lasers might interfere with the reading of the data in the documents. The microprocessor analyzes the data obtained from the optical lens. Once the data is analyzed, the microprocessor encrypts and temporarily stores the data to later be sent to the decoding section of the IBR system. Communication takes place between the microprocessor and the decoding section of the IBR system. A series of pin connectors are connected to the

output ports of the processor and the data is sent to a decoder that outputs the information to the USB of the circuit board.

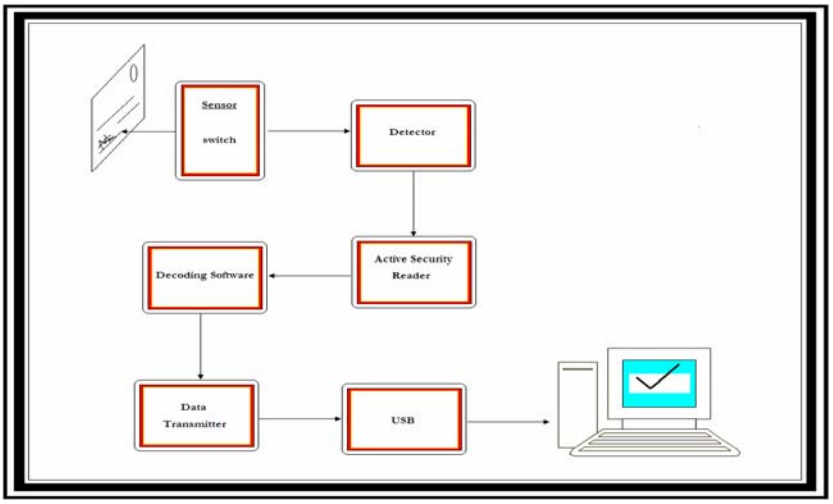

Figure 2: Block diagram of the complete system

Results

From the marketing survey, BCT observed that the majority of survey participants valued price and the quality of a product more than features. From the BCT project parts list, the cost of soldering the electronic components, the cost of the processor and the optical lens, BCT estimates that the price of IBR should be no less than five hundred dollars. The prices of the two other competing products are much lower than the price of IBR. These products, however, do not have the features and versatility that IBR has. Although it is true that the price of IBR is somewhat higher than the other two products, the quality and reliability of IBR is worth the extra dollars spent.

The PCB layout for the completed circuit is shown in Figure 3. The Gerber file for the PCB was provided to a PCB fabrication company. The PCB had two components placed backward. The error was fixed by prompt analysis of the PCB without providing signal to it. Once the components were placed correctly and continuity check was positive, the circuit was ready for testing.

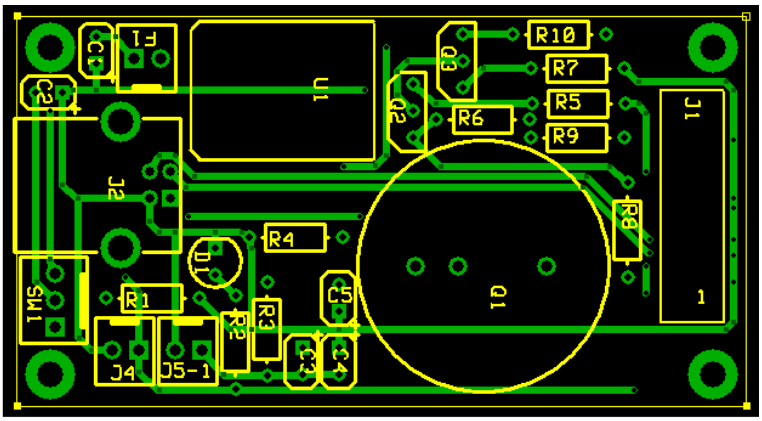

Figure 3: PCB Layout of the IBR circuit

The final PCB had a compact layout with new, efficient components. Final analysis revealed a 61% reduction in the number of components used, as compared to the original layout that served as the starting point. In addition, the physical size was reduced by a margin of 79%, enabling the new PCB to fit into the device chassis without any modifications.

Testing of the circuit board under actual working conditions was successful. The system successfully (100%) identified bar codes of 10 products. The board was then housed in a case provided by the sponsoring company and tested for checks. The tests were successful and fraudulent checks were correctly identified.

Capstone Project as an Assessment tool

The design was completed and implemented as part of a senior design project. The project enabled students to work in teams; apply their knowledge gained from the curriculum (technical and mathematical); demonstrate a working model and make a professional presentation to their peers and others. In doing so, the students and the program fulfilled program and departmental objectives and satisfied ABET criteria for assessment.
Particular assignment methodology is used in the Senior Projects/Capstone course due to the requirement that students enroll in this course, just prior to graduation. Thus, they have experienced the complete range of courses, faculty and facilities in the curriculum. The Senior Projects/Capstone course can be a rich source of information related to outcomes criteria, department and college goals and program objectives. The following assessment methods were incorporated in to the Senior Projects/Capstone course: 1) graduating seniors one on one exit interviews, 2) graduation surveys and 3) evaluations by semester, and typically involves teams of two, who develop a project proposal, plan and track the project using project management software, make several oral presentations on their progress, and submit regular status reports and interim and final reports. The final week of the class includes oral presentations on the projects before an audience of faculty, students, advisory board members, family members and other guests from the community.

Impact on Students

Students involved in the senior design project got to work one-on-one with industry and learned the importance of customer specifications. As a result of the regular meetings with industry, students became more professional in their presentations and project delivery. The importance of deadlines and meeting milestones were significant learning outcomes to come out of the project from a student perspective. Students also learned and proved the importance of good research, diligent troubleshooting and timely checks on requirements. The project was technically satisfying and the final presentations and demonstration reinforced the significance of soft skills allied to technical competence.

Conclusion

The project was a successful collaboration between industry and academia. The designed unit met expectations of the sponsor and clients. The students grabbed the chance to work with industry personnel and maximized their interactions by meeting deadlines and exceeding their milestones. The project also provided industry with an idea of the capabilities of students in the ELET program and served as a precursor for more such interactions in the future. The model put in place here by the ELET program at UNT is worthy of emulation. This year, the program had 80% of senior design projects sponsored by industry. The goal is to increase the sponsorship to 100%. It is imperative for students to work on projects that are industry sponsored. Such projects round their knowledge and could potentially lead to internship or job opportunities in the companies.

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Biographies

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