CHAPTER 20
WAYNE STATE UNIVERSITY

College of Engineering
Department of Electrical & Computer Engineering
5050 Anthony Wayne Drive
Detroit, MI 48202

Principal Investigator:

Robert F. Erlandson, Ph.D., (313) 577-3900

rerlands@ece.eng.wayne.edu

ADNON LIGHT WIRELESS DISPLAY UNIT

Project 1: Adnon Light Wireless Display Unit: Adnon Board
Designer: Fakhir Habib and Naveen Selvam
Client Coordinator: Richard Vasiloff, Goodwill Industries of Detroit
Supervisors: Dr. Robert Erlandson, Mr. David Sant, and Mr. Santosh Kodimyala
Department of Electrical and Computer Engineering
Wayne State University
Detroit, MI 48202

Project 2: Adnon Light Wireless Display Unit: Workstation Switch Units
Designers: Daniel Wrubel and Elden Saba
Client Coordinator: Richard Vasiloff, Goodwill Industries of Detroit
Supervisors: Dr. Robert Erlandson, Mr. David Sant, and Mr. Santosh Kodimyala
Department of Electrical and Computer Engineering
Wayne State University
Detroit, MI 48202

INTRODUCTION

The Adnon Light Wireless Display Unit was designed to allow supervisors at an agency for persons with disabilities to monitor their departments without being in the area the entire time. This project is an example of universal design in the workplace in that it increases productivity and quality for all workers, while enabling workers with cognitive disabilities to participate competently in a broader spectrum of jobs.

Individuals with cognitive impairments may have difficulty with a number of packaging jobs. If they run out of inventory, some individuals simply stop working and do not obtain or request additional inventory. If the machine stops or malfunctions, they may stop working. If workers need a toilet break, they may simply leave the work area. All these behaviors result in lost productivity and poor job performance. Work supervisors believe that many workers can adapt to pushing a switch if they run out of inventory, their equipment fails, or they need a break. The two Adnon Light Wireless Display Unit projects address this need.

The project has two distinct but related components: the switch unit for the worker and the Adnon board. Twelve workstation-based switch units were designed and built. Figure 20.1 shows an individual workstation switch unit. There are two switches: red for equipment malfunctions/emergencies and yellow for inventory replacement. Each switch is a different shape and color. The workstation units contain a wireless transceiver that communicates with one of two Adnon boards. Each Adnon board has displays for six workstations. Each workstation transceiver has a unique address as do the two Adnon board transceivers. Each column corresponds to a workstation. A supervisor can see who needs assistance and the nature of the assistance required.

SUMMARY OF IMPACT

The Adnon Board and Workstation projects started with an existing system. The X10 system components were scrapped, leaving only the Adnon board frames. A wireless communication system was designed for communications between the workstation units and the Adnon boards. The wireless system exhibited universal design in that it improved productivity and reduced non-value added activities for all workers.

TECHNICAL DESCRIPTION

Project 1: Adnon Board

The Adnon Light Wireless Display Unit consists of two display boxes that allow up to 12 stations to visually display the status of their machines. These four foot by six foot Adnon boards are hung from the ceiling and are visible throughout the work area. Each Board has six labeled columns, which correspond to one of 12 transmitters. There are two lights for each column. This allows for visual communication between supervisors and workers. There is one red light and one yellow light for each column. The yellow light indicates that the worker needs parts while the red light indicates that a station is down and needs assistance. Priority is given to the red light, station down, function. If the yellow light is on first and the red light is turned on, then the yellow light will turn off.

At the receiver end, the transceiver is used to receive the data that is then sent to the PIC16F876. The microcontroller decodes this data and illuminates the light(s) accordingly. This circuit uses triads with optoisolators to isolate the DC part of circuit from AC. The Figure 20.2 shows the receiver circuit. The LEDs at the bottom of the circuit correspond to the columns at the display board.

Project 2: Workstation Switch Units

There are 12 transmitters, which allow communication with each of the 12 columns on the display box. Each transmitter has two buttons: red and yellow. These buttons control the lights of the corresponding column on the display box. In the case that a transmitter should stop working, the transmitters have a programming mode, which allows them to be set to correspond to any one of the twelve columns on the two display boxes. The programming and reset switches are shown in Figure 20.3.

Each transmitter is also equipped with an indicator light, which has two functions. The first function allows the user to have visual verification that the transmitter is sending data, and the second function allows the user feedback on the energy left in the battery. The light stays on while the transmitter is sending data; the light turns off after the transmission is complete. The light remains green while the batteries are charged. It turns red when the batteries are running out of energy and need to be replaced.
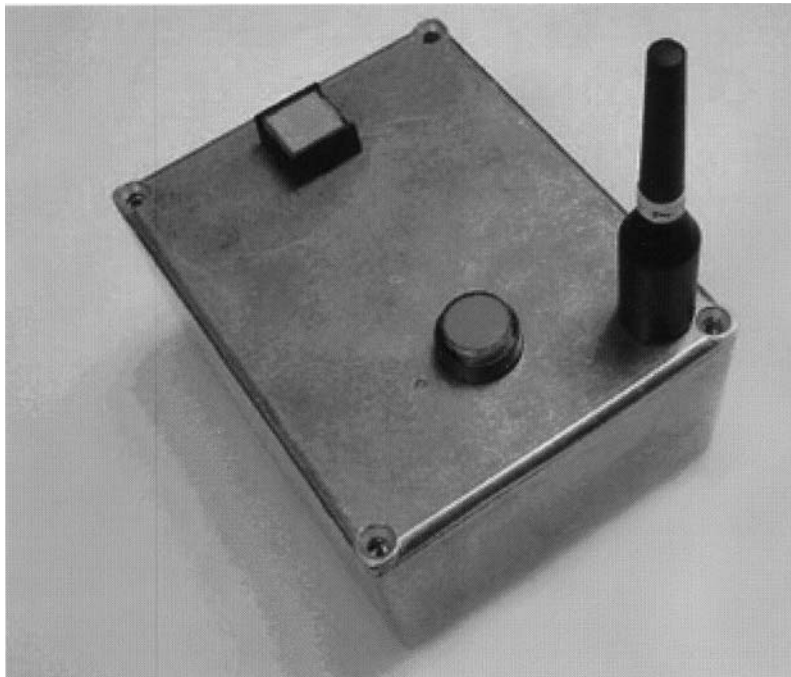

Figure 20.1. Transmitter Unit.

When new batteries are added, the light becomes green again. Figure 20.4 shows the red and yellow push buttons, PIC microcontroller and the LED indicator on the top layer of the PCB.
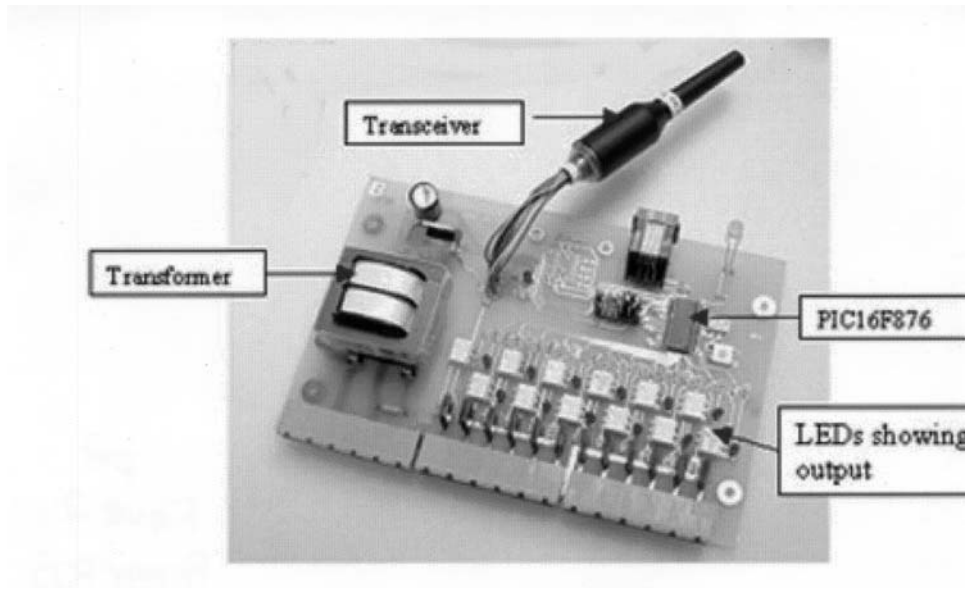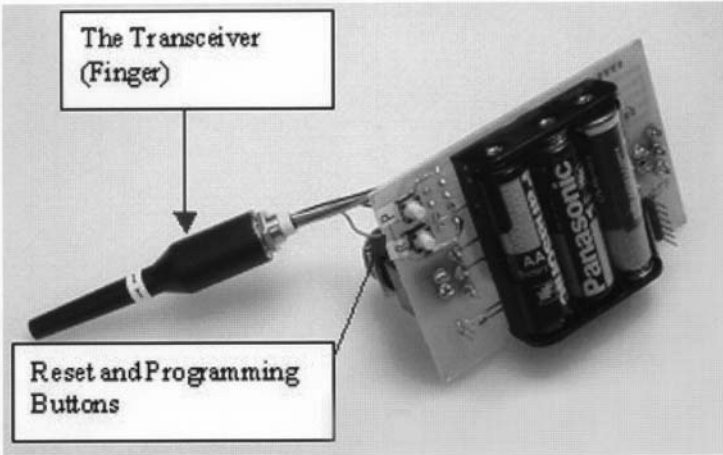

Figure 20.2. Receiver PCB.
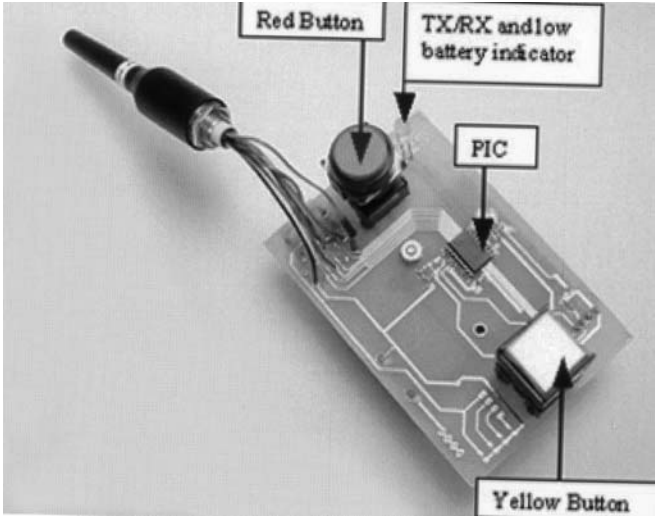
Figure 20.3. Transmitter PCB Bottom Layer.

Figure 20.4. Top Layer of Transmitter Board.

WEIGH STATION PACKAGING QUALITY CONTROL SOFTWARE AND HARDWARE

Project 1: Weigh Station Packaging Quality Control: Software Design
Designer: Aakash Arora
Client Coordinator: Asif Khan, Goodwill Industries of Detroit
Supervisors: Dr. Robert Erlandson, Mr. David Sant, and Mr. Santosh Kodimyala
Department of Electrical and Computer Engineering
Wayne State University
Detroit, MI 48202

Project 2: Weigh Station Packaging Quality Control: Hardware Design
Designers: Isabela Alonso and Jason Miller
Client Coordinator: Asif Khan, Goodwill Industries of Detroit
Supervisors: Dr. Robert Erlandson, Mr. David Sant, and Mr. Santosh Kodimyala
Department of Electrical and Computer Engineering
Wayne State University
Detroit, MI 48202

INTRODUCTION

The Weigh Station Packaging Quality Control Software and Hardware Design project demonstrates a universal design's capability to support workers with and without disabilities while addressing quality, productivity, and efficiency. The project is designed to aid in packaging automotive license plate kits for a final auto assembly plant. A center for workers with disabilities packages 200 kits per large shipping container.

License plate kits are assembled at individual packaging stations. The assembled kits fall off a conveyor line into a large box. A worker collects the kits and places them in an organized fashion into large shipping containers. These containers are then weighed to ensure the proper number of kits per container.

SUMMARY OF IMPACT

The new Weigh Station Packaging Quality Control System utilizes a universal design approach to create a process that accommodates users with a range of cognitive abilities. Someone who cannot count or read can use the system. The system also error-proofs and reduces non-value added activity of the final count process by eliminating a per kit weight determination procedure each time a final count is made.

Quality assurance is improved by the driver's required "sign-off" procedure when the correct count is reached. The new system creates a database that keeps track of jobs completed and inventory shipped. The information in this database will be integrated into an evolving computerized inventory and quality control system.

TECHNICAL DESCRIPTION

To get an accurate weight using the previous system a forklift driver picks up a large shipping container. The container is placed on a large floor scale; the driver must jump off the forklift and push buttons on the scale to perform a tare operation (find the empty container's weight). Then the driver writes the tare weight on a tag that is hooked onto the shipping container.

The driver then uses the forklift to pick up the carton and deliver it to a license plate kit assembly station. Here another worker places 200 kits into the container. When filled, the forklift driver picks up the carton and returns to the floor scale. The driver exits the forklift and goes through a process wherein the scale software can determine a per-kit weight. Then the driver places the shipping container onto the scale. Next, the driver again exits the forklift to input the container's tare weight to the scale. The scale determines the number of kits in the container by subtracting the tare weight and dividing the remaining weight by the per-kit weight. If there are too many or too few license plate kits in the

container, the operator makes the final corrections by reading the scale. When the count is correct, the carton is delivered to the shipping area.

A wireless item identification process in conjunction with a digital weight scale, each interfaced with a computer, was implemented. All relevant data are stored on the computer to create a packaging and quality control system. While gathering important data, the system is designed to increase worker productivity while using existing weighing hardware.

Figure 20.5 is a block diagram representing the new system. It uses passive RF tags, an RF Reader/Scanner, and the computer control features of a digital scale to greatly simplify and improve the process described above.

Using the new RF tag system, the forklift driver picks up an empty shipping carton and places it on the floor scale. The driver then exits the forklift and places an RF tag onto the side of the carton. The RF Reader/Scanner interrogates the RF tag on the container and the control computer recognizes that the tag is being reassigned to a new container and records the empty container weight as the tare weight.

The system also requests that the driver enter a job number. System I/O is designed to be versatile. Information can be presented to the driver in iconic and/or written form, with additional verbal prompting if required. The driver's supervisor can create user preferences unique to each user. Whereas the old process required the driver to go through a per unit kit weight determination procedure every time a new carton was brought for the final count, the new system requires the per unit kit weight be determined only once, when the job is originally entered into the system. Hence, after the driver enters the job to be counted, the system automatically associates the correct per unit kit weight with the RF tag. The system prompts the user when this assignment step is completed. The driver then delivers the container to an assembly station.

When the shipping container has been filled, the driver picks it up and returns it to the floor scale. While the container is placed onto the scale, the RF Reader/Scanner identifies the unique tag and recognizes that the container is being returned for a final count. The system detects the tare weight, the

per unit kit weight, and total weight, so it can determine the kit count and inform the driver as to the required action. If any adjustments are required, the driver makes them after being prompted by the system. When the correct count is reached, the system prompts the driver and he/she must respond by entering a count-completed command to the system. This step is required for quality purposes.

Project 1: Software
Visual Basic 6 (VB) is used for the system's software. This is a robust coding language that allows for a variety of ways to write code. For proper user interface, a number of VB forms (screens) are used. Communications procedures are built into VB for both RS232 communication and database manipulation. With the databases in this project, users are able to store, view, and back-up all relevant data.

For employees to maintain proper controls over the software, two different permission levels were created: administrative and user. Under the administrative permission level, users can find and edit all stored data, such as user information, job information, and tag associations. They also have the ability to generate reports based on specific dates and back-up the main database of information, as well as perform tare and piece-count functions. Mainly, the Materials Supervisor will be performing these operations. For each individual job, the supervisor will be required to initially go through a calibration process. This is used to find the individual piece weight. After this, the process of tare and piece-count is started and repeated as many times as required. The Materials Supervisor will also be required to verify all information stored on the computer to maintain materials accountability.

The user permission level is for the forklift driver and floor worker. This portion of the I/O is designed to accommodate workers with a wide range of cognitive abilities..

Project 2: Hardware
This project is a combination of radio frequency identification (RFID), digital weighing, visual basic code and storage of information in databases. Each of these parts play a crucial role in the functionality of the overall project.

RFID hardware consists mainly of a reader, an antenna, and the FID tags. A Creform stand is designed and built to house the RF antenna, the reader/scanner, and the power supply. To turn on the reader, the user must flip up the switch on the side of the housing and ensure that the indicator light is on. Once the power supply is turned on, the reader is ready to identify any tags brought to within one meter of the antenna. Upon recognition of the tag, the reader is setup to output the number of the tag that was found over an RS232 serial communications port. This tag number is stored on the computer, and is used as the primary key for all data manipulation. All of these components are manufactured by Texas Instruments and are reliable.

The client workplace already has a large floor scale that has a capacity of 5000 pounds. They also have a digital scale connected to the floor scale for tare of containers and piece counting. Like the RFID reader, the digital scale has an RS232 output. The output from the scale will differ depending on the input it receives. For this project, scale weight output is used. Weigh-Tronix is the manufacturer of both the floor scale and the digital weight scale.
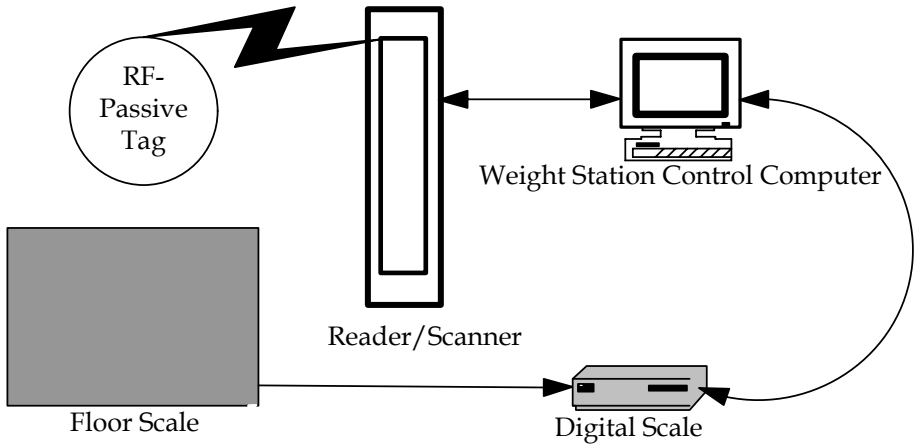
Figure 20.5. Block Diagram Representation of the RF Tag Based System.