INFRARED BAT-SPEED-TRACKING DEVICE
CVG Systems Baseball Edition

by

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A SENIOR THESIS PROPOSAL

Presented to the Faculty of

The Computer and Electronics Engineering Department

In Partial Fulfillment of Requirements

For CEEN 4980 Senior Thesis

Major: Computer Engineering and Electronics Engineering

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The accompanying Senior Thesis Proposal, “Infrared Bat-Speed-Tracking Device”, is submitted in accordance with the requirements of CEEN 4980, Senior Thesis. As stated in the proposal, this project is the first of many unique infrared speed-tracking devices designed and funded by CVG Systems. Coonrod, Vergo, and George (CEOs and founders of CVG Systems) have reviewed this proposal and find that it meets the needs of the company.

Herb Detloff, has been selected as a university contact (project advisor) and has also reviewed this proposal and accepts that it will comply with project specifications for Senior Thesis.

Respectfully yours,

Brent E. Coonrod

J.Scott George

Marc A. Vergo

Herb Detloff

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1.0 BACKGROUND

Today's competitive softball player is concerned with the speed of their bat. It is a well-known fact that as one's bat speed increases, so does the distance that the ball travels. Increasing the distance that the ball travels increases the likelihood of a homerun.

From physics, we know that momentum equals mass times velocity.

Kinetic Energy = mass * velocity

$$k = mv$$

Since the mass of the bat and the ball are constant, in order to increase the momentum, we must increase the velocity of the bat.

Currently in the world of softball, players wish to track their bat speed. Equipment for tracking bat speeds, however, does not exist. The goal of our project is to provide an accurate infrared bat-speed-tracking device.

2.0 THESIS OVERVIEW

A user will be able to swing an object through a designated zone. If the user has properly swung the object through the zone, the speed-tracking system will measure, calculate, and display the speed of the object to the nearest mile per hour. The speed will also be automatically sent to an attached PC, where the speed will be displayed on the PC's screen. This information can used by coaching staff, as a tournament or game initiation, or by the user to understand how to swing the object in the most beneficial manner for training improvements.

The user is allowed to swing any object that can be registered within the designated zone. The speed-tracking device or CVG System has been designed to track the speed of softball or baseball bats. A user will swing a bat through a designated hitting zone, our device will measure, calculate, transmit to a PC, and display the speed of the bat to the nearest mile per hour on a visual display.

Note: the device will measure the speed of the bat that passes through the designated hitting zone only.

3.0 GENERAL DESCRIPTION

3.1 Design constraints

The physical project will be comprised of a break-beam infrared detection system, microprocessor, calculation unit, display unit, and a housing unit.

The break-beam infrared detection system will have to be modulated to override background infrared (noise), for both indoor and outdoor use. The analog modulated infrared signal will be captured by demodulation circuitry and will be converted to a digital signal for processing by the microprocessor. The infrared modulation will have to be accurate in order to acquire a large designated distance or hitting zone.

The hitting zone will be large enough that the user will feel comfortable while swinging a softball/baseball bat through the region. The mechanical design and housing of the infrared detection system will allow the user to adjust the hitting region for his/her needs, such as height, arc of swing, and depth of momentum. The housing will be ruggedized in case of accidental impact and will allow the device to be utilized in most weather conditions.

As the user swings a bat through a designated hitting zone, the CVG System will recognize that an object has entered the hitting zone and will calculate the time it takes the device to leave the hitting zone. The user will be able to enter the hitting region from either side, the microprocessor will determine which side the user has entered and count internally how long the user has been inside the hitting zone. Once the user has completely left the hitting zone, the microprocessor will calculate (to the nearest mile per hour) how fast the bat passed through the region, this depends on the amount of time within the region. The CVG System will then display the speed on the visual display and transmit the speed over an RS232 connection to an attached PC.

The visual display will be comprised of a number display, push buttons, and light emitting diodes. The number display will physically show the speed to the nearest mile per hour. Push buttons will be used to prepare the system for the next hit or the next hitter, which will be determined by the user and presented by the LEDs.

An RS232 connection will transmit the speed that has been displayed on the visual display to an attached PC. The PC's display will show which swing the user is on, which hitter is currently hitting, and how fast of a swing they just had. If the PC is not attached the device will operate as normal. This connection is merely a means of allowing coaching staff or the user to keep track of their performance while using the CVG System.

The microprocessor will be written in assembly code, according to the specifications of the microprocessor that is chosen. The code will recognize user input and calculate the speed of any recognizable object that passes through the designated hitting zone. The process will reset and re-initialize upon startup.

The system will be powered through a wall transformer. The system will be able to be turned on/off from the main power supply.

3.2 Circuit fabrication

The final circuit(s) will be wire-wrapped on prototype board(s) and enclosed in protective housing units. The break-beam circuit will be composed of discrete parts that need to be specifically aligned with a sturdy housing unit. All circuit schematics will be designed using ORCAD version 9 or equivalent.

3.3 Testing

The accuracy of the machine will be compared against a device that produces a known speed. Our intent is to test each module of the project during implementation and then interface each module individually together.

Note: a device that provides a known speed will be announced later (possible testing devices include: a passing automobile or an accelerometer).

3.4 Evaluation

A softball team from the Omaha area will evaluate the device. Each participant will fill out a satisfaction survey. In addition, all faculty members will be invited to evaluate the infrared bat-speed-tracking device.

3.5 Block Diagrams

The hardware block diagram is attached as:

B. Coonrod, S. George, M. Vergo, Thesis 6

The assembly code flow has been attached as:

B. Coonrod, S. George, M. Vergo, Thesis 7 - 10

4.0 COMPONENTS LIST

	Quantity	Estimated Cost	Subtotal
Processor			
PIC16C73B	3	$19.74	$59.22
PICDEM2 - demo. Board	1	$110.00	$110.00
PIC Programmer	1	$208.95	$208.95
Canned Crystal Oscillator (14.318MHz)	1	$3.00	$3.00
Subtotal			**$381.17**
Transmit/Receive Units			
IR Diodes	2	$0.99	$1.98
IR Detector Modules	2	$5.98	$11.96
Op-Amps UA741	2	$0.25	$0.50
10k Pot.	2	$0.99	$1.98
50k Pot.	2	$0.45	$0.90
Resistors			
1k Ohms	4	$0.27	$1.08
10k Ohms	8	$0.27	$2.16
120 Ohm (1watt)	2	$3.00	$6.00
330 Ohm	10	$0.27	$2.70
Capacitors			
1nF	2	$0.19	$0.38
10nF	2	$0.29	$0.58
.33uF	1	$0.19	$0.19
.1uF	1	$0.12	$0.12
220uF	2	$0.29	$0.58
NPN Transistors - 2N2222	4	$0.39	$1.56
Transistor 3904	2	$1.18	$2.36
SPDT/SM Switches	3	$1.29	$3.87
555 Timer	2	$0.49	$0.98
Integrated Circuits			
7496 - 5-bit Shift Register	2	$0.59	$1.18
7400 - NAND Gate	3	$0.59	$1.77
74247 - BCD to 7Seg Decoder/Drivers	3	$0.79	$2.37
Subtotal			**$45.20**
Visual Display			
7-Seg LEDs (Large Red)	3	$4.49	$13.47
Arcade Pushbuttons	3	$1.55	$4.65
Pushbutton Covers	3	$2.15	$6.45
Red LEDs	5	$0.22	$1.10
Green LEDs	5	$0.27	$1.35
Subtotal			**$27.02**
RS232			
DB-9 Cable (9-pin to 9-pin, straight)	1	$12.00	$12.00
RS232 Adapter	1	$10.64	$10.64
Subtotal			**$22.64**

Mechanical Design			
Transmit/Receive Boxes	2	$3.95	$7.90
Metal Casing (Conduit Piping)	1	$76.41	$76.41
Umbrella Stand	1	$25.00	$25.00
Visual Display Box	1	$7.95	$7.95
Subtotal			**$117.26**
Power Circuitry			
78L05 - Voltage Regulators	1	$0.19	$0.19
Subtotal			**$0.19**
Software			
MPLAB	1	$0.00	$0.00
HyperTerminal	1	$0.00	$0.00
Subtotal			**$0.00**
Miscellaneous			
Wire-wrap	1	$15.92	$15.92
Prototype PCB Boards	4	$5.95	$23.80
Dip Sockets	1	$16.16	$16.16
Screw (Bag of 20)	1	$1.50	$1.50
Decals	1	$5.83	$5.83
FedEx	1	$48.85	$48.85
Domain Name (1-year)	1	$29.00	$29.00
9V Battery Clips and connectors	1	$11.11	$11.11
Washers	1	$5.45	$5.45
Battery Holder and Screws	1	$6.01	$6.01
Mending Plate	1	$1.77	$1.77
Solderless Connectors	1	$5.00	$5.00
Pop Rivets	1	$1.00	$1.00
Diode Metallic	4	$0.75	$3.00
Bat Speed Indicator	1	$155.00	$155.00
Subtotal			**$329.40**
Grand Total			**$922.88**

5.0 TIME SCHEDULE

5.1 Intentions

Prior to the end of the spring semester 2001, the final working prototype will be demonstrated and presented to the faculty at the University of Nebraska Lincoln on the Omaha campus. The final report and documentation will also be presented at this time. The presentation date will be scheduled for a date prior to the end of the spring semester 2001, sometime during "Dead Week" (April 23-27).

5.2 Hardware/Software Integration

See Page: B. Coonrod, S. George, M. Vergo, Thesis 14

5.3 System Evaluation and Accuracy Testing

See Page: B. Coonrod, S. George, M. Vergo, Thesis 14

5.4 Write-up

See Page: B. Coonrod, S. George, M. Vergo, Thesis 14

5.5 Presentation

See Page: B. Coonrod, S. George, M. Vergo, Thesis 14

Sections 5.2, 5.3, and 5.4 are a cyclical process that will be performed as required starting upon acceptance of this proposal, and ending on or before April 27.

6.0 ACCEPTANCE TESTING

- Measure speed to nearest mile per hour of any object that can be registered within the targeted hitting zone.
- Display speed in nearest mile per hour on visual display.
- Transmit the displayed speed to attached PC via RS232 connection.
- System can be utilized both indoors and outdoors, under any light conditions.

7.0 TEAM MEMBERS

The Thesis team is comprised of the following individuals:

BRENT EDMUND COONROD - Is a senior, working towards a Bachelor of Science degree in computer engineering with minors in mathematics and computer science. The vast knowledge that Brent has obtained about computer hardware design and programming software will be crucial building blocks in the thesis implementation. Brent has the intelligence, experience, and integrity to start an endeavor that will ultimately lead to success. He has made many contacts at the university and in his workplace that will allow for easy access to any information and services needed in the team's design. Anyone who knows Brent would agree that he is an enthusiastic, cooperative, outgoing individual who is and always will be a step above the rest.

J.SCOTT GEORGE - Is currently in his fifth and final year of a Bachelor of Science in Electronics Engineering. Scott's main area of emphasis to date is in hardware theory and implementation. Scott's remaining classes are mainly in communications (data and voice) engineering, which are focused on theory as opposed to application. Scott brings a broad base of circuit fabrication and personal experience in hardware design to the team. He will meet and succeed in the completion of all tasks laid before him, as has been proven time and time again in his college career.

MARC ANTHONY VERGO - Is a hard-working, do-what-it-takes member of the team. He has had experience with microprocessors and assembly language (both Intel and PIC) and is talented at learning new software and hardware tools and applying them. Marc is also a good team player and will pull his weight in the group. Most importantly, he wants to pull together the engineering principles that he has learned and develop a marketable, well-designed, and quality project for completion of his undergraduate degree.

8.0 ASSIGNMENT OF EACH MEMBER

BRENT EDMUND COONROD

- Scholarships
- Project/Patent Research
- Mechanical Engineering Design
- PIC Processor – Software Design
- RS232 Data Transmission
- Final Presentation

J.SCOTT GEORGE

- Scholarships
- ORCAD Schematics
- Fabrication of Hardware
- Testing of Hardware
- Visual Display
- Power Usage

MARC ANTHONY VERGO

- Project Budget
- ORCAD Schematics
- Testing Software/Hardware Interfaces
- PIC Processor – Software Design
- Project Calibration
- Final Report

9.0 SUMMARY

This is an innovative project that requires analog and digital interfacing, power concerns, RF/communication techniques, and software development processes with an emphasis in assembly. It also encompasses new areas not previously covered in our course curriculum, such as materials engineering (housing unit and sensor alignment) as well as physics.

The physical project will be comprised of a break-beam infrared detection system, microprocessor, calculation unit, display unit and a housing unit. The break-beam infrared detection system will be modulated to override background infrared. As the user swings an object, which can be registered through the hitting zone, the microprocessor will determine how long the object was in the target region. Once the object has left the hitting zone, the microprocessor will calculate and transfer data to the visual display and an attached PC via an RS232 serial connection. The user will then press a button on the visual display to prepare the system for the next swing.

LEDs on the visual display will show the user the speed of the object to the nearest mile per hour and which hit the user is on. The circuitry of the visual display will be attached to the housing unit.

The housing unit will be ruggedized to withstand accidental impacts and will conceal all wires and circuitry. The user may adjust the housing unit to fit his/her needs, to make the training process as comfortable as possible. Circuitry within the housing unit will be wire-wrapped, unless the circuit can be bought “off shelf”. All circuits will be designed using ORCAD version 9 or equivalent.

The microprocessor will be written in assembly code according to the specifications of the microprocessor that is chosen. The code will recognize user input and calculate the **B.**

speed of any recognizable object that passes through the designated hitting zone. The process will reset and re-initialize upon startup.

The entire system will be powered through a wall transformer. The system will be able to be turned on/off from the main power supply.

The accuracy of the machine will be compared against a device that produces a known speed, such as a passing automobile or an accelerometer. Our intent is to test each module of the project during implementation and then interface each module individually together.

To verify the usefulness of the CVG System, a softball team from the Omaha area will evaluate the device. Each participant will fill out a satisfaction survey. In addition, all faculty members will be invited to evaluate the infrared bat-speed-tracking device.

We plan on being finished by the end of the spring semester. Even though each team member will have individual responsibilities, all members will collectively be involved with all aspects of the project.

The device has been designed with the needs of a softball/baseball player in mind. The speed of the bat is what the device has been produced to acquire. Alternative objects may be used within the designated region, this leads to CVG System's future line of speed-tracking sporting good equipment.

We predict that this project will take no less than 450 hours per member to complete, which includes: project proposal, research, parts acquisition, design, hardware development, software coding, testing, debugging, documentation, and report compilation. Once the CVG System is complete, it will perform the following criteria: measure the speed to nearest mile per hour of any object that can be registered within the targeted hitting zone, display the speed to the nearest mile per hour on a visual display, transmit the displayed speed to attached PC via RS232 connection, and will be able to be utilized both indoors and outdoors, under any light conditions.

On behalf of CVG Systems, we present this proposal to the University of Nebraska-Lincoln on the Omaha campus for review.