

INDIANA UNIVERSITY—PURDUE UNIVERSITY FORT WAYNE

# A Web-Enabled Parking Garage Monitoring System for Real-Time Data & Trend Analysis


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# Project Outline

- Executive Summary
- Problem Statement
- Solution Statement
- System Design
- System Testing
- Conclusion

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## Executive Summary

- Monitor vehicles entering and exiting
- Maintain a count of vehicles currently in the garage
- IPFW used as case study
- Prevent students from wasting time
- Spring Semester 2009 – Fall Semester 2009
- Final deliverables
  - GarageMon Software
  - Web Page
  - SMS Alert Component

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## Problem Statement

- Project members were frustrated with parking
- Survey of 12,000 active Spring-Semester students
- Approximately 20% of these students responded
- IPFW students verified to be frustrated with parking
- IPFW Chief of Police Jeff Davis
  - A system such as this was investigated a number of years ago, it was proposed to cost \$60,000
- Our project cost significantly less
  - Project Cost Was Less than \$1000

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# Solution Statement

- Create a system which monitors the number of cars in the garage and displays this information to the user

•INPUT


- Car Trips Sensor

•OUTPUT

- LED Sign
- Web Page
- SMS Message Notification

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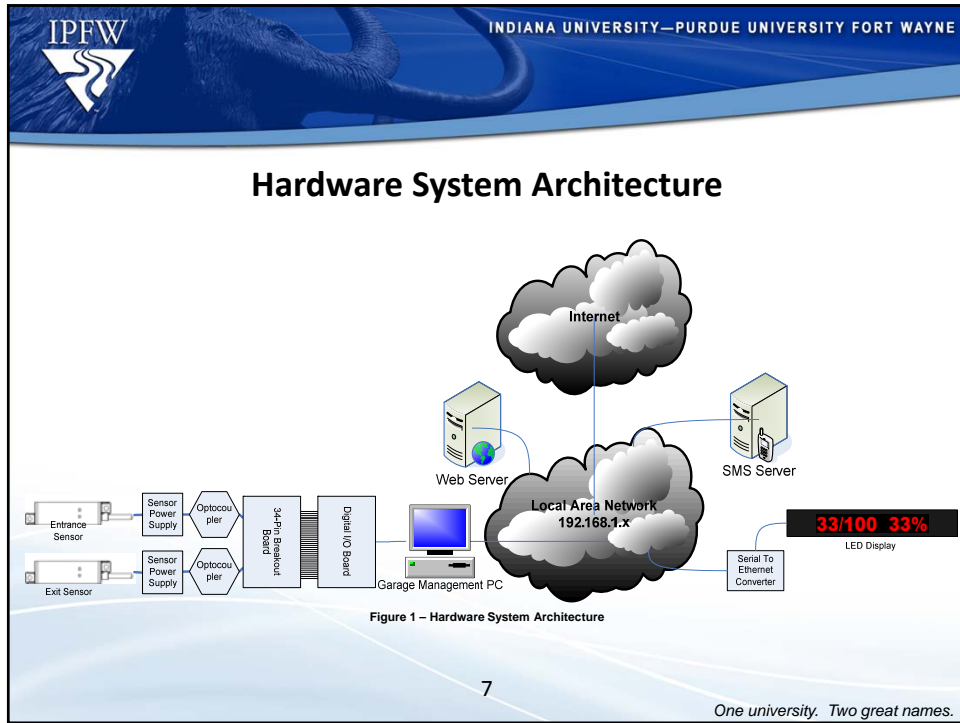


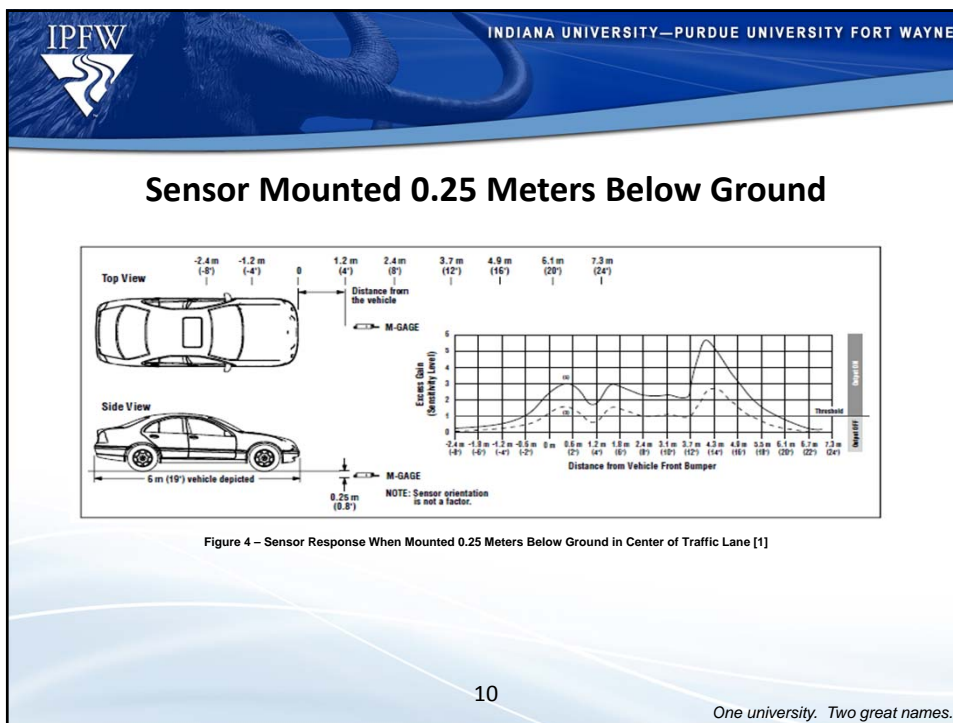
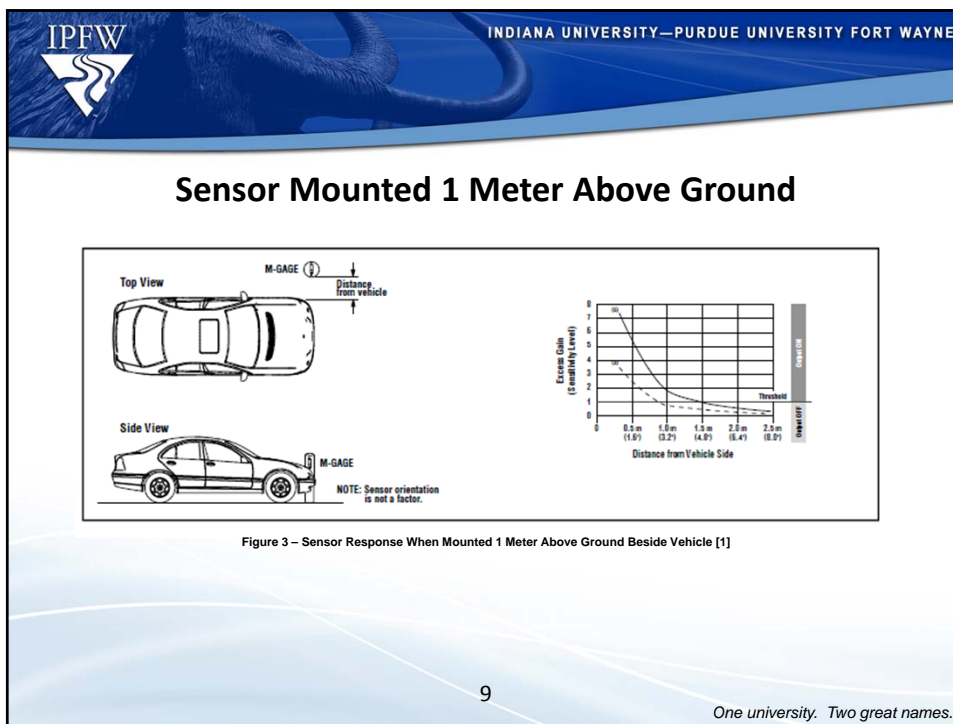
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# System Design

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## EMI Filter

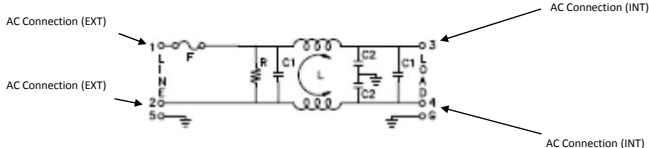



Figure 5 – EMI Filter Circuit Diagram [2]

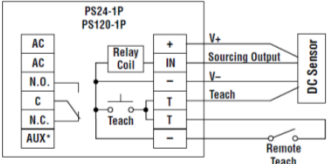
11

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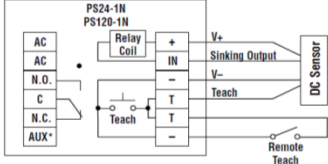

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## Sensor Power Supply

**PNP (Sourcing) Input**



**NPN (Sinking) Input**




\* AUX is an electrically isolated terminal.

Figure 6 – Sensor Power Supply Block Diagram [3]

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## Input Subsystem

Figure 7 – Input Subsystem, ABB Optocoupler Circuit Diagram [4]

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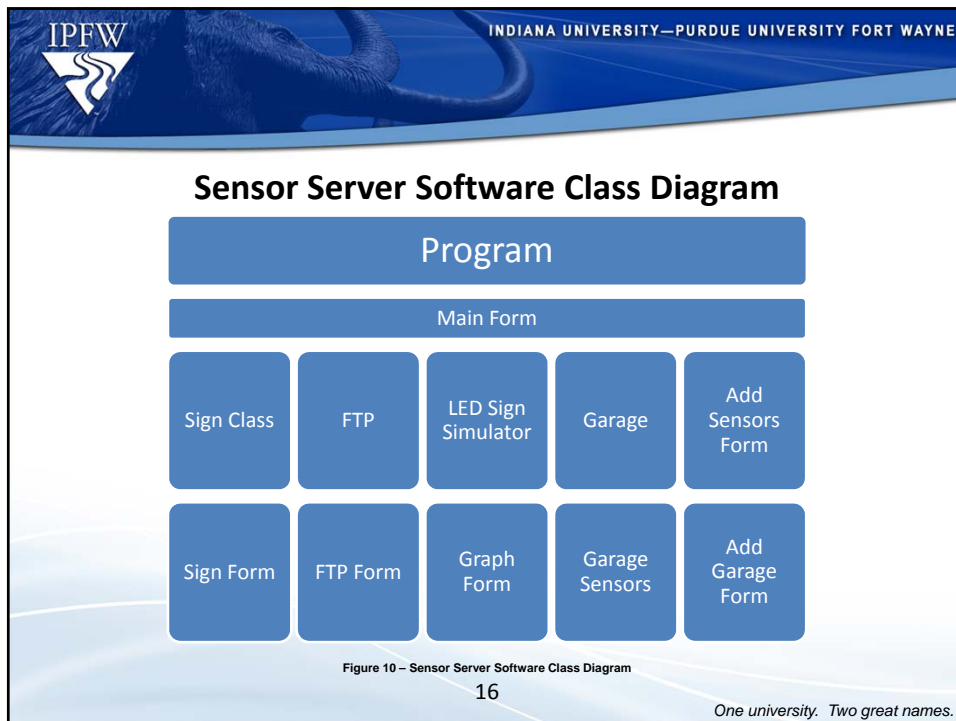
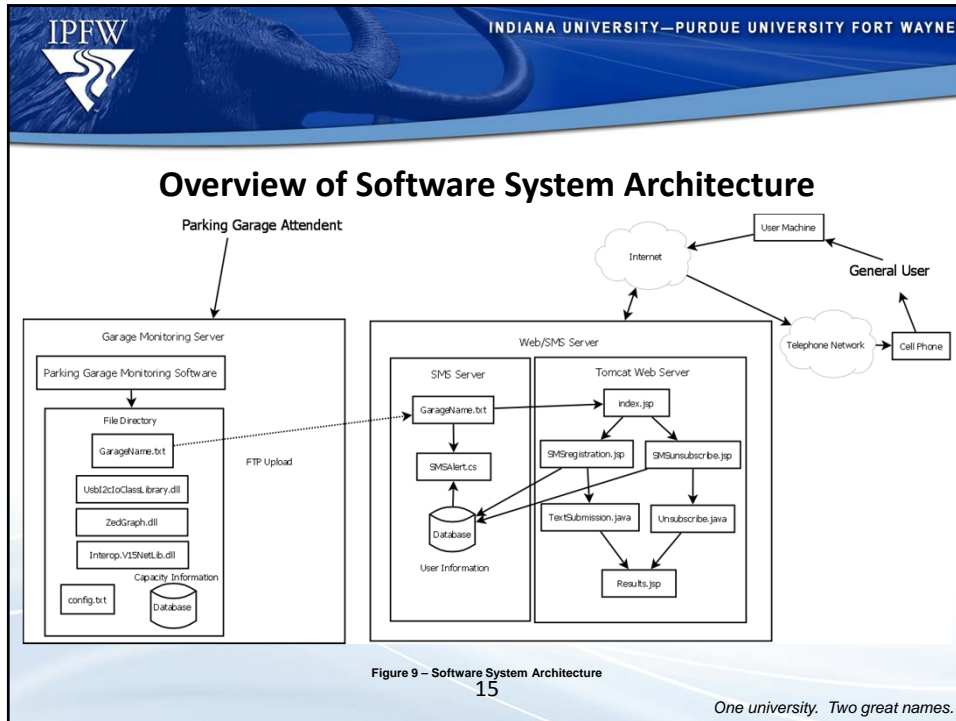

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## Output Subsystem

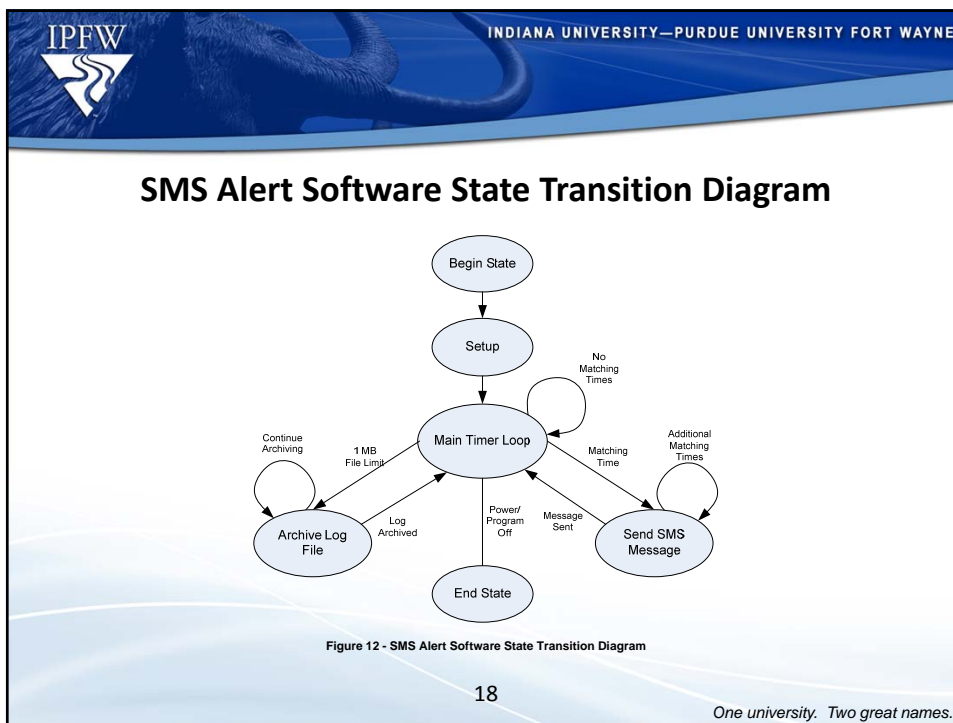
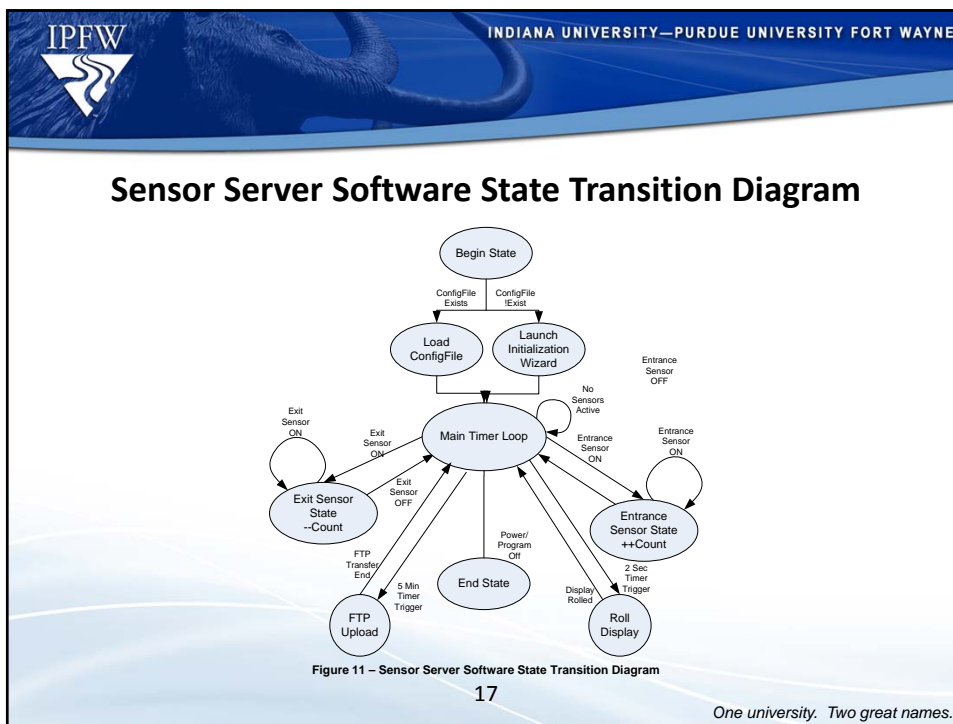
Figure 8 – Output Subsystem, Weidmuller Optocoupler [5]

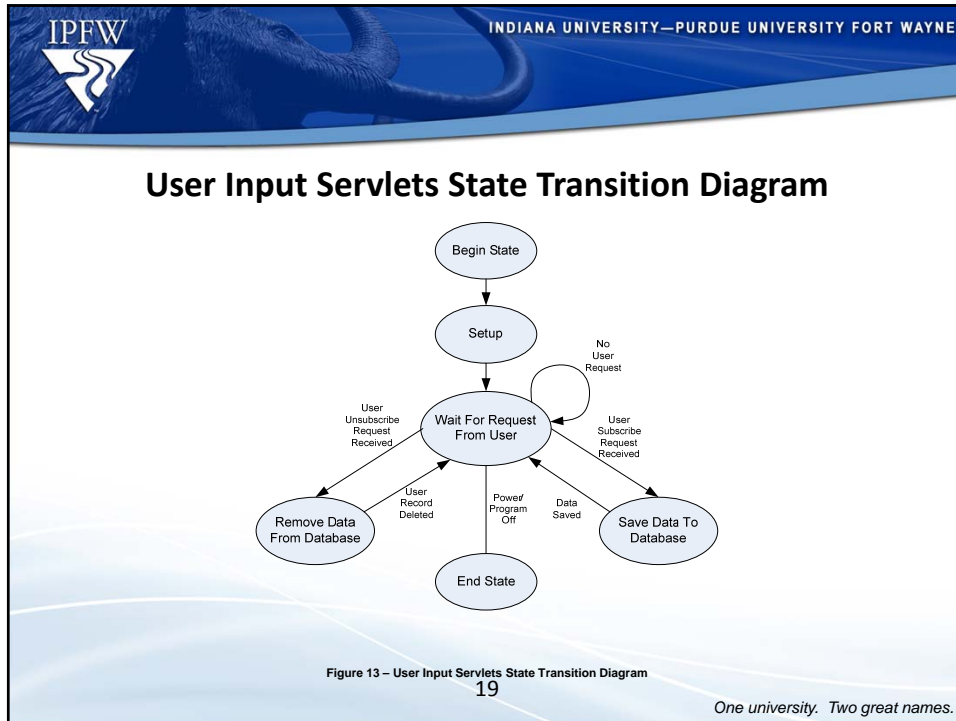
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The slide features the IPFW logo and the text 'INDIANA UNIVERSITY—PURDUE UNIVERSITY FORT WAYNE' at the top. The main content is the title 'System Testing' in a large, bold, black font, centered on the page.

# System Testing

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## Sensor Testing

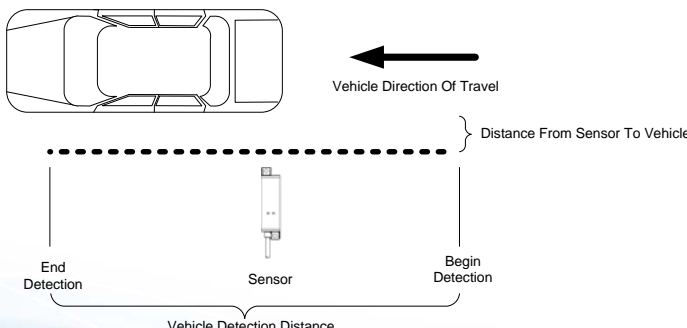



Figure 14 – Sensor Testing Rig

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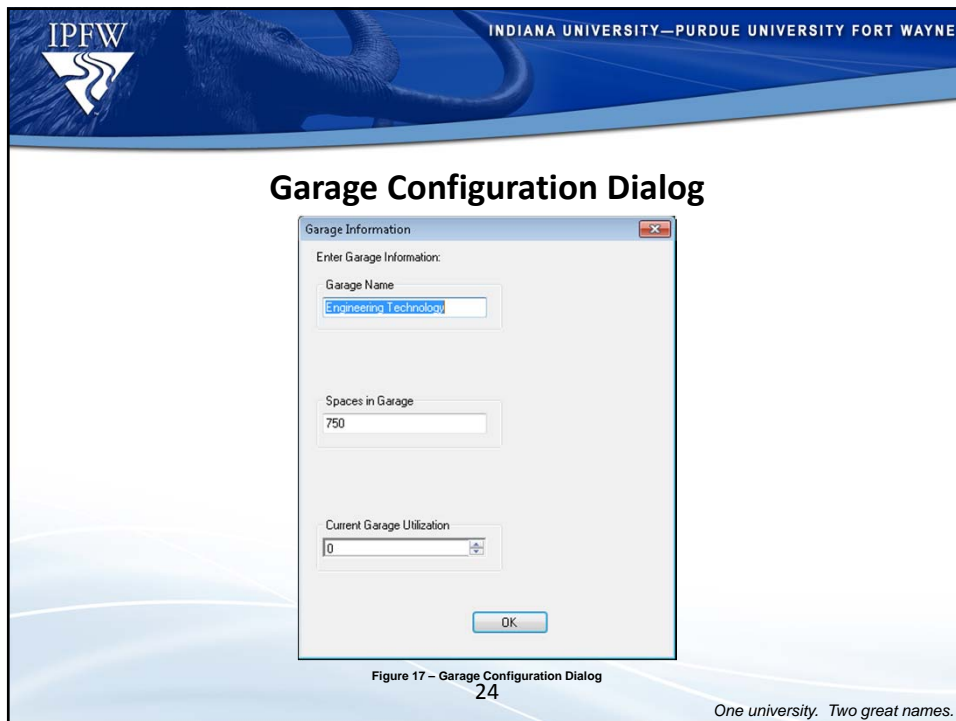
## Sensor Testing (cont.)

Distance Vehicle Detected	Height Above Ground	Distance From Vehicle	Vehicle Speed	Sensitivity Level	Errors?
0	18 inches	9 inches	5mph	6	Tripped Twice
0	18 inches	9 inches	5mph	5	No Trips
0	18 inches	9 inches	5mph	4	No Trips
0	18 inches	9 inches	5mph	3	No Trips
0	18 inches	9 inches	5mph	2	No Trips
0	18 inches	9 inches	5mph	1	No Trips
16 feet	30 inches	9 inches	2mph	6	
0	30 inches	9 inches	2mph	5	No Trips
0	30 inches	9 inches	2mph	4	No Trips
0	30 inches	9 inches	2mph	3	No Trips
0	30 inches	9 inches	2mph	2	No Trips
0	30 inches	9 inches	2mph	1	No Trips
12 feet	30 inches	19 inches	2mph	6	
	30 inches	19 inches	2mph	5	No Trips
	30 inches	19 inches	2mph	4	No Trips
	30 inches	19 inches	2mph	3	No Trips
	30 inches	19 inches	2mph	2	No Trips
	30 inches	19 inches	2mph	1	No Trips

Table 1 – Sensor Testing Results

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### Sensor Configuration Dialog

Figure 18 – Sensor Configuration Dialog

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### FTP Configuration Dialog

Figure 20 – FTP Configuration Dialog

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### Sign Configuration Dialog

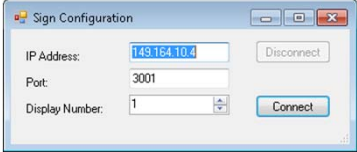


Figure 19 – Sign Configuration Dialog

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### Sensor Server Software Main Form

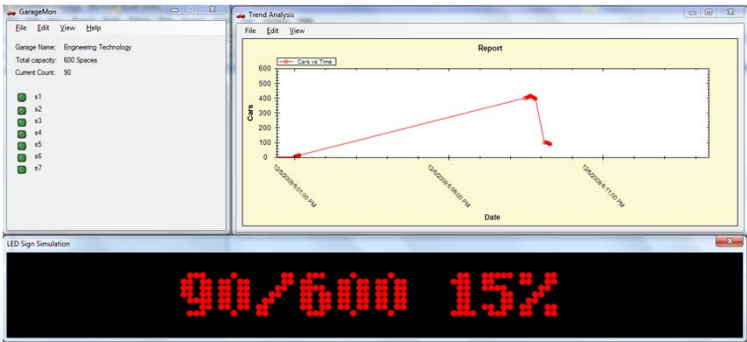


Figure 16 – Sensor Server Software Main Form

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## Parking Garage Status Web Page

Figure 21 - Parking Garage Status Web Page  
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## Parking Garage SMS Alert Subscription Page

Figure 22 – Parking Garage SMS Alert Registration Form

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**SMS Alert Subscription Error Page**

• Please enter a valid phone number.  
 • Please enter a password.  
 • Please select a carrier.  
 • Please select the day(s) you wish to receive messages on.  
 • Please enter the correct security code.

Figure 23 – Parking Garage SMS Alert Registration Form

**SMS Alert Subscription Confirmation Page**

Thank you for subscribing.

- Phone Number: (315)-111-1111
- Carrier: Sprint
- Day(s) to receive messages on: Monday, Wednesday, Friday
- Time of day message will be sent: 01:17 pm

Figure 24 –SMS Alert Registration Confirmation Page



**Parking Garage SMS Alert Unsubscribe Page**

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keyword  SEARCH  
Site Map | A-Z | People | Advanced Search

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**SMS Alert Unsubscribe**

Cell phone number:  
(317) 331-3111

Password:  
\*\*\*\*

**img7**

Please enter the security code shown above:  
img7

Submit

URL: <http://garagemon.ipfw.edu/8080/GarageMon/SMSUnsubscribe.jsp> Updated: December 5, 2009

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Figure 25 – Parking Garage SMS Alert Registration Form

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**SMS Alert Unsubscribe Error Page**

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**Incorrect phone-number/password combination.**

URL: <http://garagemon.ipfw.edu/8080/GarageMon/Unsubscribe> Updated: December 5, 2009

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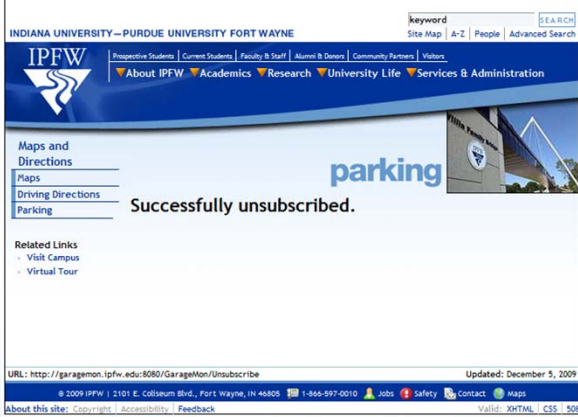
Figure 26 –SMS Alert Unsubscribe Confirmation Form

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## SMS Alert Unsubscribe Confirmation Page



keyword  SEARCH

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Maps and Directions

- Maps
- Driving Directions
- Parking

Successfully unsubscribed.

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URL: <http://garagemon.ipfw.edu:8080/GarageMon/Unsubscribe> Updated: December 5, 2009

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Figure 27 –SMS Alert Unsubscribe Confirmation Form

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## USB I<sup>2</sup>C/IO Board

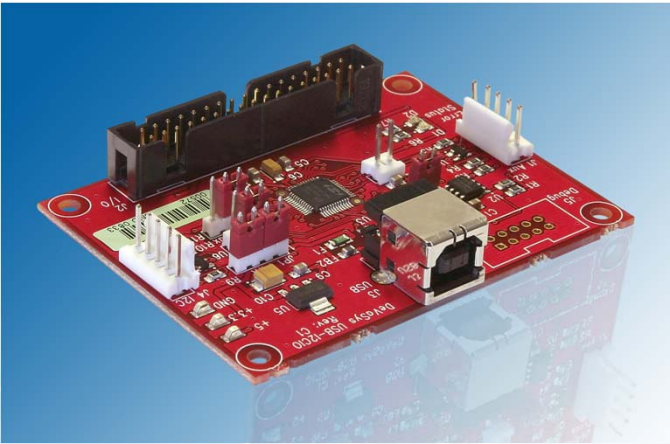


Figure 28 – USB I<sup>2</sup>C/IO Board [6]

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**Final Project Board**

Figure 29 – Final Project Board

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**Project Cost**

Item	Quantity	Unit Cost	Total Cost	Actual Cost
Banner Engineering Q7MB Sensor	2	\$221.00	\$442.00	\$0.00 (Donated)
PS115-1P Sensor Power Supply	2	\$68.00	\$136.00	\$0.00 (Donated)
ABB R900 OBC0100-24VDC Optocoupler	2	\$29.29	\$58.58	\$0.00 (Donated)
Weidmuller 839894-TTL Optocoupler	2	\$31.08	\$62.16	\$0.00 (Donated)
Devasys USB Digital I/O Board	1	\$89.00	\$89.00	\$0.00 (Donated)
34-pin Breakout Board	1	\$29.50	\$29.50	\$29.50
34-pin Ribbon Cable	1	\$1.75	\$1.75	\$0.00 (Had Part)
1 Meter DIN Rail	1	\$8.90	\$8.90	\$8.90
Qualtek 862-06/001 Power Line Filter	1	\$13.25	\$13.25	\$0.00 (Donated)
2x1' Laminated Wood Board	1	\$15.00	\$15.00	\$0.00 (Donated)
Electrical Conduit End	1	\$1.50	\$1.50	\$0.00 (Donated)
High Quality Power Cable	2	\$12.00	\$24.00	\$0.00 (Donated)
Philips Wood Screws	8	\$0.34	\$2.72	\$0.00 (Donated)
PVC Plastic Sheet	1	Unknown	Unknown	\$0.00 (Donated)
Spool of Wire	3	\$3.99	\$11.97	\$11.97
Aluminum Sheet, stamped	1	Unknown	Unknown	\$0.00 (Donated)
Fuse	1	Unknown	Unknown	\$0.00 (Donated)
Screw-down Terminal	5	Unknown	Unknown	\$0.00 (Donated)
1 Hour of Work Time	120	Unknown	Unknown	Unknown
			\$896.33	\$50.37

Table 2 – Project Cost

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## Summary

- Conclusion
  - Project was a success
  - Project goals reached
  - Provided invaluable project design, build, and management experience
- Lessons Learned
  - Project completion estimate is a difficult matter
  - Learned how to work with third party vendors for support / donations
  - Exercised programming skills
  - Exercised system integration skills

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- [2] Qualtek Electronics Corp. (2009, Sep.) Qualtekusa.com. [Online].  
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- [5] Weidmuller. (2009, Sep.) Product catalogue. [Online].  
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# Questions?

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# DEMO

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