


INDIANA UNIVERSITY—PURDUE UNIVERSITY FORT WAYNE

A Cloud-enabled Parking Garage Monitoring System with Smartphone Notification

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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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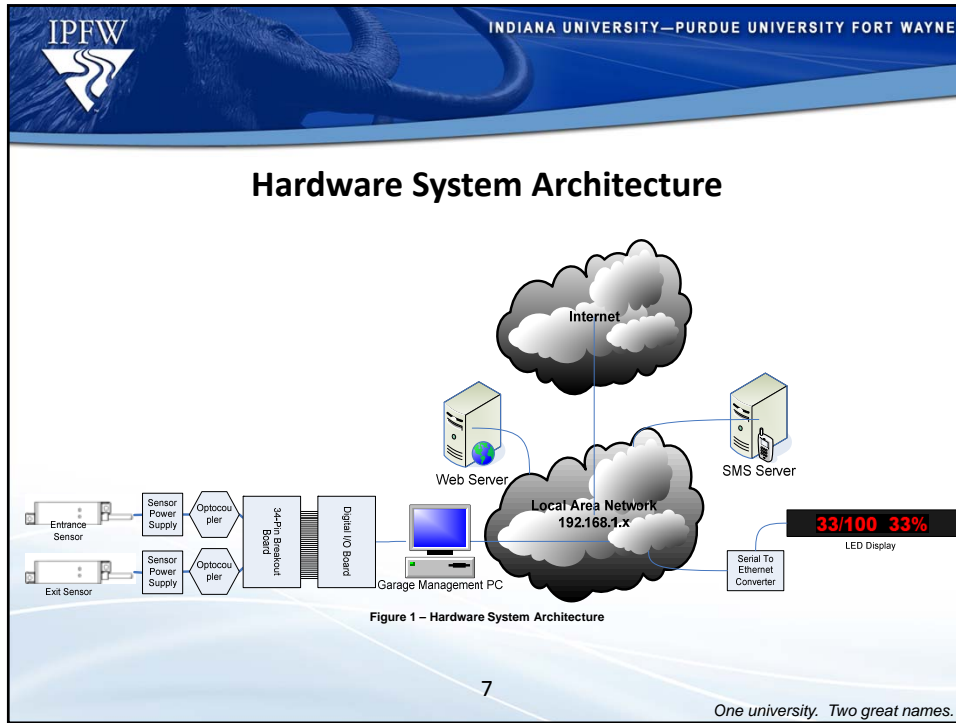


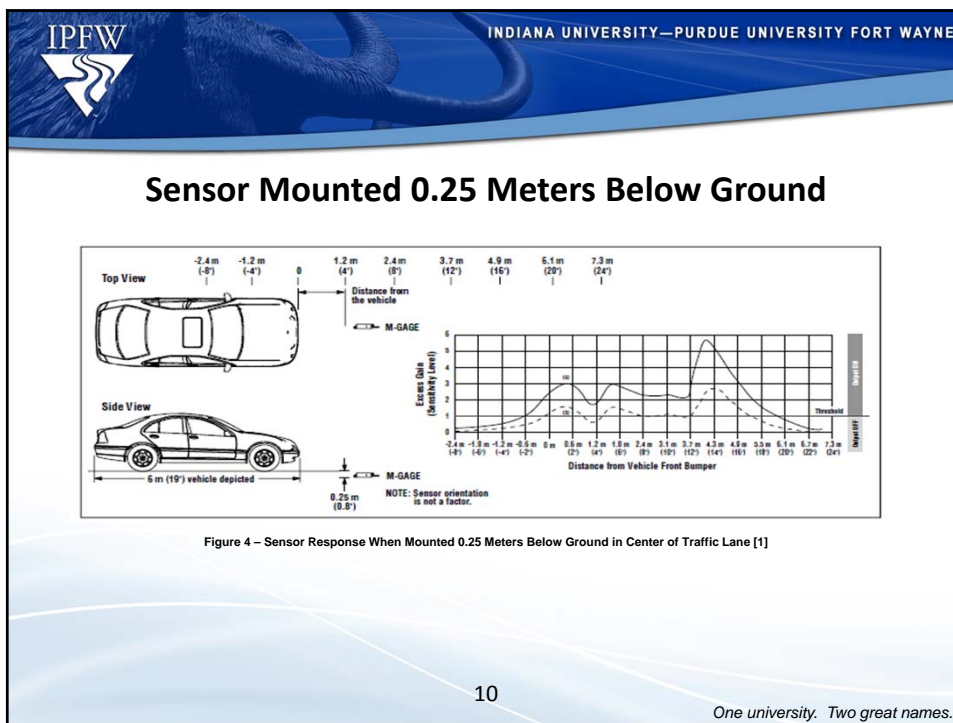
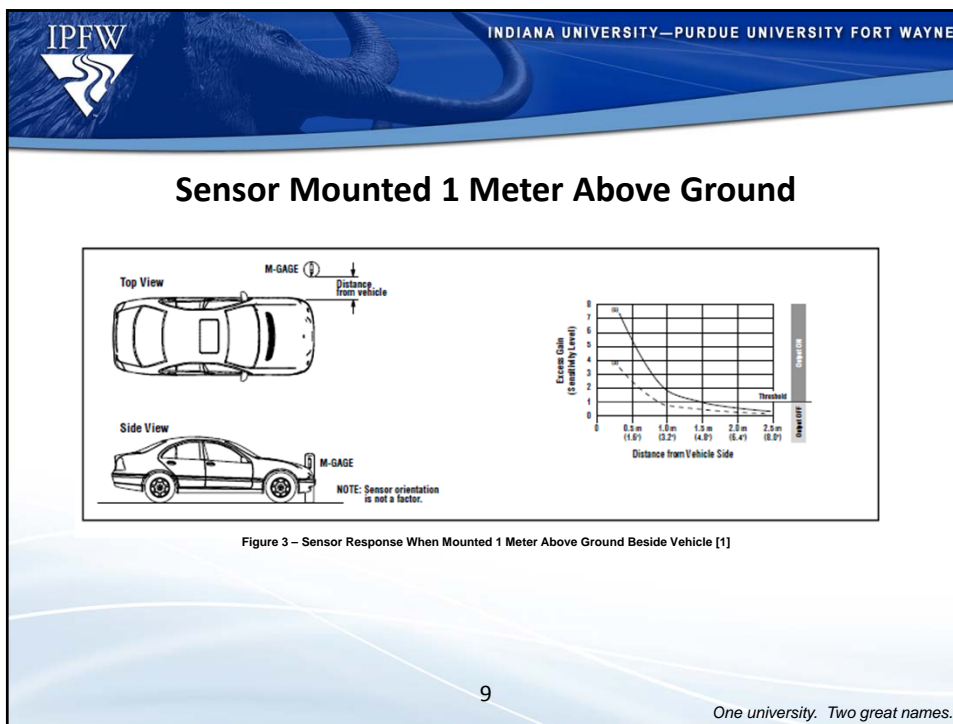
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System Design

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EMI Filter

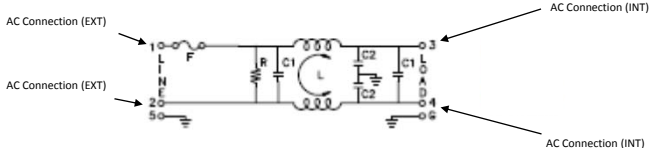



Figure 5 – EMI Filter Circuit Diagram [2]

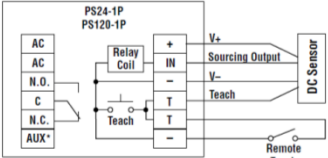
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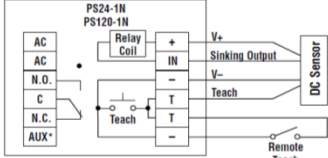

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Sensor Power Supply

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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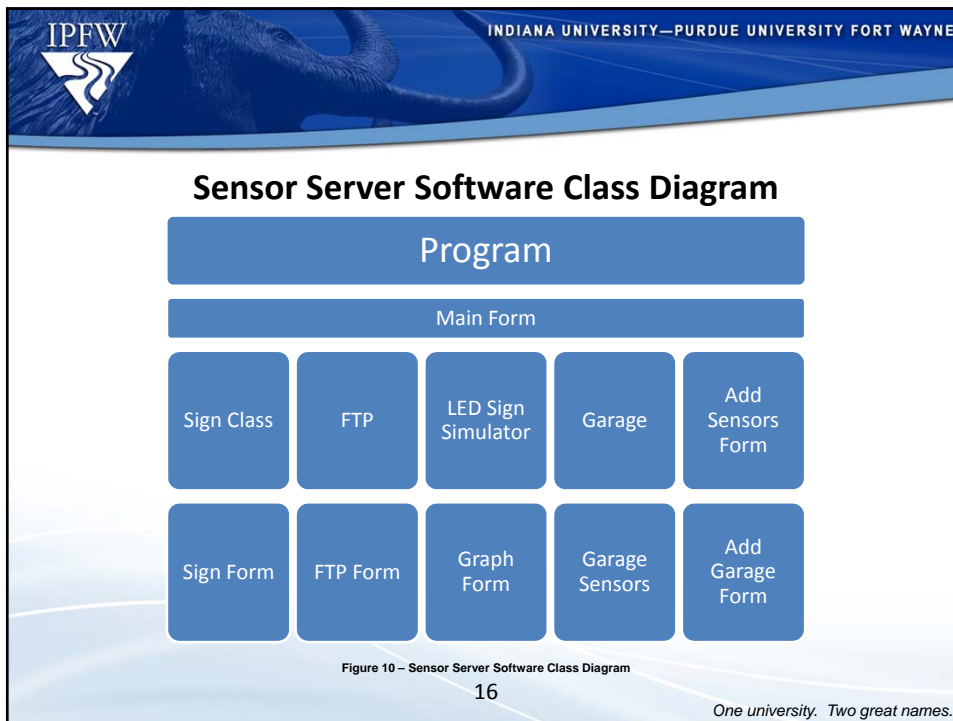
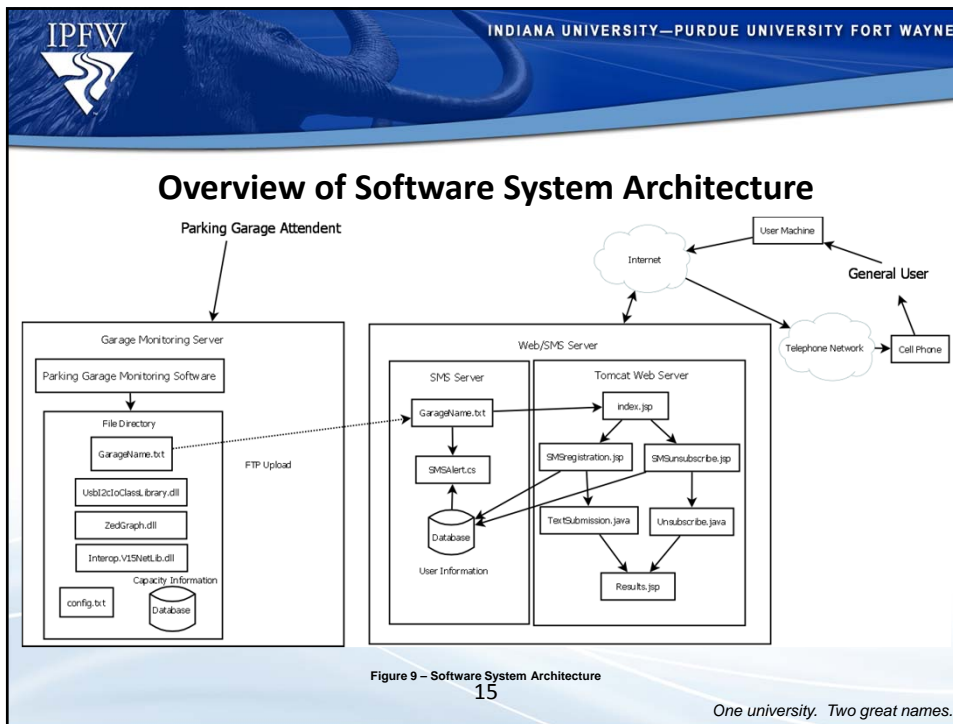

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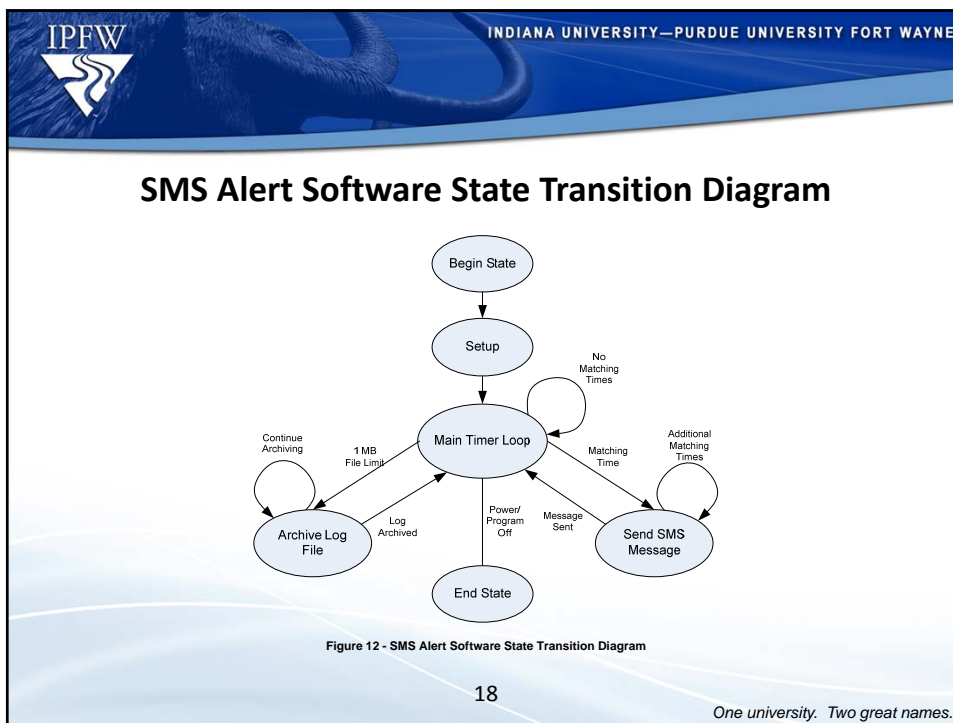
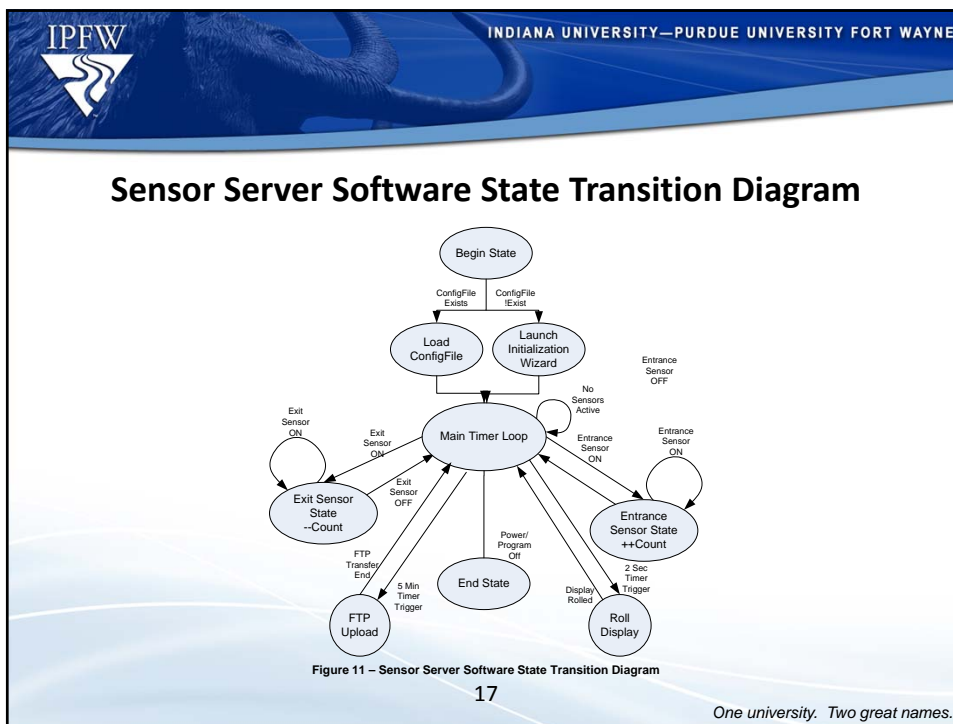
Output Subsystem

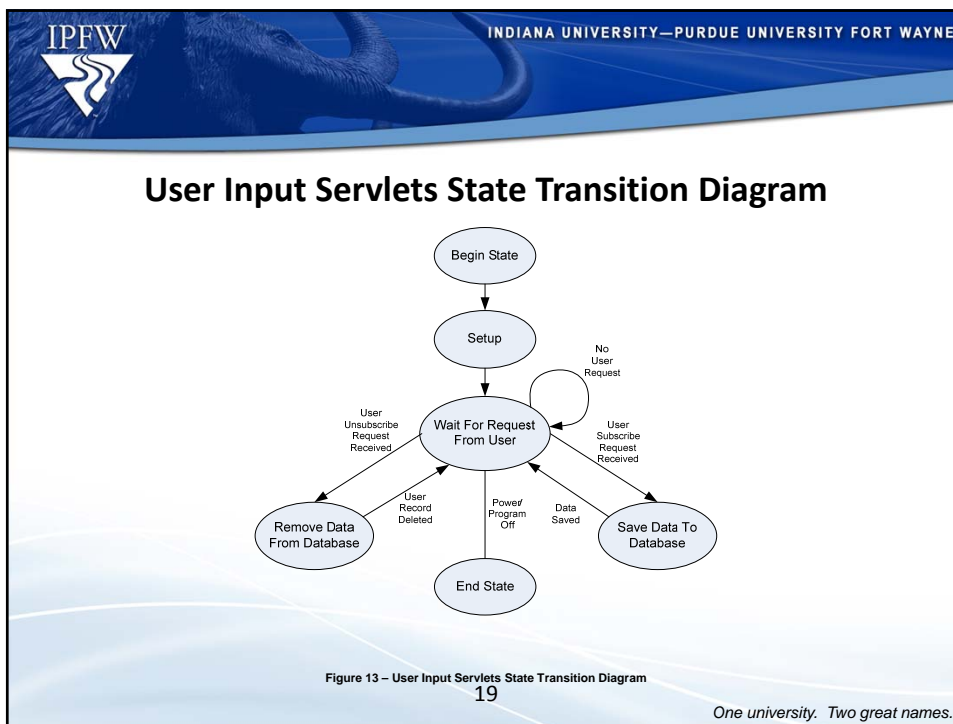
Figure 8 – Output Subsystem, Weidmuller Optocoupler [5]

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The slide features a large, bold, black text 'System Testing' centered on a white background. The slide is framed by a blue header with the IPFW logo and the text 'INDIANA UNIVERSITY—PURDUE UNIVERSITY FORT WAYNE'. The footer contains the number '20' and the slogan 'One university. Two great names.'

System Testing

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Sensor Testing

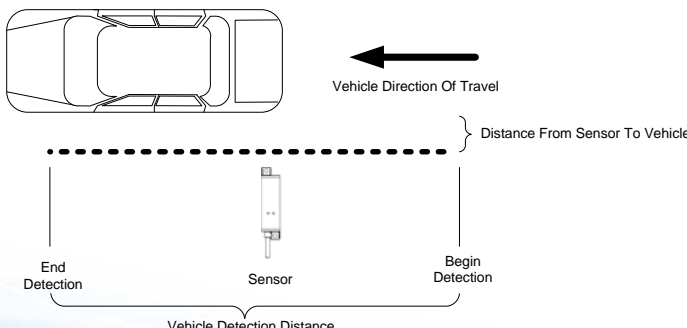



Figure 14 – Sensor Testing Rig

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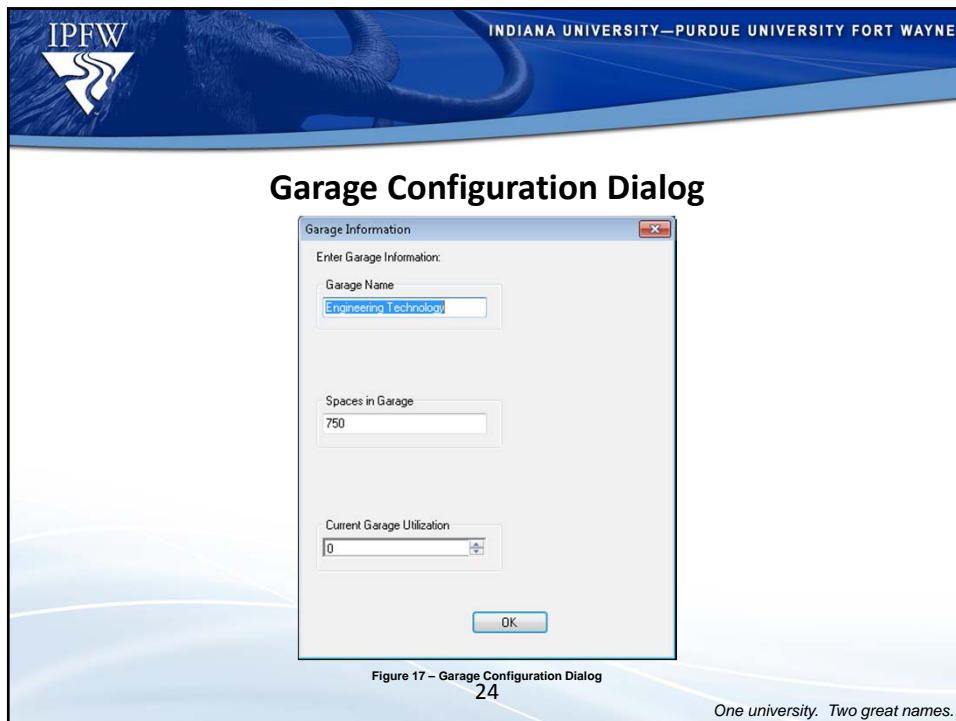
Sensor Testing (cont.)

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

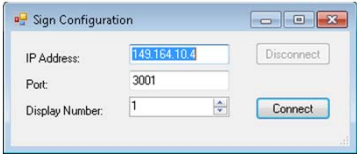


Figure 19 – Sign Configuration Dialog

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Sensor Server Software Main Form

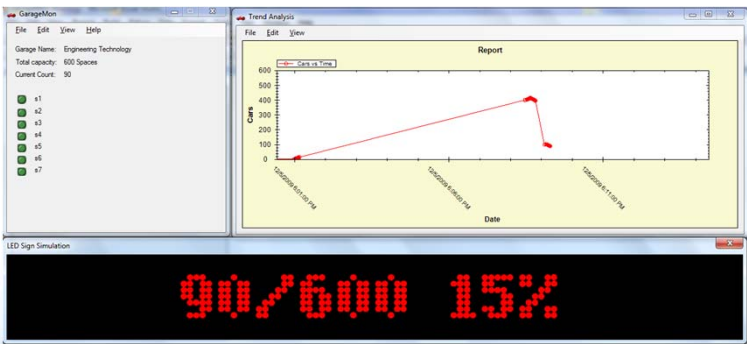


Figure 16 – Sensor Server Software Main Form

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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

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SMS Alert Subscription Confirmation Page

Thank you for subscribing.

- Phone Number: (317)-311-1111
- 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

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Parking Garage SMS Alert Unsubscribe Page

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Maps
Driving Directions
Parking

parking

SMS Alert Unsubscribe

Cell phone number:
(111) 3-3111 -3111

Password:

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

SMS Alert Unsubscribe Error Page

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Maps and Directions
Maps
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Parking

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Incorrect phone-number/password combination.

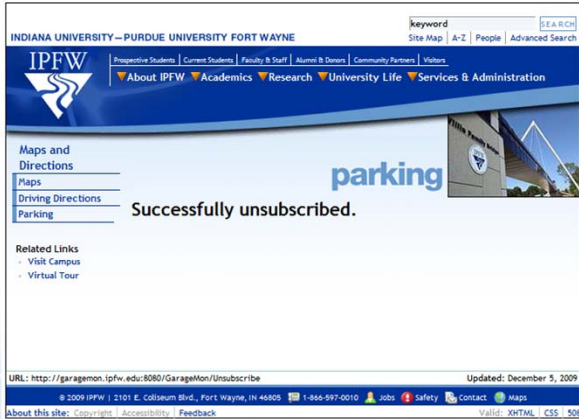
URL: <http://garagemon.ipfw.edu/8080/GarageMon/Unsubscribe> Updated: December 5, 2009

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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.

parking

Related Links

- Visit Campus
- Virtual Tour

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 I²C/IO Board

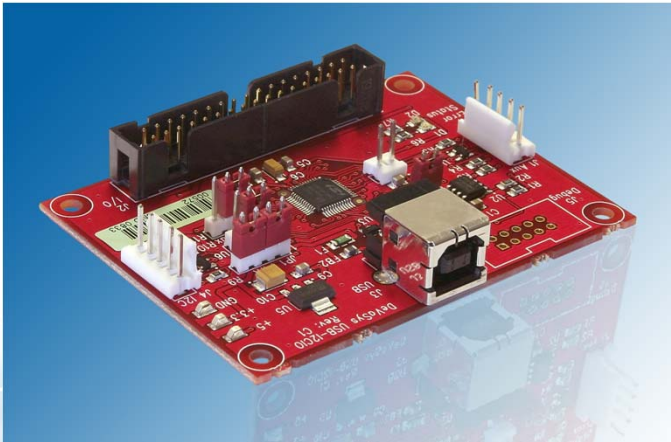


Figure 28 – USB I²C/IO Board [6]

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Final Project Board

Power Supply

Power Supply

Output Optocoupler

Sensor

Input Optocoupler

34-Pin Breakout Board

Figure 29 – Final Project Board

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Power Distribution

EMI Filter

Sensor

Digital I/O 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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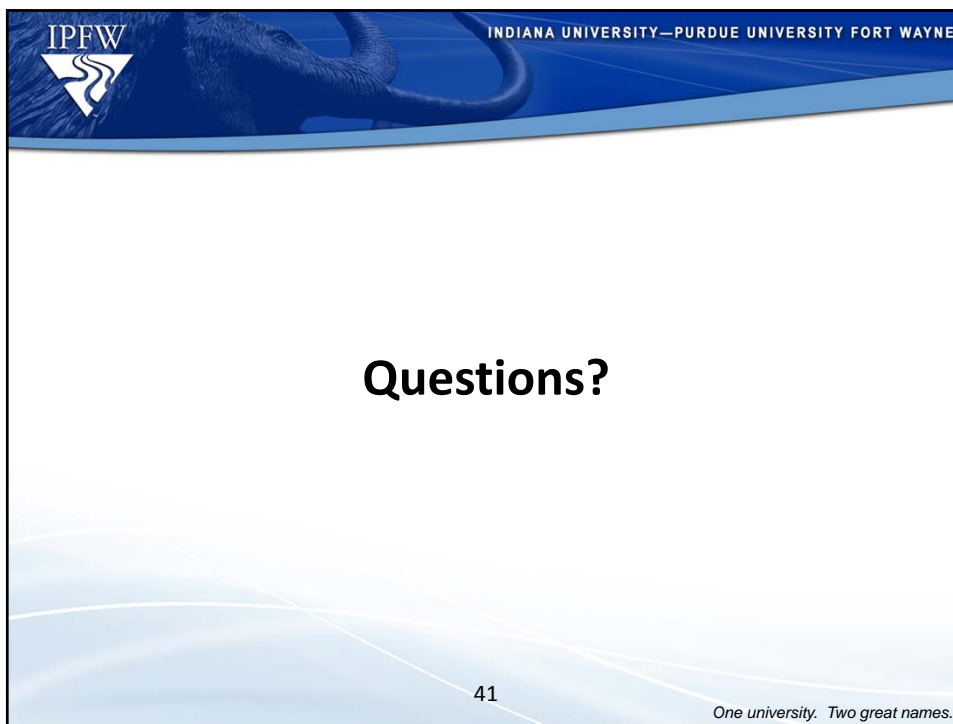


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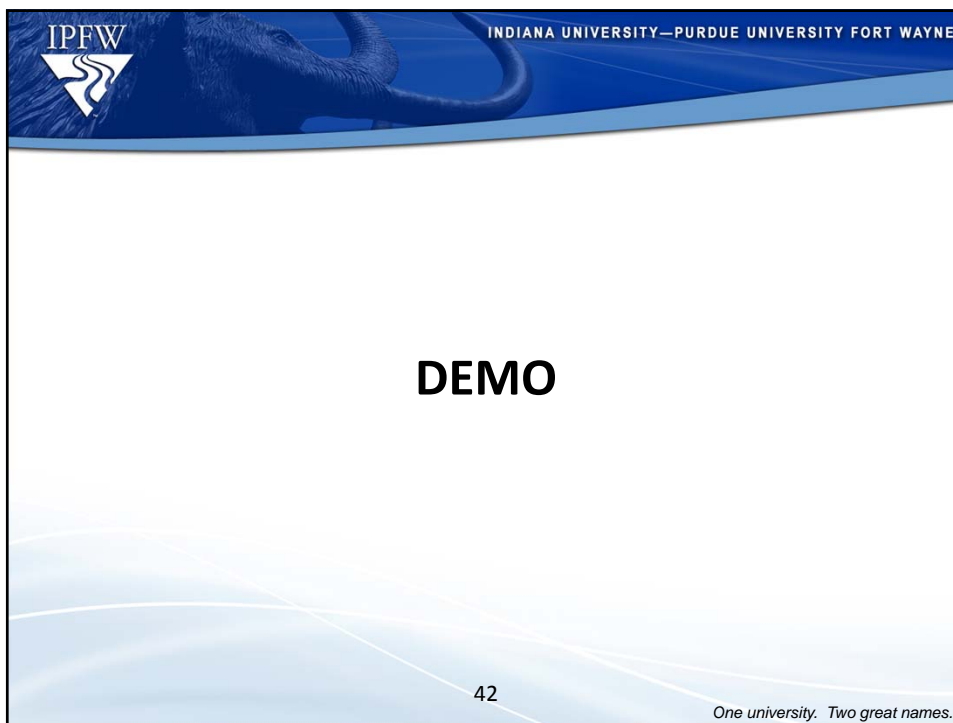


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Questions?

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DEMO

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