Idaho Incubation Fund Program

Final Report Form

Proposal No.	**TOIF12017**
Name:	**Richard W. Wall**
Name of Institution:	**University of Idaho**
Project Title:	**Development of Independent Fault Monitor to Increase the Safety and Marketability of the Advanced Accessible Pedestrian System**

Information to be reported in your final report is as follows:

1. Project Summary:

A. Accomplishments and milestones

The completed Pedestrian Fault Monitor (PFM) system was successfully tested in the University of Idaho (UI) Digital Research Laboratory in April 2012. The test was highly representative of a field test because an actual traffic controller and advanced accessible pedestrian systems (AAPS) were used. The system was tested with eight pedestrian buttons.

Since the fundamental AAPS operations is inherently secure rendering faults to being a very rare occurrence, faults were introduced to the system by injecting false data packets using a test PC. Using fault injection testing allowed us to reliably determine the time required to remove the faulty system from service.

Test results showed that the maximum time to detect and remove a fault system from service was less than 0.35 seconds. This is well less than the 0.45 seconds required by the National Electric Manufactures Association (NEMA) specifications for traffic control devices. Detection of injected faulty data packets were properly detected in all instances.

The results of the system design and testing were presented at the PED ACCESS 2012 workshop held in Boise, ID on May 4, 2012. Those present to review and evaluate the system included Campbell Company engineers as well as technicians and engineers representing the Ada County Highway Department and the Idaho Transportation Department.

The design plans and installation details were submitted to Campbell Company during a technical oversight meeting on June 12, 2012. During this meeting, the implementation plans were discussed and target intersections that were dependent on the PFM technology were identified.

B. Barriers encountered, and how the barriers were overcome:

The only significant barrier to implementing this design was the current carrying limitation of the electrical–mechanical relays that were used to provide both power and communications to the intersection pedestrian buttons. Each of the relays used in the off-the shelf equipment design are rated at 5 amps AC/DC. The potential power required for a 16 button AAPS is 14.4 amps. This requires that the three available relays be placed in parallel to distribute the current between the three relays. Using the 90% de-rating factor suggested for benign service, the total current carrying capacity of the three relays is 13.5 amps thus restricting the use of the PFM to an AAPS with 15 or fewer buttons.

The lowest cost solution is to use an auxiliary relay with a de-rated current capacity sufficient to power all 16 buttons when required. This presently represents less than 1% of the AAPS installations. .

2. Describe the current state of the technology and related product/service:

Since the software is completed and the system hardware uses commercial off the shelf (COTS) equipment, the PFM system can be deployed immediately. The direct cost for the hardware is $200. It is possible that quantity purchase of the COTS hardware can result in lower direct costs. It is possible that a proprietary design could result in lower direct costs but would require the investment of design and development that would need to be amortized over the life of the product.

3. List the number of faculty and student participants as a result of funding:

One faculty member, one graduate student and three undergraduate students were involved in the project. Prior knowledge of the graduate student proved invaluable to the successful completion and he was the technical engineering advisor. The majority of the actual programming was accomplished by one of the undergraduates who was a senior majoring in computer engineering.

4. What are the potential economic benefits:

The most significant market enhancement is for the installations in Canada. Although the PFM provides the level of fault detection expected by US traffic agencies, in general, these customers have not specifically requested this capability. They are relying on the intrinsic security and reliability design into the system through checks and expectation of timely response. It is important to note that fault detection provided by the PFM is not required by the most recent edition of the MUTCD. However, based on current trends in the pedestrian control technologies, we expect that changes that address this issue are forth coming.

5. Description future plans for project continuation or expansion:

   Basically, the PFM addresses unintentional hardware failures. The PFM is consistent with the industry expectation for failure detection and mitigation. The current design meets or exceeds the level of reliability specified by the NEMA specifications and meets the environmental operating requirements.

   The AAPS and the PFM are dependent network technologies. To date, the traffic industry has not been aggressive in addressing security risks associated with intentional hardware and software failure. Elementary research has reviled that the concept of digital and audio water marking could be used to significantly reduce these lapses in security.

   Current traffic malfunction management philosophies of the Federal Highway Administration require only that the signal operations are in agreement. This means that when certain signals are displaying a green or yellow light, other signals must display a red light. This signal agreement is independent of the program that controls the signal timing or the sequence in which the signal lights are controlled. This philosophy falls under the much studied approach to network fault detection known as Byzantine Agreement.[1] Unfortunately, some traffic agencies ignore disagreements between pedestrian signals and traffic signals. Such practices degrade the validity of pedestrians as legitimate users of signalized traffic intersections and render all efforts to detect and mitigate audible pedestrian signals useless. Given that the traffic signals are correctly installed, the Byzantine network theory can be expanded to cover fault detection in both visual and audible signals.

[1] http://www.cs.cornell.edu/courses/cs614/2004sp/papers/lsp82.pdf

6. Final Expenditure Report

A. FACULTY AND STAFF		
Name/Title	$ Amount Requested	Actual $ Spent
Richard Wall/PI	$9,607	$14,409.60
B. VISITING PROFESSORS		
Name/Title	$ Amount Requested	Actual $ Spent
C. POST DOCTORAL ASSOCIATES/OTHER PROFESSIONALS		
Name/Title	$ Amount Requested	Actual $ Spent
D. GRADUATE/UNDERGRADUATE STUDENTS		
Name/Title	$ Amount Requested	Actual $ Spent
Cody Browne/Graduate Student	$20,435	$6,270.00
Jacob Preston/Undergraduate Student	$0	$3,487.11
Benjamin Sprague/Undergraduate Student	$0	$1,479.00
Kyle Swenson/Undergraduate Student	$0	$1,440.00
E. FRINGE BENEFITS		
Rate of Fringe (%)	$ Amount Requested	Actual $ Spent
PI summer rate 23%	$2,210	$3,257.16
Student academic year rate 1% and summer rate 9%	$848	$475.18
PERSONNEL SUBTOTAL:	**$33,100**	**$30,818.05**
F. EQUIPMENT: (List each item with a cost in excess of $1000)		
Item/Description	$ Amount Requested	Actual $ Spent
1. Computer hardware and enclosure	$2,500	$715.00
2.		
3.		
4.		
EQUIPMENT SUBTOTAL:	**$2,5000**	**$715.00**
G. TRAVEL		
Description	$ Amount Requested	Actual $ Spent
1. Travel to Boise	$3,000	$2,238.73
2.		
3		
TRAVEL SUBTOTAL:	**$3,000**	**$2,238.73**

H. PARTICIPANT SUPPORT COSTS:			
Description		$ Amount Requested	Actual $ Spent
1.			
2.			
3			
PARTICIPANT SUPPORT COSTS SUBTOTAL:			

I. OTHER DIRECT COSTS:			
Description		$ Amount Requested	Actual $ Spent
1.	Materials & Supplies	$800	$1,465.28
2.			
3.			
OTHER DIRECT COSTS SUBTOTAL:		**$800**	**$1,465.28**
TOTAL COSTS (Add Subtotals):		**$39,400**	**$35,237.06**
		TOTAL AMOUNT REQUESTED:	**$39,400**
		TOTAL AMOUNT SPENT:	**$35,237.06**

7. Under section B-2b of the University of Idaho Faculty Staff handbook section 5300, the University of Idaho will retain ownership of this copyright protected technology and will license this technology to Campbell Company in Boise, Idaho. Campbell Company has an existing exclusive license from University of Idaho for the patented pending technology titled "Advanced Accessible Pedestrian System for Signalized Traffic Intersections," US patent application number 13/059,635. Inclusion of this new technology to their pedestrian intersection package will allow for the company to penetrate additional foreign markets.

8. Additional pertinent information: The product produced under this research grant extensively relied upon software developed for the AAPS currently licensed to Campbell Company of Boise, ID. The software was designed to operate under the cost free and royalty free Debian Linux operating system.[2] This software was developed using the cost free and royalty free Debian GNU C and C++ development environment. The specific computer hardware we used is commercially available and requires no modification when running the PFM application software. The functionality of the PFM is embedded to the computer code programmed to run on the Technologic TS7500 single board computer that has specific I/O requirements.[3]

[2] http://www.debian.org/
[3] http://www.embeddedarm.com/products/board-detail.php?product=TS-7500

The PFM program can be implemented on a variety of computers provided that the code is modified to accommodate the specific hardware requirements to control the IO that regulates the power to the system pedestrian stations.