final report

Project code: A.MQT.0064

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Date published: March 2012

PUBLISHED BY
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SmartStim 2 System Development

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

1 Abstract

The SmartStim 2 system development was initially undertaken as projectP.PSH.0386 “Modular and wireless control system for SmartStim technology” to develop modular hardware for a wireless controlled SmartStim system. This was required to counter the environmental and cost limitations of the PC based SmartStim System. Custom wireless modules were developed built and tested to a limited extent in the laboratory

Commercialisation of the SmartStim 2 System, undertaken as project P.PSH.0555 “Pilot Commercialisation of the Wireless SmartStim System - Phase 2”, started with an independent review by a consultant and recommendations presented to MLA on the way forward for this development. Due to the identified technical and commercial risks, the recommendation from this review was to transfer the SmartStim software over to a more robust National Instruments based Programmable Automation Controller (PAC). This was undertaken and Laboratory Tested during Stage 2 of project P.PSH.0555.

For commercial reasons project P.PSH.0555 was put on hold at the end of Stage 2.

2 Executive Summary

Meat and Wool New Zealand and *Meat and Livestock Australia* have jointly funded the development of a technology that measures the responses of each carcass to stimulation. This technology has been termed SmartStim, because it allows the response characteristics from each carcass to be analysed and subsequent stimulation tailored to the need of that carcass.

The SmartStim 2 system development was undertaken to overcome the environmental and cost limitations of the original PC based SmartStim system. The initial development undertaken as project P.PSH.0386 “Modular and wireless control system for SmartStim technology”, involved the development of a modular wireless system using Zigbee wireless communication protocol. This projectwas started with MLA and Merit of Measurement, however half way through the development Merit of Measurement was acquired by CPE Systems who continued the project with MLA. The outcome of this project were prototypes of the relay and control modules which were tested to a limited extent in the laboratory, Final Report for P.PSH.0386 refers.

At the end of the project P.PSH.0386 a proposal was submitted by CPE Systems to transfer and test the PC based SmartStim software to the embedded platform developed in the Project. This proposal involved 3 stages as follows:

- Stage 1: Independent review of the system
- Stage 2: Development and verification of the System to a Pilot Production Level
- Stage 3: Pilot Production site installation and testing

This proposal was accepted as project P.PSH.0555.

The independent review, undertaken as Stage 1 of project P.PSH.0555, concluded that there were significant technical and commercial risks associated with commercialising the modular system and an alternate approach using a National Instruments Programmable Automation Controller (PAC) would provide a more robust, cost effective and modular system. This alternate approach provided the following advantages:

- Hardware designed and certified to operate in harsh environments such as those experienced on a kill chain in and abattoir.
- The selected PAC used a Real Time Operating System (RTOS) more suited to deterministic process control
- Hardware supported by worldwide with module being available off the shelf.
- Would use the same development environment as the original SmartStim software allowing for better reuse of software and ongoing system development.
- Hardware platform contained a number of industry standard interfaces allowing for better integration into existing plant systems.

The recommendations of this independent review of the SmartStim 2 system were supported by CPE Systems.

As result of the independent review, Stage 2 of project P.PSH.0555 was re-scoped and software was transferred and tested on the new hardware platform. However due to commercial reason the project was halted at the completion of Stage 2.

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3 Background

Meat and Wool New Zealand and *Meat and Livestock Australia* have jointly funded the development of a technology that measures the responses of each carcass to stimulation. This technology has been termed SmartStim, because it allows the response characteristics from each carcass to be analysed and subsequent stimulation tailored to the need of that carcass. These projects form part of the overall strategy to develop, test and commercialise a robust and modular system for on-line real time quality control and measurement of carcasses using electrical stimulation.

The SmartStim projects involved the development of smart systems of stimulation that first measure the response of individual carcasses to a standard pulse, and then tailor stimulation parameters (strength and duration of the current) to the needs of that particular carcass. For example, feedback from the initial pulse may cause the Smart Stimulation System to deliver 15 seconds of stimulation to one carcass but 60 seconds to another. The objective of the SmartStim system is to achieve a better meat quality through having a known and desirable pH decline.

4 Project Objectives

The Objectives of projects P.PSH.0386 and P.PSH.0555 were as follows:

- Produce a Robust and Modular SmartStim system suitable for use on a Kill Chain
- Hardware must be capable of being supported through life.
- Be capable of integrating into other plant infrastructure and information systems.
- Be cost effective through life.
- Capable of being customised for different plant configurations and developed through life.

5 Methodologies

5.1 Modular Wireless System

The modular wireless system design was based on a custom electronics design using a Texas Instruments TMS320F28335 DSP/MCU Digital Signal Processor (DSP) with a Zigbee wireless protocol for communications between the main components.

The system design for the modular wireless system consisted of:

- A controller module that would connect to the Load Cell, process carcass responses and communicate with the wireless relay units to switch on and off the Stimulator Bars. Each Load Cell is required to have a controller module, with one of the controllers being allocated as the Master
- A Wireless Relay Units, to turn on and off the Stimulator bars as ordered by the master controller. Each Wireless Relay Unit is required for each set of stimulator bars associated with the Load Cell

In project P.PSH.0386 prototype units for both the control module and Wireless Relay Unit were design, built and tested to a hardware level however the System

Software was not transferred from the PC to the Embedded Platform during this project. Software development was to be undertaken in project P.PSH.0555.

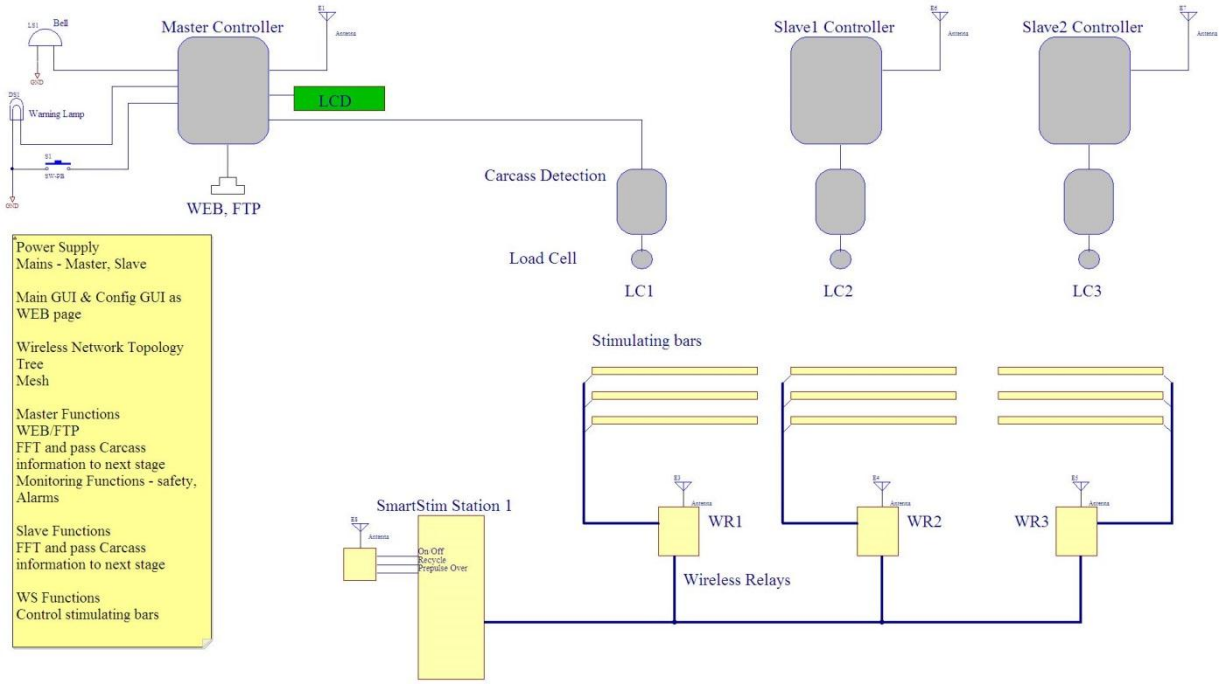

Figure 1 - Modular Wireless System Design

5.2 PAC System

Following independent review of the of the Modular Wireless System during Stage 1 of project P.PSH.0555, The commercialisation of the SmartStim 2 System was changed to using the National Instruments cRIO Programmable Automation Controller (PAC).

The PAC SmartStim 2 System is based on the National Instruments cRIO PAC fitted with modules to:

- Receive the signal from the Load Cells fitted on the line.
- Output control signal to turn the Stimulator bars on an off
- Receiver signal from the stimulator
- Indicate status to the operators
- Interface with the plant system via the Ethernet port

The system is hardwired to all sensors and indicators and is housed in an environmental IP66 enclosure suitable for a Kill Chain. Software is developed in LabVIEW and LabVIEW Real time and the pH analysis for each load cell is implemented in the onboard FPGA. The software was further developed to allow it to be configurable to the expected Plant configurations, including single or multiple load cells running in either Serial or Parallel operation. Integration into the Plant IT system was allowed for in the design, however due to the lack of an Interface Specification; this provision was not fully implemented and was tagged as an item for individual plant customisation.

The following figure shows the main components of the updated SmartStim 2 system:

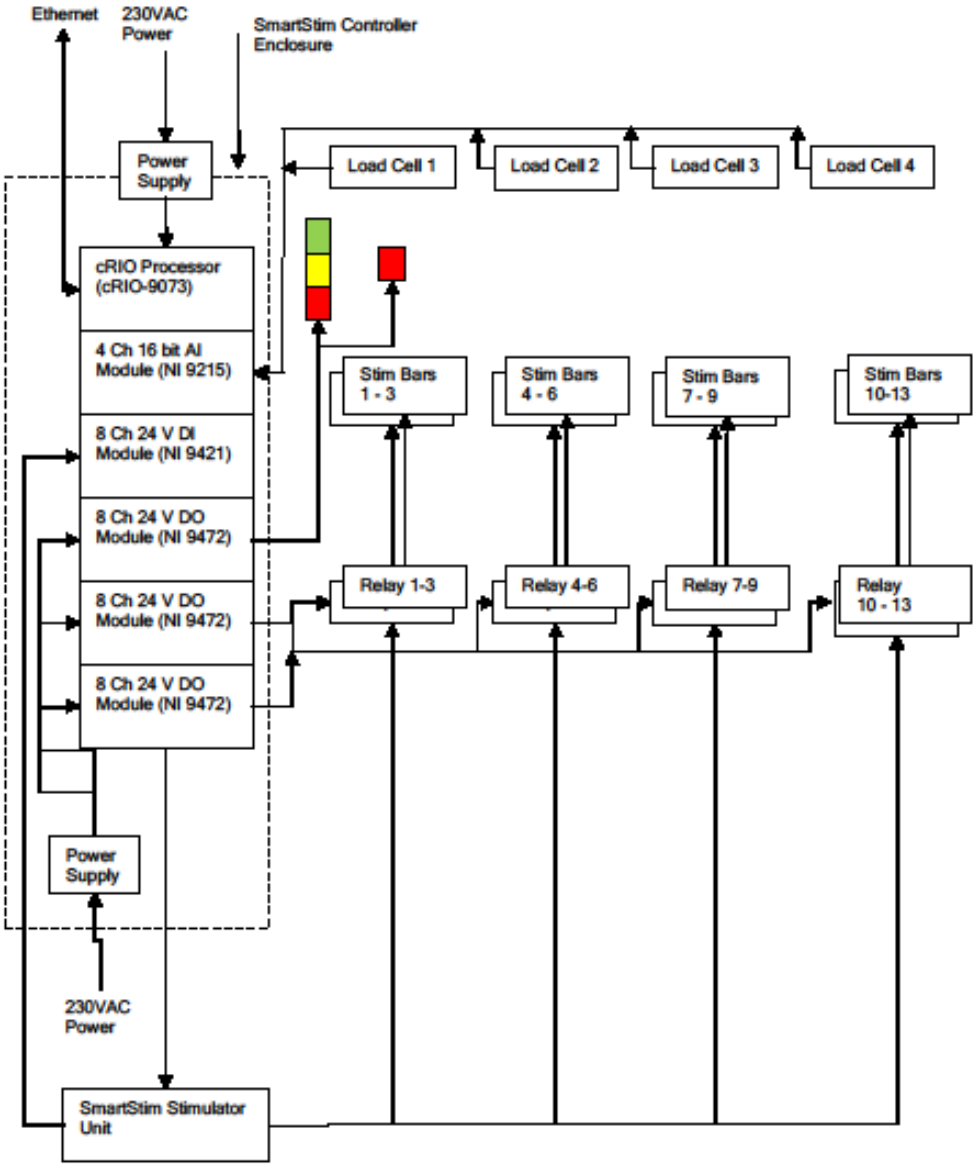

Figure 2 - PAC SmartStim2 System

6 Results

6.1 Modular Wireless System

The modular Wireless System developed as part of project P.PSH.0386 was tested at a functional level during development to prove the concept. Prototype circuits were developed and tested at an electrical level. Transfer of the software from the PC based application and, system performance and functional testing was to be undertaken as part of project P.PSH.0555, however after independent review of the projectas part of Stage 1 it was decided to use the PAC as the hardware platform for the SmartStim 2 system.

6.2 PAC System

After the Independent Review, Stage 2 of project P.PSH.0555 involved transferring of the PC Application to the National Instruments cRIO PAC hardware platform. This involved refactoring of the software to the Real Time environment and moving the pH analysis to the onboard FPGA. The SmartStim2 system was tested using simulation in the Laboratory and the pH analysis was validated against actual test data recorded from an actual plant installation using the base coefficients used in the PC system.

7 Conclusions

The following conclusions can be made from the SmartStim 2 System Development;

- The Modular Wireless System proved the concept of using the a cutom design zigbee wireless system to implement the SmartStim system, however a full operational system was not developed due to the commercial and technical risk associated with this approach.
- The PAC SmartStim 2 System, based on the National Instruments cRIO PAC hardware, was developed and validated against the PC based system. The system provided a viable alternative to existing SmartStim system. The PAC System is modular and designed for operation in a harsh industrial environment.
- Integration into Plant IT systems has been allowed for in the design however was not implemented due to the lack of an Interface Specification. It is anticipated that if the PAC based SmartStim 2 System was to be introduced in the future that this development would either be done as a custom design activity or that consideration be given to developing an Interface Specification for the SmartStim2 to Plant IT System Interface.