final report

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DigitDetect – small processor / value added bandsaw reduced cuts mechanism

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Abstract

The aim of the Digitdetect project is to develop a low cost bandsaw safety mechanism suitable for smaller processors and other industry sectors. The DigitDetect system is based on a high speed electronic motor stopping circuit, combined with a camera based visioning system (a modified version of Glovecheck).

This milestone is concerned with the retrofitting of the DigitDetect system, developed in Milestone 1 of this project, to existing bandsaws. The saws selected for this are the Thompson Mk 6 and the HT Barnes Mk1 models. The design consists of a motor DC injection system that acts as a braking mechanism and eliminates the mechanical components associated with Bladestop. In addition the Glovecheck Technology from Bladestops has been utilised and modified to suit the smaller saw physical size.

The retrofit development effort was focused on four main areas:

- High voltage electronics
- Control electronics
- Vision system
- Mechanical components.

Following extensive development and testing the system was successfully fitted to the Thompsons saw. Unfortunately however, due to the mechanical design of the HT Barnes saw the DC braking system was not suitable for retrofit without extensive mechanical redesign of the saw.
The Thompson MK6 saw has been installed and is in use at the Meat and Allied Trades Department at Granville TAFE. An industry demonstration day was held on 17/6/16 in the presence of MLA, AMIC, TAFE staff and a number of processors. A similar evening session is proposed for a month's time to allow opportunity for further processors to attend out of business hours.
Due to the large cost over run on the project, caused by the excessive hours consumed in testing and trialling the Digitdetect system, following the demonstration sessions and distribution of marketing fliers allowing the wider industry to be made aware of this new technology, Scott's would not envisage shipping the current saw to any further sites and would consider the project complete following the evening demonstration session.

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Project objectives

Over the past ten (10) years Scott's engineers have reduced the reaction time of the Bladestop mechanism to under 10 milliseconds. When taking into consideration the across the bandsaw table velocity at which a human hand moves, whilst performing a cut within the operations of the fastest meat processing facilities in Australia, the mechanism reaction time now results in only the indent of the saw teeth being evident on the part of the body that came into contact with the saw on triggering.

Following the development of BladeStop, Scott Engineers independently developed Glovecheck, to further increase the reliability and reduce the frequency of false trips on the current body detection device. Glovecheck works by constantly monitoring an operators hands (whilst wearing blue gloves) and when the gloves are within a set distance from the cutting edge of the blade the glove is detected and the blade is stopped. DigitDetect trips can be reset immediately without having to change the bandsaw blade, which reduces unnecessary processing down time and costs.

Some smaller businesses within the Australian meat processing supply chain, such as those within the Queensland Country Meat Processors Association, Value Added Rooms, Australian Butcher stores and Australian supermarkets will struggle to justify BladeStop financially for bandsaws that are not in use 24/7.

Although DigitDetect will not be as infallible as the BladeStop technology, with the types of cuts of meat produced, combined with the retraining of staff to cut those 'suspect cuts' in a different manner, would enable DigitDetect to provide a significantly increased level of safety over that of an unguarded bandsaw blade or other non-sensing guarded saws on the market.

- Develop a low cost bandsaw safety mechanism (DigitDetect) suitable for smaller processors and other industry sectors. DigitDetect will be based on a modified version of the BladeStop stopping mechanism, or a high speed electronic motor stopping circuit, or a combination of both, combined with a camera based visioning system (a modified version of Glovecheck)
- Retrofit DigitDetect into five existing, processor supplied, bandsaws, and trialling these in a production environment
- Submit a final report and video suitable for uploading to MLA's website

Success in achieving milestone

This milestone is concerned with the retrofitting of the DigitDetect system, developed in Milestone 1 of this project, to existing bandsaws. A survey conducted through AMIC as part of Milestone 2, resulted in responses from eighteen separate processors/butchers who, combined, had a total of 45 bandsaws in operation. From the survey it was clear that 80% of these saws are of two brands, HT Barnes and Thompson, with the majority of these being HT Barnes MK1 and Thompson MK6 models.

As discussed in previous Milestone reports, efforts have been made to develop a low cost alternative to the Bladestop System. This design consists of a motor DC injection system that acts as a braking mechanism and eliminates the mechanical components associated with Bladestop. In addition the Glovecheck Technology from Bladestops has been utilised and modified to suit the smaller saw physical size.

The retrofit development effort was focused on four main areas:

- High voltage electronics
- Control electronics
- Vision system
- Mechanical components.

HIGH-VOLTAGE ELECTRONICS

Development of the DC injection concept from Milestone 1 initially utilised contactors, solid state relays and bridge rectifiers. Early results highlighted issues with individual components which, although rated for the theoretical demands, did not actually fulfil the practical demands of the injection system, resulting in component failure. The components were upgraded to higher rated components and testing with these uncovered issues with high transient voltages, this caused tripping of supply breakers and induced noise on the main AC supply. To combat this, circuitry was added to isolate the main supply during the injection sequence, including the introduction of capacitors to hold the injection voltage.

Through continued testing and with injection voltages of approximately 1000V DC and currents of up to 160A DC it became evident that the components were not able to handle the conditions required to effectively stop the saw motor. This led to the use of thyristor modules which, in turn, required the development and fabrication of custom driver circuits.

A custom transformer was designed and fabricated to supply the DC Injection charging voltage from a wide range of AC supplies minimizing the need for customer-specific components.

IGBTs were considered for controlling the AC supply to the motor as these would provide faster turn-off times than the contactor and solid state relay configuration. Appropriate control circuitry was developed which improved the response time as expected. However the solution was bulky, unstable (resulting in further component failures) and expensive which was not in line with the aims of this project. Hence this design was not pursued.

Further design modifications allowed for the removal of the AC contactors and transformers and these were replaced with fast-switching DC circuitry. This reduced unnecessary component cost and saved physical space.

CONTROL ELECTRONICS

In parallel with the High Voltage Electronics development custom PCBs were designed and developed to optimise switching times through voltage, current and phase monitoring, along with control of the thyristor firing sequences and solid state relays. In addition, a custom single board processor was developed and manufactured to bring together all system actions; start, stop, injection and vision allowing maximum optimisation of the system and hence response and stopping times.

VISION SYSTEM

The Vision component of the Digit Detect System is based on the Glovecheck Technology from Bladestop. Glovecheck has been developed to detect the presence of an operators hand by detecting a blue glove within a specified region prior to the hand reaching the saw blade.

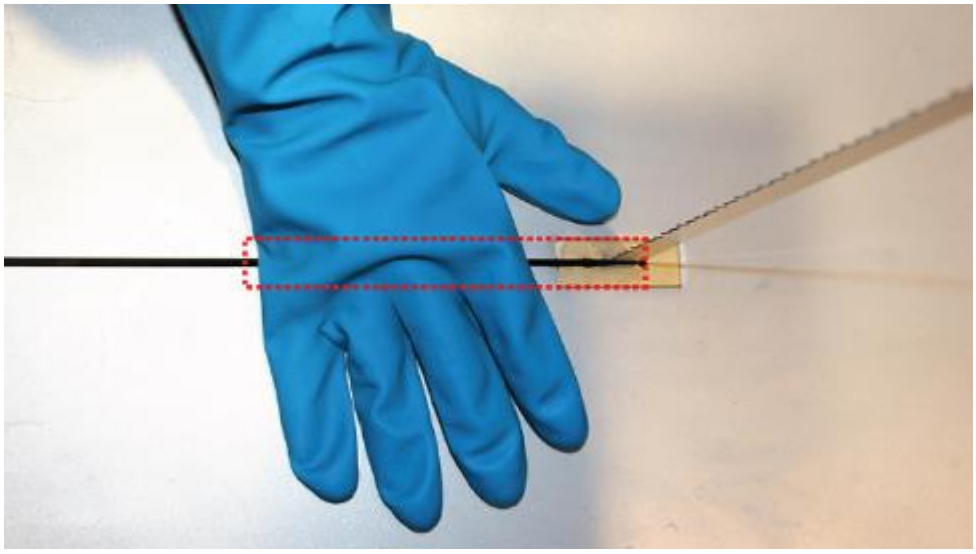

Fig.1 Glovecheck zone in from of the saw blade

This was optimised for the Digitdetect system with the use of a custom-designed camera enclosure (double skinned bandsaw door) and LED lighting system. Commercially-available lighting was assessed and found to be unsuitable given the size restrictions (due to smaller saw size when compared to Bladestop saws) and light output requirements. Customised lighting was designed and a CNC-machined stainless steel enclosure was designed to fit the layout of the saws, as well as incorporating the required heat-sinking capability for the LED lighting. This design also brought the benefits of easy access for service work and firmware upgrades, interchangeable poly-carbonate lenses, and a more streamlined design.

Fig.2 Electronics box fitted to the rear of the saw

Fig.3 Custom double skin bandsaw door for housing the LED lighting system

MECHANICAL COMPONENTS

As mentioned above from the processor survey conducted 80% of the respondents used a saw that was one of two brands, Thompson or HT Barnes, with the majority of these being the Thompson MK6 and the HT Barnes MK1.

Development of the Digitdetect system began using the Thompson MK6 saw. During testing of the electronics and vision systems discussed above a high speed camera was used to record system firing and saw stopping times. The desired sub100ms stopping time was achieved without any major modifications to the mechanical makeup of the saw. Trials were conducted with aluminium wheels which further improved the stopping time due to their lighter weight. However these industry feedback was that they preferred to use stainless steels wheels due to the proximity of the wheels to product.

Once it was evident that these modifications made it possible to achieve the desired results on the Thompson saw attention was turned to the HT Barnes saw. Trials on the HT Barnes saw highlighted major mechanical issues with the saw design. The Barnes saw used a smooth 'V' belt drive with a 2:1 ratio to couple the motor to the drive shaft. While stopping times of the motor appeared good, actual stopping times of the blade were measured to be well in excess of 100ms. One cause was thought to be slippage of the coupling due to the 'V' belt coupling.

The 'V' belt drive was replaced by a tooth belt drive and this immediately highlighted the mechanical difference with the saw. The motor stopped quickly with DC injection as with the Thompson Saw, however because the motor and drive wheel are attached on a floating mount, the shock load resulting from the fast stop causes the mount to lift, releasing the blade tension and hence the blade allowing it to continue moving once the motor had stopped. HT Barnes we approached and tasked with modifying the saw design to negate this issue. Unfortunately to date a suitable redesigned has not been achieved

Overall progress of the project

As result of the unsuitability of the HT Barnes saw design, the Digitdetect system is only fitted to a Thompson Mk 6 saw. This saw is currently installed and being used at the Meat and Allied Trades Department at Granville TAFE. A small addition was made to the saw after it had been on site for a couple of weeks. The operators were having issues with a 'lens obscured' fault making the saw inoperable. This was being caused by condensation build up on the camera window. As such a 'breather valve' was added to the enclosure to eliminate this.

During its time at the TAFE, the system has been demonstrated to several senior managers from retail butcher chains, all of whom provided positive feedback.
An industry demonstration day was held at the TAFE on 17/6/16. Attendees from the TAFE, AMIC, MLA and several retail butchers again responded positively to this technology. An evening demonstration session will be conducted within the next month to allow more retailers to attend outside of business hours. The images below and the attached video show the saw being demonstrated by TAFE staff. A marketing flyer will be put together following this demonstration and distributed to all contacts on the TAFE and AMIC contacts list.

Fig.4 Industry Demonstration Day at Granville TAFE

Recommendations

The development and extensive testing that has been carried out during the past 15 months of this project has lead to a large cost overrun. This overrun is due mainly to the man hours spent performing trial work. A total of 3755 hrs has been spent on the project which is in contrast to the 460 hrs that were originally allowed.
Following the demonstration sessions and distribution of marketing fliers allowing the wider industry to be made aware of this new technology, Scott's would not envisage shipping the current saw to any further sites and would consider the project complete following the evening demonstration session.