FUTURE FORESTS RESEARCH

HARVESTING TECHNICAL NOTE

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Remote Control of a John Deere 909 Feller Buncher

Summary

A remote-control system was designed, built and tested to control a subset of functions on a John Deere 909 feller buncher. The remote-control system was developed to comply with the New Zealand standard for remote-controlled mining equipment, NZS4240. The remote-control system included: an emergency stop system to allow the operator to stop motion while in remote-control mode; a trapped-key system to prevent operation in both remote and manual modes; and remote control of all motion functions including operation of the felling head and saw.

The next steps in the project are to continue development of the remote control system, and implement video feedback to the operator to enable full teleoperation. The final product will then be peer reviewed and the teleoperation control system commissioned.

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INTRODUCTION

The objective of FFR's teleoperation project is to develop a teleoperated felling machine for steep terrain harvesting of forests.

A Nelson logging contractor, Wood Contracting (Nelson) Limited expressed a desire to control their John Deere 909 feller buncher remotely. The John Deere 909 (Figure 1) was chosen as the target machine for teleoperation because it already has electrically-actuated pilot hydraulics, and therefore the hydraulic systems do not require modification.

Figure 1: The John Deere 909 feller buncher

METHOD

A three-stage plan was developed to achieve teleoperation of the John Deere 909 feller buncher. The three stages were:

- Stage 1: Implement basic remote-control functionality on the 909.
- Stage 2: Extend the remote-control system to include all the desired machine functions.
- Stage 3: Add live video feedback to achieve full teleoperation.

The remote control system was designed in accordance with the New Zealand standard for remote-controlled mining equipment, NZS4240.

The system was built and programmed to control a subset of machine functions, including all the functions of the joysticks and pedals.

The remote control system was installed and tested in the target machine. This report describes the initial testing of Stage 1 which was completed on 6 July 2014.

REMOTE CONTROL UNIT

The remote-control system was designed, built, programmed and bench-tested. The completed

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prototype remote-control unit (RCU) is shown in Figure 2.

The joysticks on the RCU function in the same way as the joysticks in the machine cab except that the pedals are replaced by proportional levers on the joysticks in the RCU.

Figure 2: The remote control unit

MACHINE SIDE ELECTRONICS

The remote-control system included: an emergency stop system to allow the operator to stop motion while in remote-control mode; a trapped-key system to prevent operation in both remote and manual modes; and remote control of all motion functions including operation of the felling head and saw.

A photograph of the machine-side electronics is shown in Figure 3. The red boards are the emergency stop boards, the green board controls motion and the blue board is part of the trapped-key system. The boards communicate via an Internet Protocol (IP) network.

The prototype remote control system, including emergency stop and motion functions, was tested and worked well. This completed Stage 1 of the John Deere 909 teleoperation project.

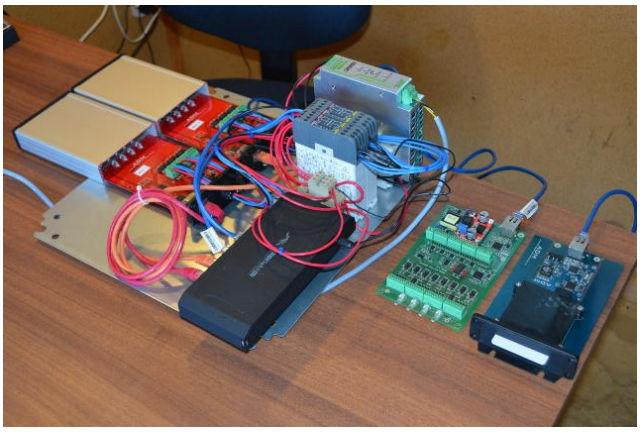

Figure 3: Internals of machine-side electronics

RESULTS OF INITIAL TRIAL

The system was installed in the John Deere 909 feller buncher on 5 July 2014 and tested during normal tree felling operations on 6 July 2014. The machine was remotely operated by Ben Lewis of Wood Contracting (Nelson) Ltd to fell trees (Figure 4).

Figure 4: Ben Lewis of Wood Contracting Nelson remotely operates the John Deere 909

The following observations were made during the trial of Stage 1 of the project:

- The 900MHz wireless link was susceptible to interference by cellular phones in the vicinity.

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This problem was eliminated by turning all mobile phones off or to flight mode. This is an acceptable solution, as machine operators should not be operating a mobile phone and a feller buncher at the same time.

- Testing of the remote control system showed that good video feedback will be important to achieve good productivity in a felling and bunching operation. Additionally, good video feedback will mitigate a hazard where the operator is tempted to move within two tree lengths of the machine to get a better view. Therefore, it is recommended that video feedback be added to Stage 2, the next stage of the development project.

Recommended next steps in the project are to: continue development of the remote control system to permit remote control of all the desired machine functions; implement cameras (video feedback to the operator) to enable full teleoperation; peer review the final product; and commission the teleoperation system.

CONCLUSIONS

The emergency stop functions and remote control functions of a remote-control system for a John Deere 909 feller buncher were designed, built and tested. Testing showed the system worked well. Several trees were felled during testing of the system.

Radiation from mobile telephones can interfere with the wireless link. Mobile phones in the vicinity of the felling operation should be switched off while the machine is operated by remote control.

Testing showed that video feedback will be important for productivity. It is recommended that video feedback, originally planned for Stage 3, be included in Stage 2 of the project.

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