Snapshot Report

Remote Guided Robots

Remote Operations – Remote Guided Robots (Stage 1) – Strategic Engineering Pty. Ltd.

Project Code	Prepared by	Date Submitted
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Project Description

This project aims to research, develop, and design a system to remove an operator from a dangerous process, while simultaneously introducing new technologies to the red meat industry allowing operators to perform tasks in exciting manners, this also includes operators that may be at a physical disadvantage. The purpose of this design is keeping the operator safe, while concurrently allowing the operator to continue tasks that are comparable with the current operations but in a more comfortable workspace. The utilisation of technologies that analyse the operators hand movements and the mixed reality industry allow for the operator to immerse themselves to interact both with the real world and digital world simultaneously.

The project involved developing and testing a tele-operated robot system to provide insight into the potential uses of remotely operated robots in the Red Meat Industry. The system developed integrated a motion controller to capture an operator's hand movements, an industrial 6 DOF robot with pneumatic gripper to allow for remote picking of objects and a virtual reality headset and environment to allow for feed-back to the operator. The system was tested against a potential application in the Red Meat Industry of the hazardous task of cutting primal sections on a band-saw.

Project Content

To achieve the final objective of real-time remote guided robotics, the following stages were completed:

1) Literature review.
2) Conceptual design.
3) Procurement of devices.
4) Rudimentary integration of motion controller.
5) Improved integration of motion controller.
6) Integration of visual feedback.
7) Testing of Human-Robot integration.

Project Outcome

Initially, the motion controller was connected, and hand tracking was tested. It was observed in the provided software that an operator's hands could be detected and tracked, Fig. 5. The system was initially observed to have noisy data, plus it was observed that the robot would have a more significant movement than the operator's hand. A test was set up where the operator would run their hand along the inside of a box; it was measured that the displacement of the operator's hand was 50mm in one direction. This test was conducted across the three-axes. A gain variable, a Kalman Filter and adjustments to the code were made, which shows improvements in the robot's movement. The data across all three axes shows the removal of the majority of noise and that the robot is moving at approx. 50mm in each direction, proving the robot is moving at a 1:1 ratio of the operator's hand. Initial results showed the robot's movements were out by approximately 1.6-2.1 times the actual operator's motion. The repeatability of the system was approx. ±10mm. Calibration of the sensor was conducted together with modification of the code, which improved the accuracy and the repeatability of the first tests. It should be noted that the following results involve human error, which is included in the repeatability. Looking at the results, the repeatability improved to less than ±5mm with an accuracy within 1mm. The latency of the system was calculated to be 12ms.

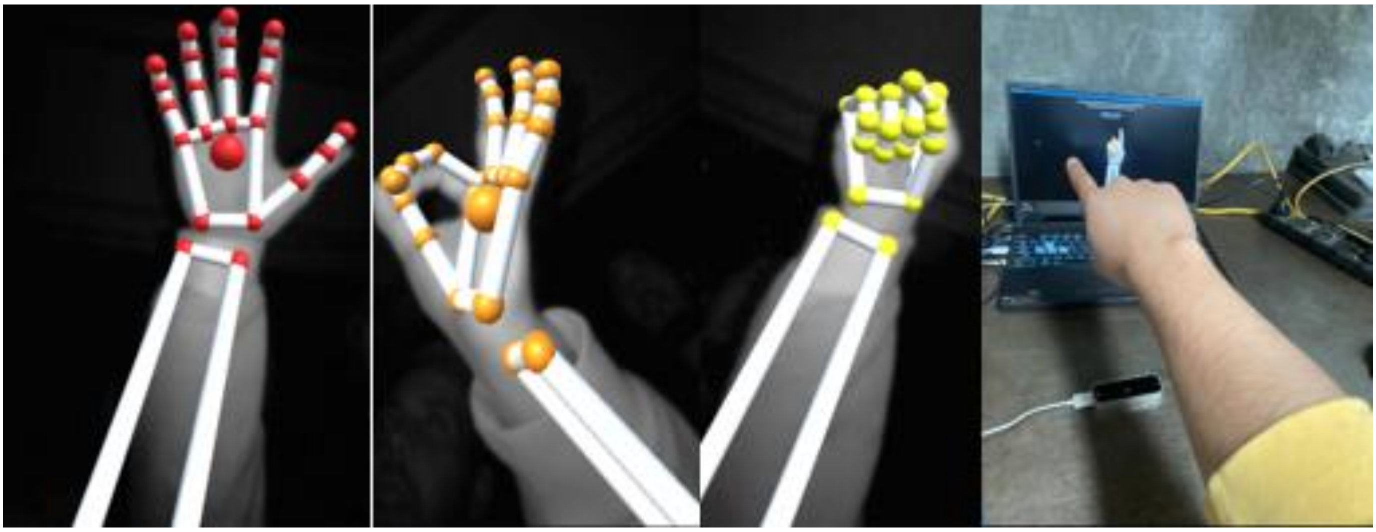

Figure 1 - Hand Gesture Recognition and Hand Tracking

When the gripper was introduced to the system, it was noted that the gripper would open sporadically when the operator’s hands were closed and would close sporadically when the operator’s hands were open. As stated in the previous, a debouncing signal code was introduced to mitigate the false change of state. Tests were conducted over 5-minute periods counting the number of false state changes; this was to determine if the system improved with the newly introduced code. The introduction of the debouncing meant the gripper opening and closing had a 60ms latency compared to its original 12ms. As the opening and closing of the gripper are not regarded as time-critical (sub 500ms), it was deemed that the latency of 60ms was satisfactory. Table 1 shows a significant improvement with the debouncing, improving the grippers stability. Previously the gripper was falsely changing approx. 18 times every 5 minutes. Whereas the introduction of the code eliminated the false state changes. This improvement provides confidence in the gripper handling items without dropping them.

Table 1 - Debouncing Implementation Test

Debouncing Code Implemented (Y/N)	**Amount of False State Changes in 5 mins (Test 1)**	**Amount of False State Changes in 5 mins (Test 2)**	**Amount of False State Changes in 5 mins (Test 3)**	**Average False State Changes in 5 mins**
No	16	20	19	18.33
Yes	0	0	0	0

Figure 2 - (a) Gripper 1 (b) Gripper 2

When attempting to grip the foam tube with the initial gripper, Fig. 2a. The operator was having difficulties grasping the item. An observation was made by the operator that the fingers of the gripper and the movement between the gripper fingers were minimal compared to the size of the items being grasped. This created difficulty of picking up items. Table 2 shows the improvement in introducing a new gripper with longer fingers and greater movements. The success rate improved by a total of 64%. To validate the development of the remote guided robot, a test was assigned and attempted. This final test was for an operator to guide the robot and attempt to successfully pick up a foam tube and guide it through a bandsaw, Fig 3. The system needed some slight tuning to create better performance, the impact of the tuning and how successful the system is overall is shown in Table 3.

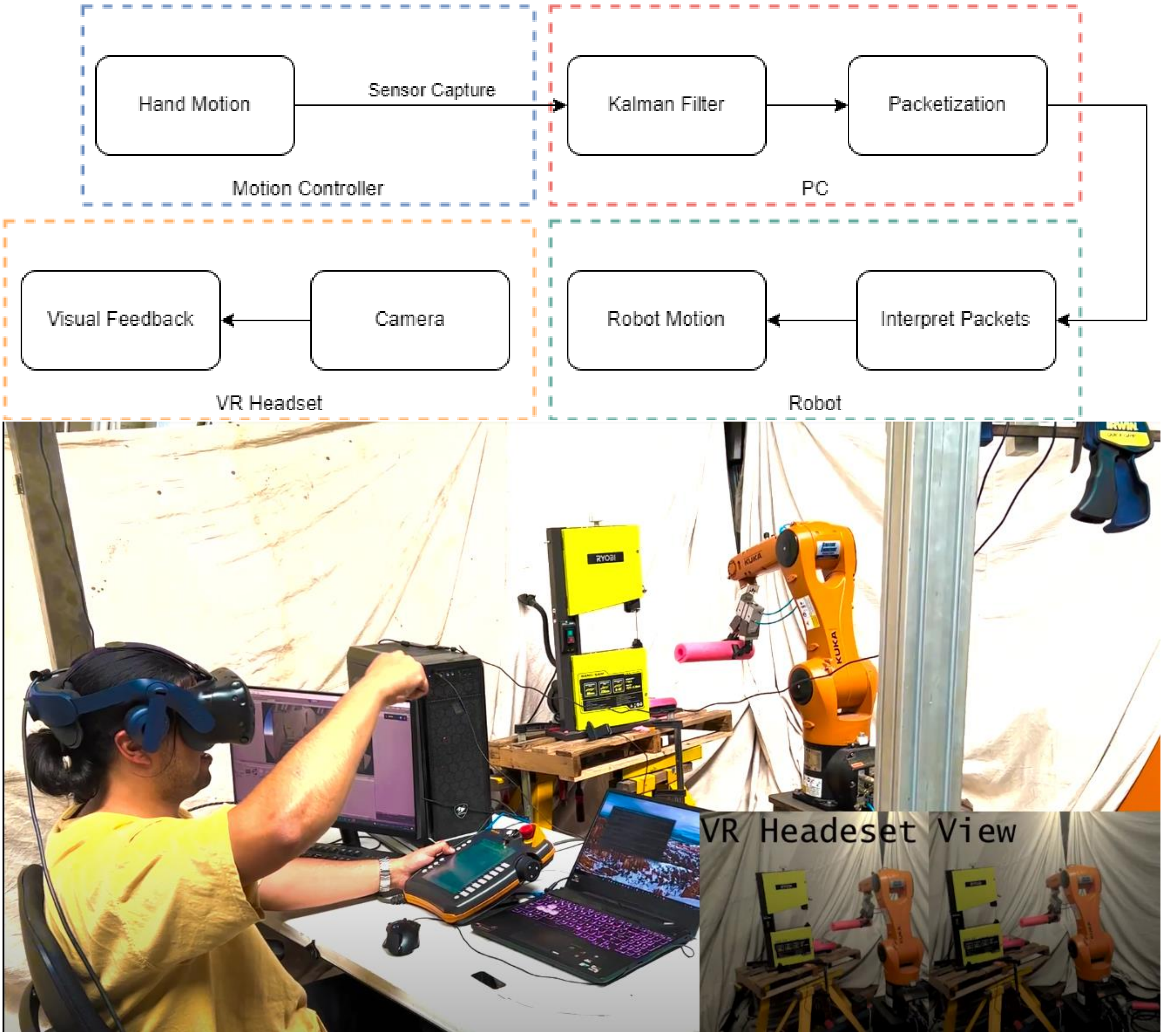

Figure 3 - Flow chart and Implemented System

Table 2 - Gripper Test

Gripper	Attempted Picks	Successful Picks	Success Rate (%)
1	50	11	22
2	50	43	86

Table 3 - Human-Robot Interaction Test

Set-Up Version	Attempted Picks	Successful Picks	Succes Rate (%)	Average Time to pick one successfully (s)
1	10	3	30	67.6
2	20	15	75	24.2

Benefit for Industry

Red Meat Processors will be able to remove operators from hazardous tasks utilising the technology developed in this project to create a safer and improved working environment. With ongoing labour shortages in rural communities this technology can be utilised to provide employers with additional labour work from remote operators coinciding in densely populated regions. This technology has the potential to enhance human abilities, by allowing operators to use this technology to pick, and control larger and heavier items than would be normally physically possible. With repetitive tasks, this technology has the opportunity to allow operators to control multiple robots simultaneously completing the same task, improving production rates.