Acquire and management of Chainsaw tree felling and bucking work by ICT

-Smart Chainsaw and utilization-

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Abstract:

Chainsaw tree felling is an inevitable forestry work which suffer from frequent manual work accidents. Even if we are delight with advanced machineries in the forestry fields, the most important work processes were carried out by chainsaw manual work especially on the steep hillsides. Our Smart Chainsaw was developed based on a general engine chainsaw and attaching sensors, such as 3 axis acceleration, 3 axis gyro and so on, on it and provided with information connect function through Bluetooth. It aims at lesser these accidents, better work environments and more efficiency. A work process and posture were acquired by sensors on the chainsaw and were showed in 3D moving scenario. Tree felling works were digitalized and the processes were compared to show the difference of process. Understanding through acceleration signals was focused on at initial stage.

1.Introduction

Chainsaw is essential machine for manual forestry work not only for tree felling and for versatile work in the forests. And chainsaw today is very sophisticated to have well design for manual handing, safety function, high power and less vibration and son on. But we still suffer from trouble/accidents through the operation. ICT offers us to make it useful by reading the condition and put management on it. The operation situation, cutting accuracy, felling productivity could obtain through the system.

2.Material

- A chainsaw with sensors and data processing/transmitting function was developed and the functions are having been evaluating and the data process system has been developing
- Through attending an WLC for chainsaw workers operation data were obtained for an operation under designed manner. In the trial of the Novice class at HLC held in Tottori Prefecture in July in 2019, it participated with a smart chainsaw, and the operation situation at that time was recorded as digital data. The trial was done by cutting down, cross cutting, and delimbing. In particular, it was analyzed using a vibration acceleration, figure 1.

Felling , Short log version for Novice.

Delimbing

Crosscutting

Figure 1. Operation trial at Chainsaw technique competition HLC (Husqvarna Logging Championship).

3.Method

- The chainsaw was equipped with sensors based on the HusqvarnaGP4350EZH, figure 2. The ICT part embedded a board with sensors embedded in the handle grip. The data was stored in a built-in SD card and also sent to the smartphone via Bluetooth.
- The chainsaw was extensively equipped with several sensors to know location, acceleration, rotation, throttle and engine revolution. The chainsaw has scarcely room and handle grip inside and bottom were utilized to install devices. Data were sampled at 100Hz.

Figure 2. Sensors and the PCB was installed inside the handle grip

4.Result

- A series of collected data is of the above three trials performed during about three and a half hours. I show the acceleration in the x-axis direction in the figure 3.
- It was divided into three sections trial of felling, cross cutting, and delimbing.

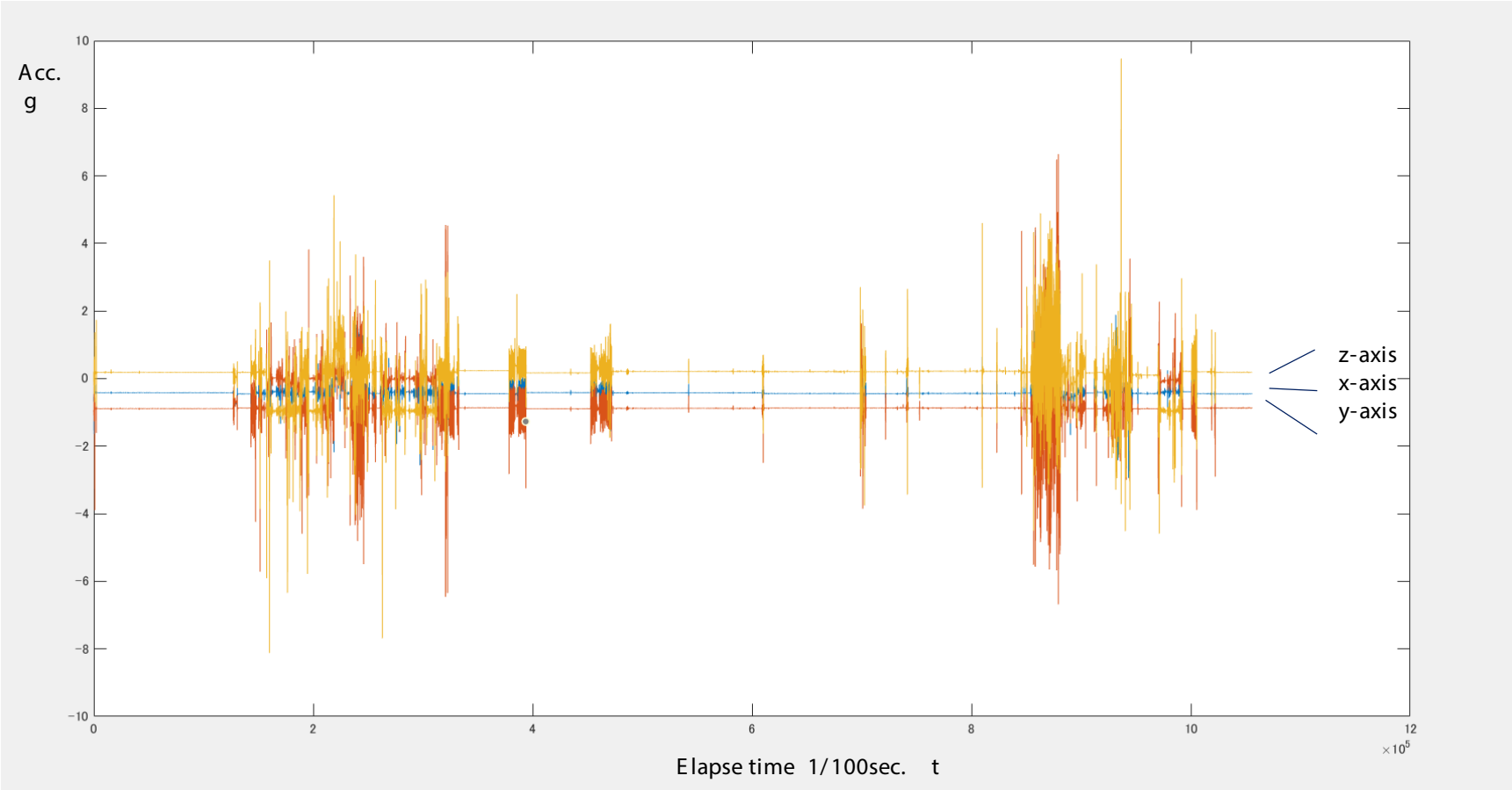

Figure 3. Record of chainsaw operation.

- Since the raw data is a synthesis of gravitational acceleration and vibration acceleration, we tried to grasp the chainsaw posture by moving average. It was determined that the tendency of the posture can be read when the moving window size was 10 seconds as shown in the figure 4,5,6.
- In the felling trial, initial tree trunk preparation by v smoothing left and right vertical sides of the trunk (a) as shown in the figure 1. Also, it was possible to read the sawing was advanced to make felling hinge last (b) and cut off. The vibration by the cutting acceleration of about 0.4 - 0.8g.
- In the delimbing trial, it was understood that the branches were cut off while moving chainsaw along on the trunk while changing the chainsaw posture as shown in the figure 5.
- In cross cutting trial, it was possible to grasp two works of cutting off of the log ends were carried out by moving one to another as shown in figure 6.

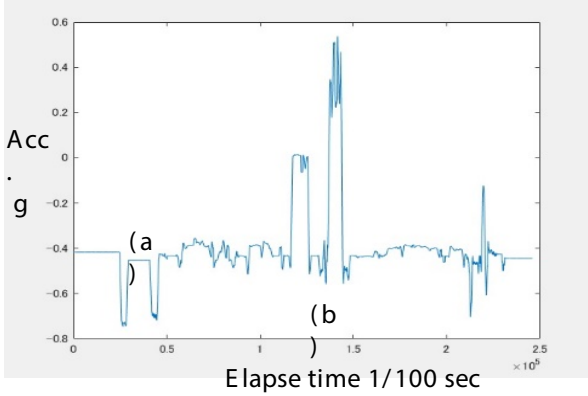

Figure 4. Acceleration-x axis Felling, 10 sec smoothed.

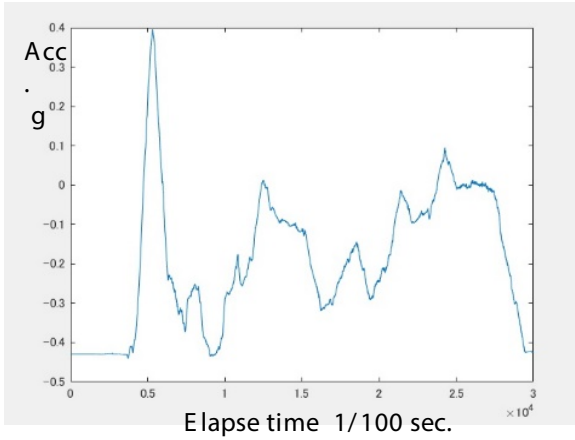

Figure 5. Acceleration-x axis Delimbing, 10 sec smoothed.

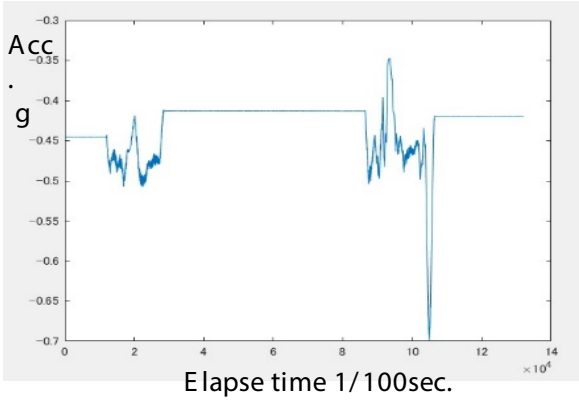

Figure 6. Acceleration-x axis Crosscutting, 10 sec smoothed.

- The machine vibration magnitude during sawing work was evaluated by three-axis synthetic acceleration, AC3.
- AC3 is defined by,
- $AC3 = \sqrt{acx^2 + acy^2 + acz^2}$ (1)

  here, acx is acceleration in x axis,

  acy is acceleration in y axis,

  acz is acceleration in z axis.

- So, we have AC3 for felling operation, AC3 for delimbing operation and AC3 for cross cutting operation, as shown figure 7, 8, 9.

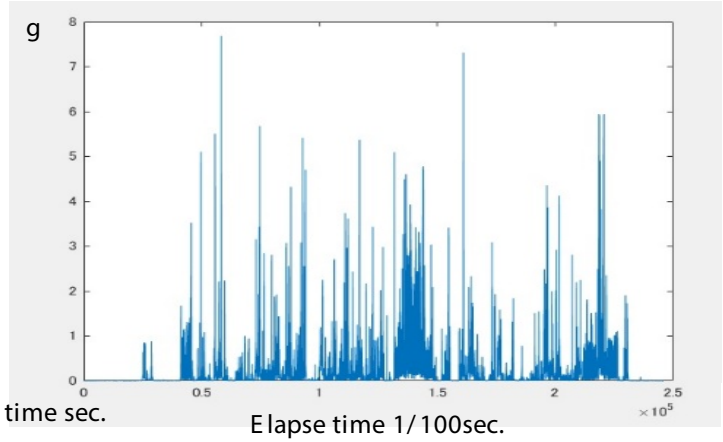

Figure 7. AC3 at Felling.

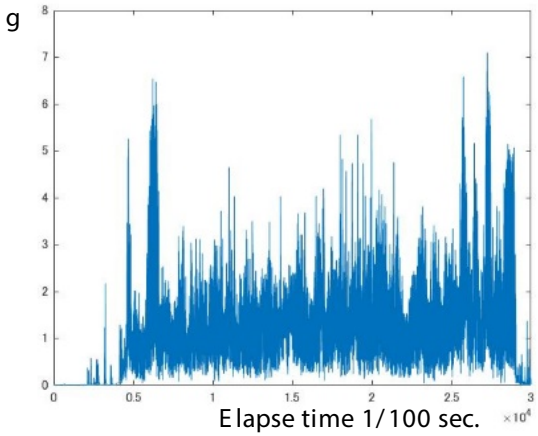

Figure8. AC3 at Delimbing

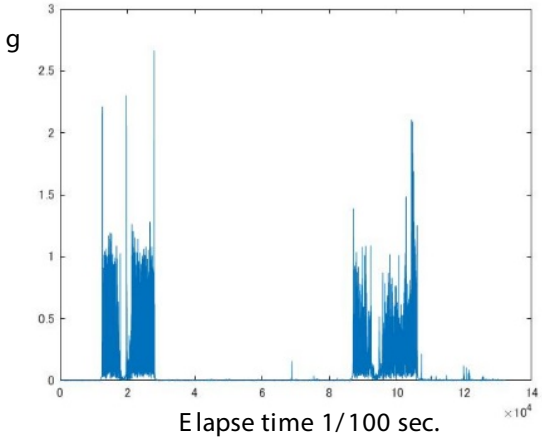

Figure 9. AC3 at Crosscutting

5.Discussion

- Vibration acceleration in the actual chainsaw sawing work is large, about 5g was frequent. Since the three-axis synthetic acceleration representing the chainsaw body vibration characteristics are many things are 4 to 5m/ s^2, i.e. 0.5 g, it was about 10 times larger than them.
- Posture action of the chainsaw manual work was shown by magnitude of acceleration move mean with the wind size of 10 seconds. Each axis acceleration was processed by this way and combination of x, y and z acceleration visualize the movement of the chainsaw.

6.Conclusion

- We were able to attach sensors to any chainsaw to understand the situation at work numerically. The acceleration data allows us to understand the working posture. From the size of the work contents and vibration, cutting mode cut to wood is the main, vibration was large at cross cutting operation. It was about 10 times larger than that of idle racing. Although it is presumed that the appropriateness sharpening of the saw chain to be cut tree/log affects the vibration, it is necessary to consider in quantity about the appropriateness and vibration that stand out in the future.
- Further development is needed to configure operation model in introducing extra measurements such as the throttle opening, engine speed, saw chain speed, and attitude angle speed.
- Sensor devices can be standardized to accommodate a wide variety of models. We would like to promote the development and development of application software and improve the functionality and convenience.
- A function for less experienced worker to advice the operation and also a function for experienced worker to keep the safety and productivity will be installed. For the business management requirement, Bluetooth connection to smartphone can be useful to have electrical daily operation report function.

- **7.Acknowledgements**
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