Application of Modern Technology for Tree Growth Monitoring

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INTRODUCTION

Nowadays tree growth measurement can be done by many ways, by using the simple tools till complex devices. Some devices have been developed to electronically read and collect data for maximum convenience. However, accuracy of such data is pretty much relies on reader's skill and expertise. If the user is professional, result may be more accurate than result obtained by an inexperienced user. This indicates human error on forest mensuration that may occur. Consequently, this study aims to develop a prototype for unmanned tree growth measurement in order to avoid such human error. The concept of prototype is to integrate the dendrometer with Internet of Things technology. The data that obtained from prototype are near real-time information, thus the forest owner would monitor the tree growth and use such information for decision making. This would help the forest owner to do the thinning or felling more precisely: right place and right timing.

METHOD

Development of prototype tree growth monitoring device

According to design, the prototype consists of 3 main parts:

1. A 60mm *Slider resistor sensor unit* encased in a waterproof case.
2. *Control unit* which takes data from the sensor and transmit to the gateway. The control unit that control data recording interval (hourly, daily, weekly, monthly etc.)
3. *Gateway* receives data from the sensor through the control unit, then transmit the data to the server for display. This unit consists of battery, and internet module.

Principle of the prototype tree growth monitoring device is following, when tree grows, a cord around the tree stretches and make movement in the sensor unit, then the sensor unit records the length it moves (considered as tree growth) before transmitting the data to the control unit, which turning it recorded data and send it to the gateway for display on the computer software or mobile application.

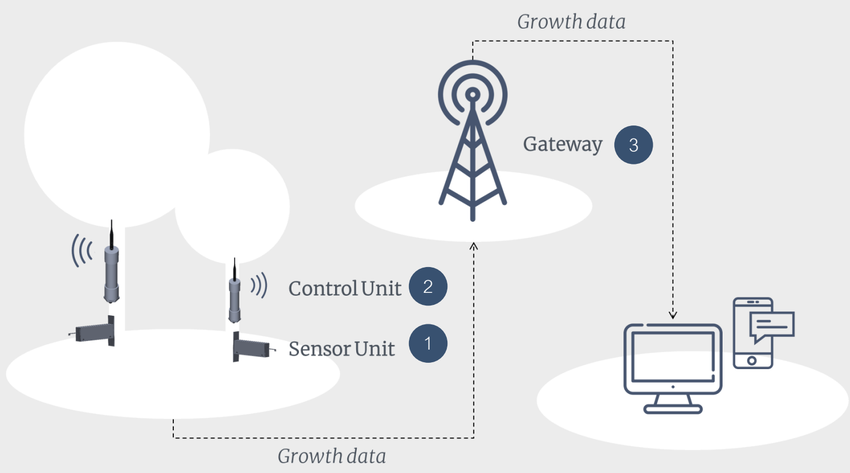


Figure Working principle of prototype tree growth monitoring device

Data analysis

Study of tree growth by using the prototype device and other equipment to measure (January – June 2019) diameter growth at the height of 1.30 meter once a month for six months. The correlation between tree growths data obtained from different equipment were analyzed and compared with data from the prototype device. Data variance for each factor is determined by using ANOVA.

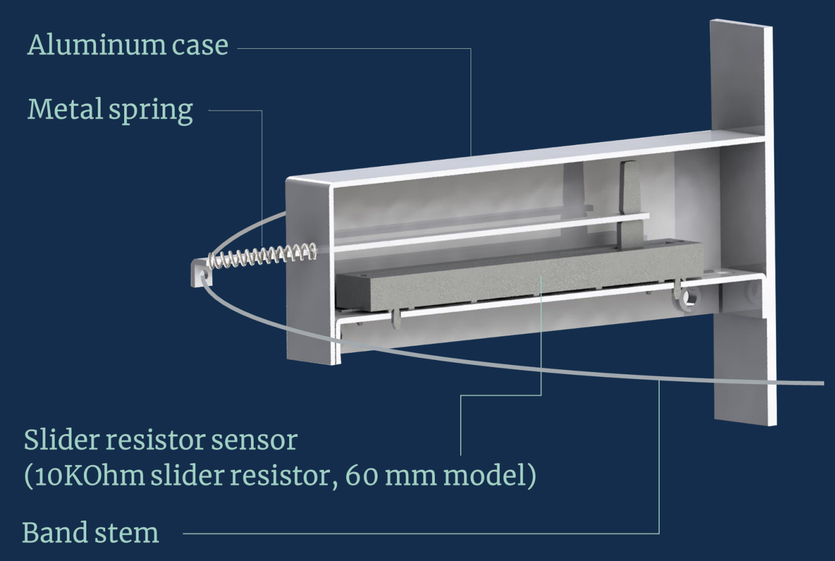


Figure 3D model of the Sensor unit

RESULTS

- The prototype can be used as other equipment but some prototype's errors were observed. It showed that collected data from prototype were noticeably inconsistent compared to other devices.
- The inconsistency might occur because of poor signal interference or external disturbances to the sensor strip (by human or animal for example).
- The implementation of prototype is limited to only 6 months of (January – June 2019), which was dry season. Perhaps, tree did not grow that much. Data collection therefore should be continue to cover whole year round including rainy season.

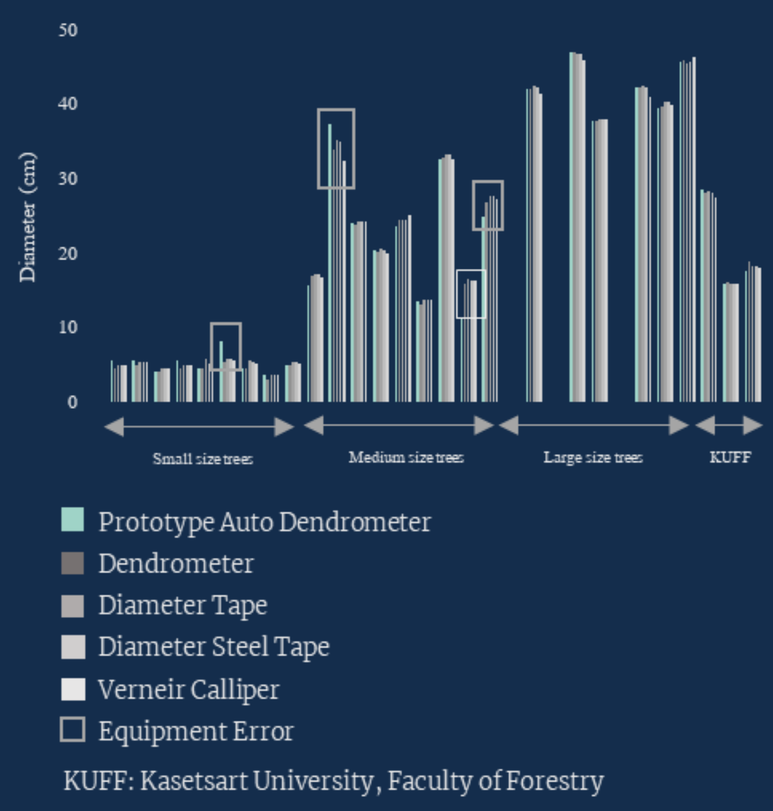
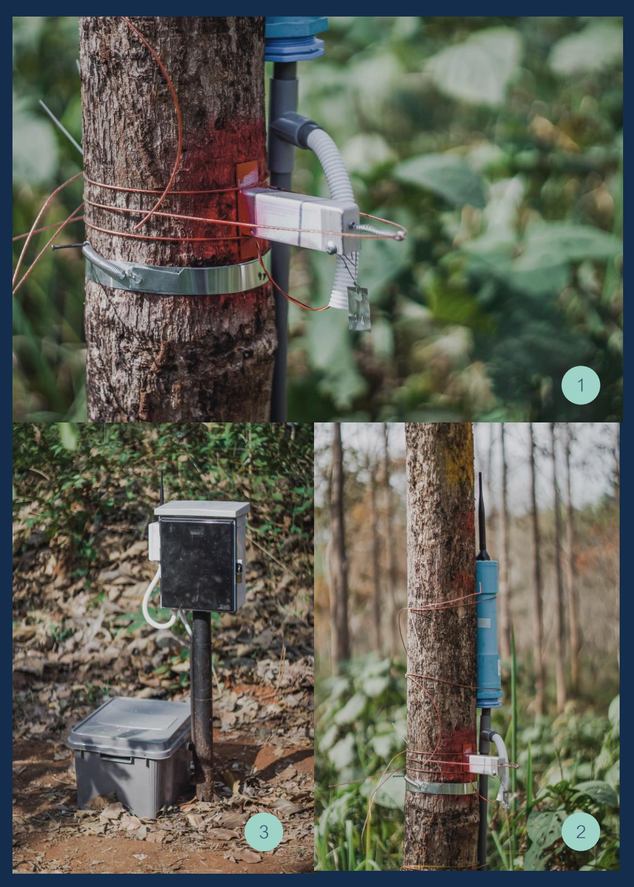


Figure Tree growth data obtained from various devices June 2019



CONCLUSIONS

- *The study demonstrated that the prototype worked well in the forest, it did not show any statistically significant difference compared to other tools.*
- *The investment cost of prototype is relatively high.*
- *The prototype it self need further development, such as, easy use, portable unit, and durable material.*
- *Future development should add warning or alert system in case of abnormal tree growth or disturbance to allow quick examination.*

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