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The Technology Research on Cutting Test of 4GXJ-I Tapping Knife for Rubber Tree

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Abstract. As the market continues slumps and an aging rubber-cutting contingent, rubber-cutting labor shortage has become one of the bottlenecks restricting the development of caoutchouc industry. The mechanical and intelligent cutting method becomes the development direction in rubber-cutting industry. This study chooses type 4GXJ-1 of portable cordless brushless tapping knife to take rubber-cutting experiment in accordance with appropriate rubber-cutting procedures. The results show that the bark cutting technology can research millimeter in precision control, and the rubber-cutting average time can achieve the projected objective. The results have been validated by the test, and it can provide the references for the other similar design. The type 4GXJ-1 of portable cordless brushless tapping knife is practical and worthy of wide application.

1. Introduction

How to surpass traditional tapping way has been the focus in the past years. Nowadays, with the development of science and technology, mechanical and intelligent tapping becomes necessity choice. The mechanical and intelligent tapping can be more greatly improve work efficiency. It can help reduce labourintensity and technical difficulty. The scientific and technological innovation and industrialization will boost natural rubber economic development.

The main factors^[1-8] of rubber tapping have been researched include tapped part, secant length and direction, slotting height, tapped frequency, rotate different trees, bark consumption, tree age, tapped efficiency, order of knife time, the degree of tree injuries, labor strength, natural rubber yield and tapping machinery. Many positive research work has been done on tapping equipments of semi-automatic and full automatic, but the equipment achievements are poor in the practical application. 4GXJ-I tapping knife has been finalised and processed in the research^[9-10]. The knife is efficient, effortless, utility, economy and simplicity and light.

2. The cutting technology of 4GXJ-I tapping knife

2.1. Millimeter control technology. The structure of rubber tree bark includes four levels, and watery sac level is in bark's innermost level. Watery sac level injured is one of the major threatening high and stable production of natural rubber. The bark thickness of rubber tree is about 7mm, and the tapping



depth should be less than it. So the mechanical tapping tools designed must be able to achieve millimeter control.

2.2. *Mechanical cutting technology.* The optimal cutting control theory is determined according to the impacts of four different methods of cutting on tapped part. The methods include vertical milling, horizontal milling, end milling and complex milling. The parameter influence is analyzed, including latex certain velocity, dry rubber yield, rubber bark consumption, ash content, ratio of rubber tree damage, total length of the bark, rate of effective bark, effective cutting and rubber tapping time. The key parameters of mechanical cutting are tested and validated, including the shape and sharpness of the rotary blade, cutting route, cutting efficiency, quality, and cutting frequency. All above, the test and the theoretical research have formed the basis of practical application for the mechanical cutting machine. The key technology of mechanical cutting is as shown in Figure 1.

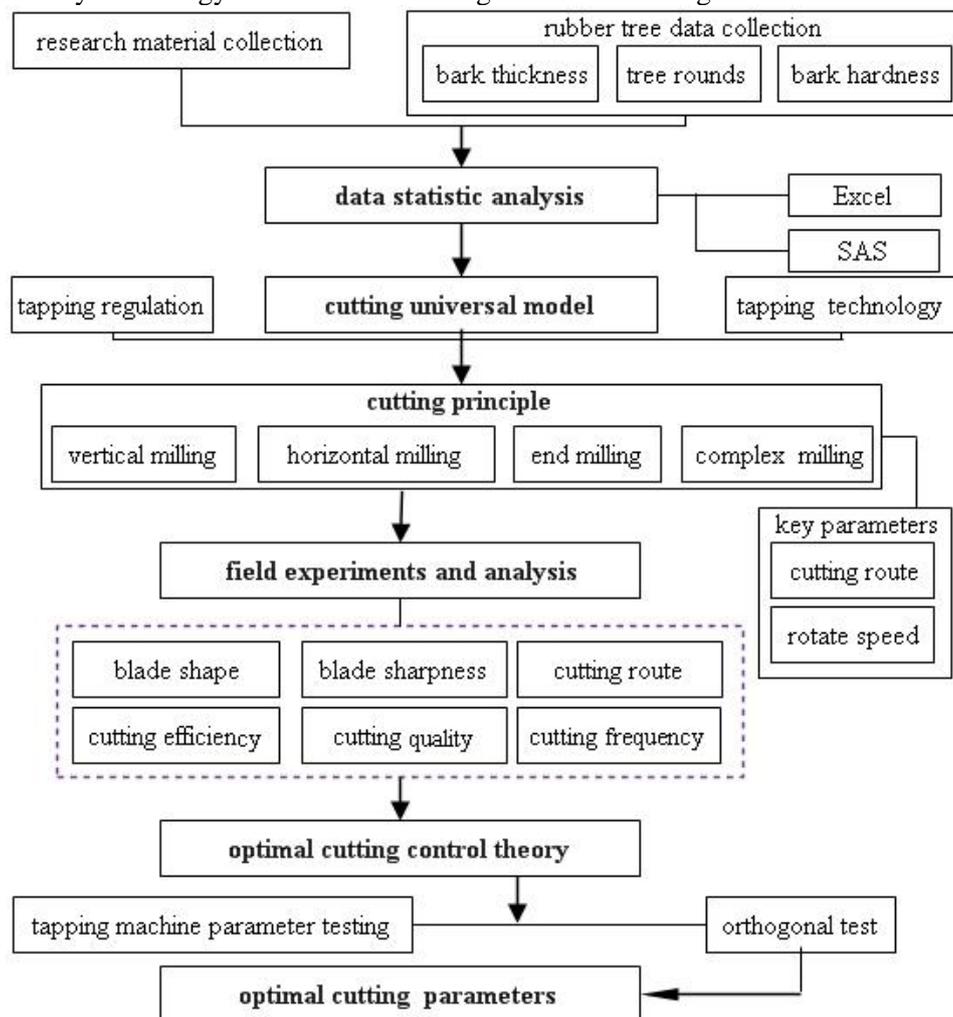


Figure 1. The key technology of mechanical cutting

2.3. *The tapping prototype finalised and processed technology.* An optimal design method for the actual parameters of mechanical tapping knife is determined using physical sensors. The resulting sample average approximation problem is then solved by deterministic optimization technique. Type 4GXJ-I tapping knife is finalised and processed. The research technology flow diagram of tapping prototype is as shown in Figure 2.

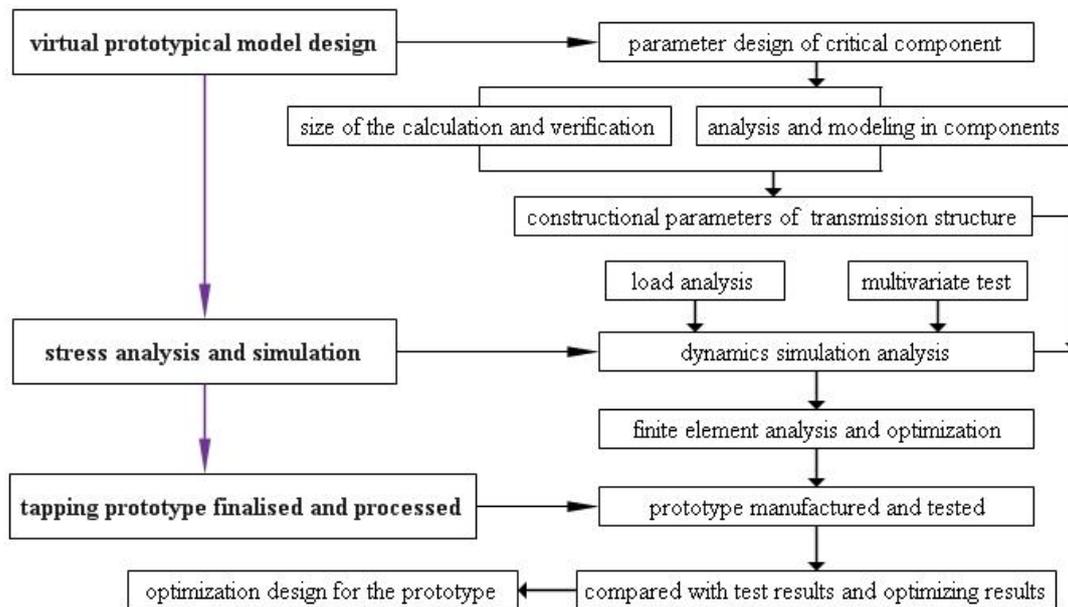


Figure 2. The research technology flow diagram of tapping prototype

3. Cutting test and result of 4GXJ-I tapping knife

The test focuses on 30 rubber trees located in Danzhou Hainan. All trees are more than 30 ages.

3.1. Tree rounds and secant length

All trees are in the 600mm rounds length above. The average amount of rounds length is 791mm. A half secant tapping method is cutted in all trees, and the average amount of secant length is 406mm. The result of rounds and secant length of rubber tree is as shown in Figure 3.

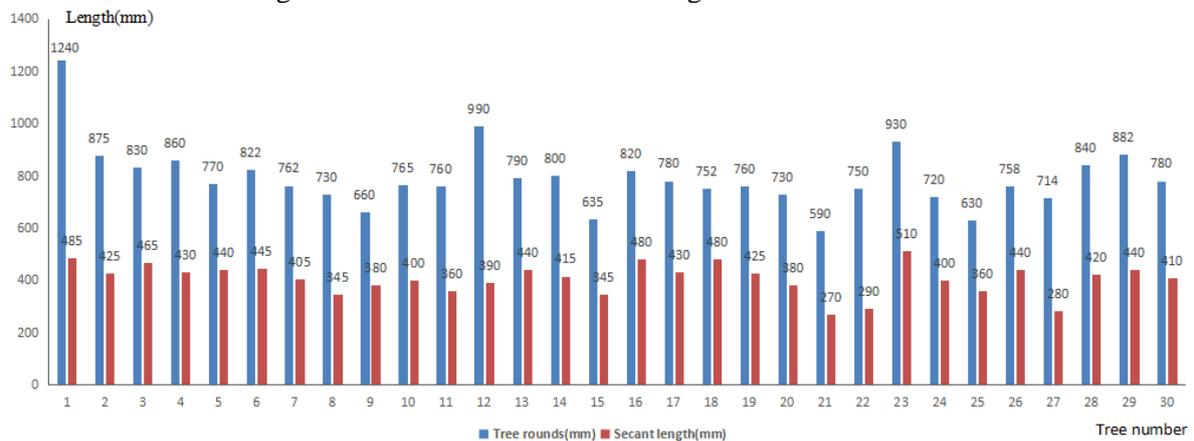


Figure 3. The result of rounds and secant length of rubber tree

3.2. Bark thickness and bark consumption

The average amount of bark thickness is 7.4mm. The average amount of bark consumption is 2.19mm. The result of bark thickness and bark consumption cut by 4GXJ-I tapping knife is as shown in Figure 4.

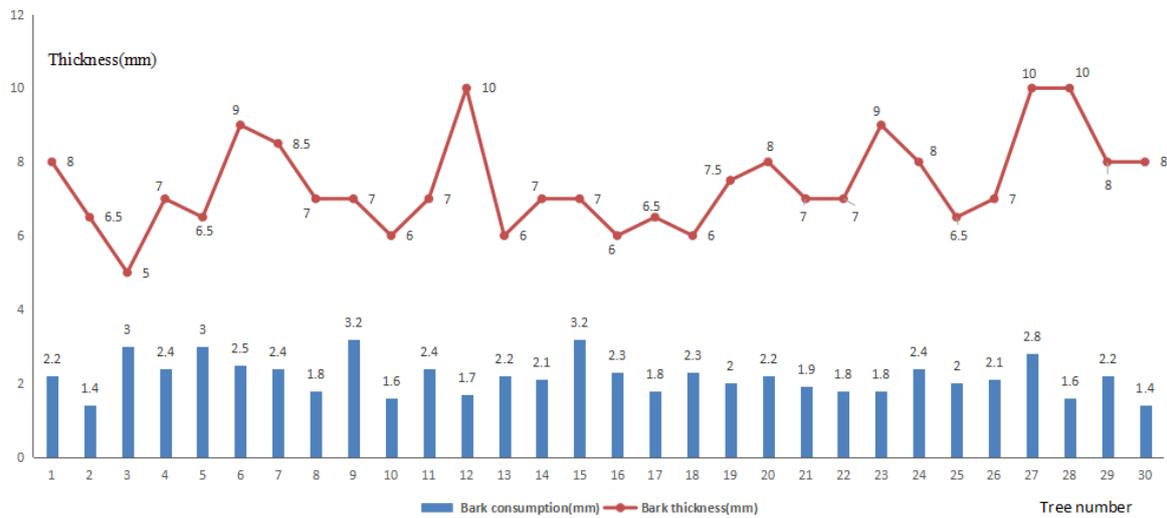


Figure 4. The result of bark thickness and bark consumption cut by 4GXJ-I tapping knife

3.3. Cutting time

Tapping time of rubber tree is in direct ratio with secant length. The tapping time is 13s on average in each rubber tree. The result of cutting time during rubber tapping is as shown in Figure 5.



Figure 5. The result of cutting time during rubber tapping

3.4. Cutting current

In rubber tapping test, The average amount of the no-load current, minimum working current, maximum working current, average working current of each tree, respectively is 0.64A, 0.88A, 1.64A, 1.29A. The currents are reasonably stable. In the test, The amount of standby current is 0.029A, and The average amount of maximum working current is below 2A.

The cutting current during rubber tapping is as shown in Figure 6.

4. Conclusion

The test result reaches the goal of millimeter control, because the average amount of bark consumption is 2.19mm cut by 4GXJ-I tapping knife. The result of the experiment reaches cutting efficient goal, because the average cutting time is 13s. The prototype experiment has confirmed the design rationality. This study provides both method and experience for mechanical tapping machine.

The result of cutting current during rubber tapping is as shown in Figure 6.

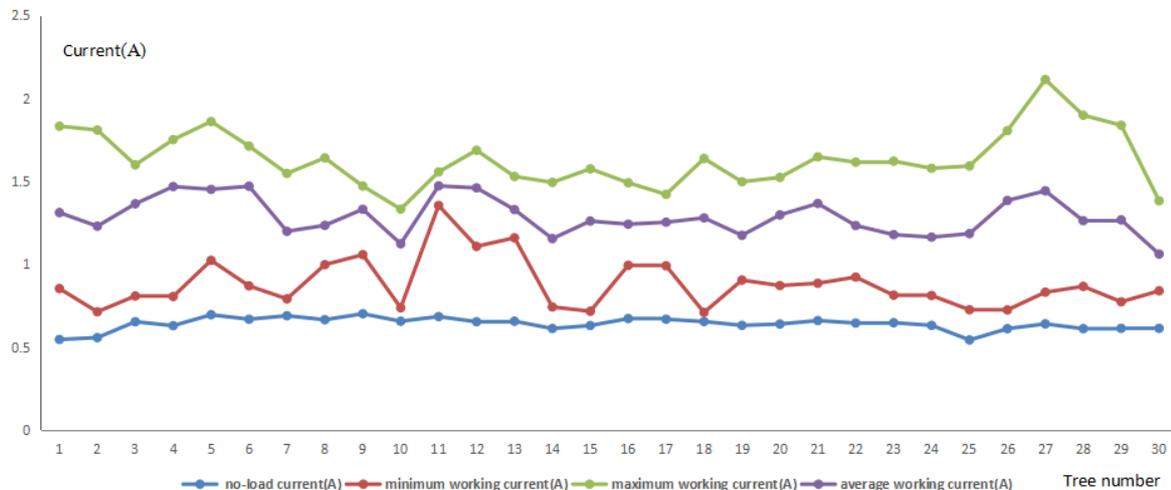


Figure 6. The result of cutting current during rubber tapping

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