OPENING MINDS: RESEARCH FOR SUSTAINABLE DEVELOPMENT

Fully-Automated, Economical Metal Bar Feeding Mechanism for Existing Power Hacksaw

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1 INTRODUCTION

Sri Lanka has historically demonstrated an ease with the technology of casting iron. From the early stages, metal-related industries grew up and spread all over the country. Despite the economy of the industry, middle and small-scale industries and workshops still continue to work with power hacksaws and band saw machines. Direct analysis of these machines found that more time was required, not for the cutting process, but for human intervention such as feeding, measuring, conveying, and clamping. If the work pieces need to be cut on a large scale, then a repetitive action has to be performed. This multiplies idle time resulting in a considerable lag. According to the analysis, nearly a quarter of the total operating time is devoted to human intervention. At an organizational level, a considerable time wastage may cause economic loss.

Automating human intervention may contribute towards cost reduction and improvement in efficiency. Knowledge and basic theories of mechanical motions are considered highly in the designing process. Upon implementing the product, approximately 40% of the process time can be saved. While the product is in performance, the safety of the machine operator can also be assured.

The complete cutting process incurred from a power hacksaw machine, can be separated into 3 major actions; loading, conveying and clamping. These actions are manually conducted through human labour. Therefore, the time that is spent to complete the cutting process increases. By considering the application, a mechanism is introduced to improve the efficiency as well as the economy.

In addition, through this design the safety of the machine operator can also be assured. However, there are a few issues that impact generally on all cutting machines, such as power consumption, machining defects, high cost of maintenance, etc. But if automatic cutting systems are considered, attention should be paid towards cutting tool wearing. So far, there is no prominent and effective monitoring system to measure the cutting tool wear percentage.

During the literature survey, it was noticed that the impact of this matter on cutting machines has had less consideration among researchers. In order to optimize the metal cutting process, we have also attempted to conduct a separate survey to develop a tool wear monitoring system.

2 METHODOLOGY

2.1 Loading unit

The initial functioning unit is the loading unit. If the cutting job is defined by the operator with measurements, the first step is to confirm whether the metal shaft is existing on the conveyor track or not. If the metal shaft exists, then the length of the existing metal shaft will be compared against the provided measurement. Next, the loading unit helps to load metal shafts onto the conveyor track. The maximum number of metal shafts that can pre-stored in the loading unit is 5. The loading unit is designed to support the repetitive cutting processes. (Figure 1)

Figure 1: Loading unit

2.2 Conveying unit

This unit helps to convey the metal shaft according to the measurements given by the machine operator. The shaft conveying speed is maintained at a constant. This helps to measure length without any expensive sensors and transducers. The slippage of shafts over the conveyor is minimized in the designing process of the conveyor roller. The conveying unit will be the main unit that plays a vital role in the repetitive cutting processes (Figure 2).

2.3 Clamping unit

Clampers are designed to power up the clamping unit with the pneumatic source. When designing appropriate clampers, it is important to consider the reciprocating motion of the hacksaw blade while in performance because the chances of slipping are high. To recognize the cutting position exactly, an inductive proximity sensor is used.

Figure 2: Conveying unit

2.4 Cutting tool wearing monitor and material recognition

If the machine is fully or partially automated, the repetitive cutting action takes place and the machine operator may turn his attention to another activity. During the continuous cutting, the tool wearing situation is very noticeable. Due to this, the machine operator may lose his concentration by having to focus on the wear of the cutting tool. This may lead to machine damage. A tool wear monitoring system observes and notifies the user of the tool wearing percentage so that the machine operator is aware of the status of the machine.

Table 1: Hardness of the selected types of metals

Material	Heat treatment	Hardness (HB)
Iron based alloy	Annealed	200
	Aged	280
Nickel based alloy	Annealed	250
	Aged	350
	Untreated	275
Cobalt based alloy	Annealed	200
	Aged	300
Titanium based alloy	Untreated	200
	Annealed	320
	Aged	375

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Prior research indicates that the possible ways of monitoring tool wear-percentage are,

- MLP neural network and multivariate process parameters.
- Cutting tool vibration pattern behaviour.

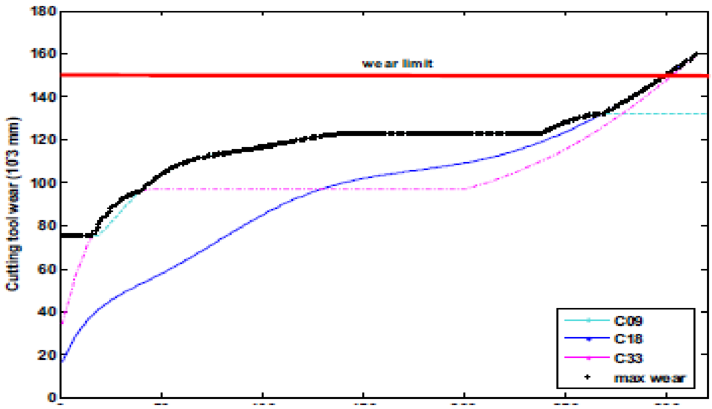


Figure 3. Wear patterns with max wear limit

Before the cutting process starts, it is important to identify the material to be cut. Therefore, the cutting tool material should be changed accordingly. Material identification is an important factor for successful machining.

Table 2: Test records of time values for conventional cutting.

work pieces diameter	Time for clamping and measuring	Time for cutting process
25mm-35mm	1min	3min-4min
35mm-50mm	1min-1.42min	5min-6.17min

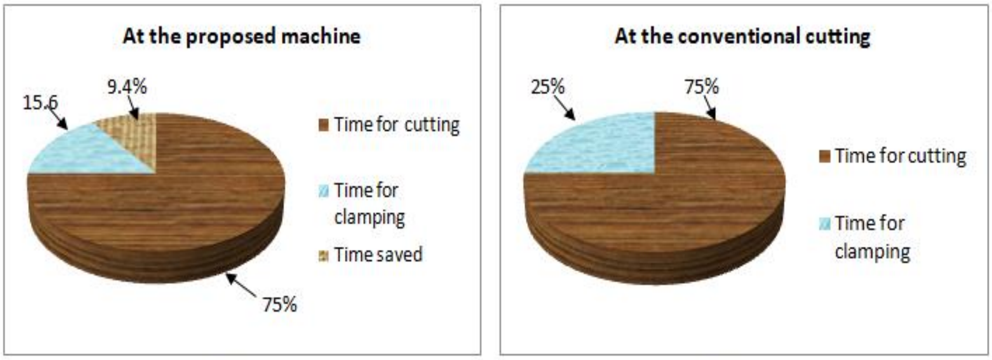
3 RESULTS AND DISCUSSION

3.1 Results

Using the current method, the worker spends about 1 minute on the clamping, measuring, and feeding operations. By using the proposed solution, the time spent on these operations can be reduced up to 36 seconds. The percentage of time saved by the designed machine is about 42% which is demonstrated by the test results. Therefore, the efficiency of the power hacksaw cutting process can be improved by automating it. By considering the expensive prices of the CNC machines compared to the budget, it is better to use an automated solution for the existing machine. The mechanisms and the materials used in the design of the machine are selected in such a way that the cost of production of the machine is minimized.

3.2 Discussion

As mentioned in the introduction, a considerable amount of time has been saved. This may lead to more sustainable process for maintaining the repetitive cutting action. Therefore, the targeted number of work pieces for a day can be increased. The concerns about the safety of the machine operator during performance is also satisfied.



(A) (B)

Figure 4: Time comparison, (A) At the proposed machine. (B) At the conventional machine

4 CONCLUSIONS

By considering the cost reduction and improved efficiency, a few mechanisms were selected and designed. During optimization the most appropriate design was selected. Cost reduction is maintained by applying the most suiTable mechanisms. Power sources are selected by considering the ease for workshops of any scale. The machine is a combination of three units, the clamping, loading and conveying unit. The machine is automated by connecting these three units to work as a single machine.

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