Design and development of ergonomics labeling machine for cashiers

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ABSTRACT – Frequent exposures to forceful hand exertion and poor wrist posture during manual labeling task of "SOLD" stickers on purchased items increases cashier's risk to injury and musculoskeletal disorders (MSDs). A labeling machine was proposed to address these issues. A needs assessment study was conducted among cashiers to identify issues, before conceptualizing potential solutions. A working prototype of a labeling machine was fabricated and tested among 10 cashiers. The prototype has shown initial promises in improving cashiers' wrist posture and reducing forceful hand exertion. Average strain index of the wrist posture was improved, while overall scanning time was unaffected with the machine compared to current manual method.

1. INTRODUCTION

The state government of Melaka, Malaysia has implemented no plastic bag policy in supermarkets [1]. Customers have to either bring their own recycling bags, or carry their items individually after payment. The main intention is to reduce the usage of petroleum by-products, and encourage recycling behaviors, as part of the state government's green policy initiatives. This policy has started to gain interest from other states such as Selangor, Penang and Perak [2].

One of the indirect consequences for this policy is the increase use of "SOLD" tape use to individually label the post-payment purchased goods, especially when customers did not bring their own bags. Tearing of "SOLD" tape, as shown in Figure 1 poses a poor posture on cashier's wrist. Besides, forceful exertion was also observed in tearing the tape. Tape tearing from the blade attached to the tape dispenser may also poses injury risk to fingers. High frequency exposure to this manual individual labeling process may increase cashier's risk to the development of work-related musculoskeletal disorders (WMSDs), especially on wrist region.

Figure 1 Poor wrist posture and forceful exertion during manual labeling task

This study aims to explore ways to reduce the frequency and magnitude of forceful exertion, poor wrist posture, and their combinations as these are well established risk factors to WMSDs [3-4]. An automated labeling machine was conceptualized, developed, and fabricated to address these issues. A comparison study was conducted to compare between manual labeling using tape dispenser and automated labeling using developed prototype.

2. METHODOLOGY

There were three stages in the design process involved in this study:

Stage 1: Needs Assessment. The needs assessment was derived from observation, interview, and questionnaire at 30 cashier stations in two different supermarkets. Thirty cashiers were involved in this stage.

Stage 2: Concept Generation and Prototype Development. Concepts were generated through discussion, creative endeavor, internet searches, patent searches, and review of literature. Concepts were screened and modelled in Computer Aided Design (CAD) software, before a functional prototype was fabricated in an in-house workshop.

Stage 3: Pilot Testing. Ten cashiers in a local supermarket were chosen at random for prototype testing process. Experience of cashiers ranged between 1 month to 15 years (cumulative experience = 93 years). They were asked to perform a series of labeling tasks manually (current method) vs. automated (using prototype). Data collected were:

- Wrist postures captured by video and analyzed using Strain Index as described by Moore and Garg [5].
- Cashiers' perception was captured using questionnaire with Likert scale.
- Time taken to perform task captured using stopwatch.

3. RESULTS AND DISCUSSION

Stage 1: Needs Assessment. Three recurring issues were identified from stage 1 are: forceful exertions, poor postures, and high frequency of the forceful exertion and poor wrist posture combination.

Stage 2: Concept Generation and Prototype Development. Six concept designs were generated and screened among research team members. A functional mock-up model was fabricated to give a physical representation of the ideas as shown in Figure 2.

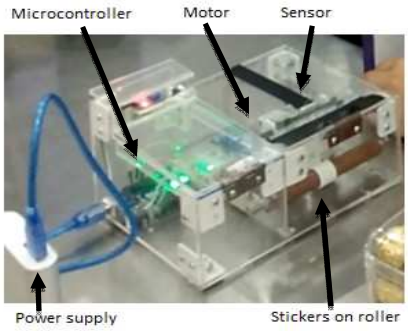

Figure 2 Prototype of labeling machine

The automated labeling prototype consists of microcontroller of Arduino system, infrared (IR) sensor, roller, bolts, nuts, brackets, and motor. The casing was custom made from Perspex. Operating procedures of the automated labeling prototype are as follow:

1. Turn on the power supply.
2. Check for sensor to detect the item.
3. Check motor rotation after detection of item.
4. Ensure sticker rolls out from the machine.
5. Swipe item to attach sticker from machine.

Stage 3: Pilot Testing. In general, it was observed that scanning with the device reduced the overall duration of forceful exertion and poor wrist postures for all cashiers. Figure 3 demonstrated the differences between manual vs scanning with prototype.

Figure 3 Labeling task of current method (top) vs. labeling machine (bottom). Note the posture of subject's right hand.

The method using prototype was also seen to have provide an improved strain index score compared to manual method, across all cashiers. Average strain index score (n=10) was reduce from 8.7 (job is probably hazardous) in current method to 1.2 (job is probably safe) in the proposed method. This indicates an early promise of how the prototype might provide improvement conditions to the distal upper extremities area.

Data from questionnaire demonstrated the cashiers are generally in agreement that labeling method using prototype made the labeling task easier and more comfortable compared to manual labeling. In a scale of 0 – 5 (where 0 = strongly disagree, and 5 = strongly agree), cashiers rated an average score of 5 for reduction of discomfort using prototype. The cashiers reported that over time, manual labeling method using tape dispenser hurts their wrist and fingers.

In terms of scanning time, it was found that the time needed to complete labeling task using the prototype (Ave: 1.54 min, SD: 0.30 min) is comparable to the manual labeling method (Avg: 1.56 min, SD: 0.34 min). The data of time needed to complete labeling task between the two methods is summarized in Table 1.

Table 1 Time taken to perform task between two methods (n = 10)

Labeling methods	**Manual**	**Prototype**
Total average time taken (min)	1.56	1.54
Standard deviation (min)	0.34	0.30

4. CONCLUSION

A device has been conceptualized, fabricated, and field tested to reduce the frequency and magnitude of forceful exertion and poor wrist posture during manual labeling task for cashiers. The study demonstrated an initial promise of improving wrist posture and reduce forceful hand exertion without affecting work productivity. Future studies will include further design iterations and additional field study involving larger samples of cashiers.

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