Ergonomic Add-On Seat for Wheelchair Users

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***Abstract*—In this talk, we discuss about issues of popular foldable wheelchairs that have been overlooked. The major issue is that firstly the wheelchairs are not designed for comfortability based on ergonomics. Users cannot sit on the wheelchairs comfortably and they might even cause some health issues, such as, muscle pains and pressure ulcers. They are normally designed for low cost and light weight. In this talk, we propose a low-cost ergonomic add-on seat that distributes the weight of the user evenly and optimized for user's comfortability. Note that this add-on seat has been patented and tested with a paralyzed patient.**

***Index Terms*—Ergonomic, Wheelchairs, Pressure contour map**

I. Introduction

Currently, our community has become an aging society over the past 10 years [1]. The birthrate has gradually decreased while older people have a longer life expectancy. Therefore, in the near future there will be a big demand on research and development focusing on tools and equipment for the elderly to help them to have a comfortable life. Of course, one of the necessary equipment is a wheelchair. Not only the elderly needs, the wheelchair is also an assistive device enhancing the personal mobility for people with disability or patients. Wheelchairs should have been designed for convenience and for long time seating, however, most of the wheelchairs in the market focus on manufacturing at a lowest possible cost, the foldability and light weight are the key themes. Normally, this type of wheelchair consists of two thin leather sheets (one for the seat and another one for the backrest) making almost 90 degrees up right angle. These foldable wheelchairs are very popular in hospitals and nursing homes, since they are very affordable. This, of course, comes with an expense of uncomfortable feelings, when the users sit on the wheelchair for too long, such as, pressure ulcers and muscle pains as indicated by a number of research [2-4]. This case is even worse, if the elderly or patients who sit on this kind of wheelchair cannot move their own body; the pressure ulcers are not only the main issue here, but sliding from the wheelchair is also one of main problems [5]. These issues do not only cause the pain to the user, but they might also lead to a major accident in case of a caretaker is not around.

II. Experimental Measurement on a Standard Wheelchair

First, we measured a pressure contour map using 471.4mmx471.4mm seat pad CONFORMat sensor, Tekscan while sitting firmly on a standard wheelchair as shown in Fig. 1. The experimenter was a health female with her weight of 50 kg and 167 cm tall; 20 years old; Thai.

Fig. 2 shows the corresponding pressure contour while seating on the standard wheelchair, where the green box in the Fig. indicates the seat pad area of the wheelchair and the area below the green box indicates the pressure on the experimenter's legs. It can be clearly seen that there were two high pressure points with the maximum force of 451.5 N applying on the experimenter's buttocks. This was just slightly less than the weight of the experimenter and indicated that the buttocks suffered from the high pressure while sitting on the

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wheelchair. Apart from an uncomfortable feeling, this might also, of course, lead to a more severe problem, such as, pressure ulcers. There are several research works reporting the similar findings [2-5].

Fig. 1 shows seating position of the experimenter on a standard foldable wheelchair.

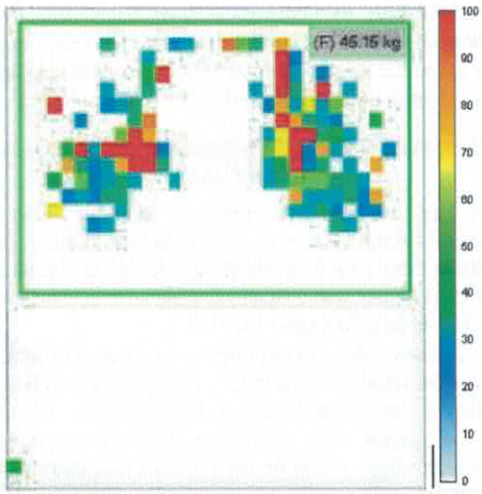

Fig. 2 shows the corresponding pressure contour while seating on the standard wheelchair as shown in Fig. 1. The green box indicates the seat pad and the area underneath is the pressure on the legs. Color-coded scale identifies from low- to high-pressure area (white to red) and position of the buttock.

III. Ergonomic Add-on Seat Design and Specification

Due to these disadvantages of the conventional wheelchairs, we have therefore developed an add-on seat. The propose of the add-on seat is to provide a more ergonomic seat and allow wheelchair users to comfortably sit on it for a long time.

Our add-on seat addresses the following issues:

1. The reason that we would like to make an add-on seat is for the cost effectiveness. We therefore would like to turn existing wheelchairs into a more comfortable one using our design.

2. Having mentioned about the 90 degrees seat, which is ergonomically not the suitable for human body. There is a number of research [6, 7] showing that an inclined s-shaped seat will help to reduce the pressure pushing the user and make the seat more comfortable.

3. The foldable wheelchairs are suitable for users who can still move their body, so they can change the sitting pose reducing the muscle pain. On the other hand, for the users who cannot move their body sitting on a wheelchair for very long time will be a very unpleasant experience. This requires the caretaker to lift the user up and adjust the pose very often.

4. The users might even slip from the wheelchair.

From the issues mentioned above, we therefore design an ergonomic add-on seat for wheelchair users focusing on (1) price (2) user comfortability (3) ease of use and, of course, (4) ergonomics. Note that it is also applicable to use this add-on seat on a chair or a car seat as well as a wheelchair.

We designed the seat so that it can be inclined in order to prevent the user from sliding and this allows the user to adjust the sitting pose by adjusting the inclined level using a manual crank (similar to the one used in hospital beds) as shown in Fig. 3.

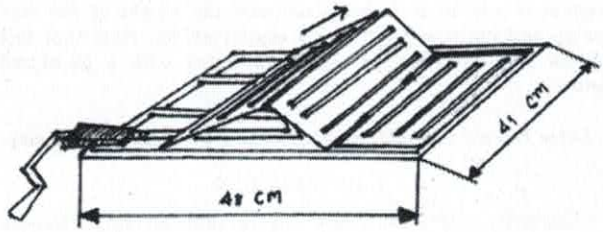

Fig. 3 shows the seat pad adjustment mechanism.

The seating pad has been designed using s-shape as shown in Fig. 4 to reduce the pressure pushing down on the user. This will fully support the full seating area; in contrast to the conventional foldable wheelchair, where only few positions on the user body have to withstand the weight of the user. The seating pad is made of memory foam and the cover made of nano-fabrics.

The backrest has been designed with an adjustable 5 steps Ratchet hinge. These Ratchet hinge usually used in sofa beds, where the backrest angle can be adjusted and locked to a position. Our backrest pad has been ergonomically designed to support the back, the hip and the spline [7] as shown in Fig. 5. The backrest is also made of the same material as the seat pad. The seat and the backrest have a set of stretchable belts and straps. These are for firmly attaching and locking this add-on seat to a wheelchair, a chair or a car seat.

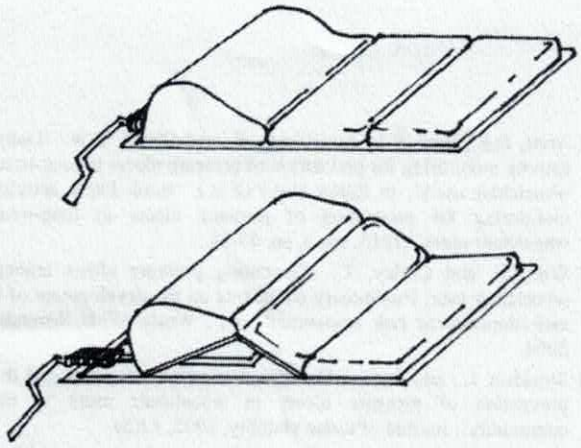

Fig. 4. shows the s-shape seat pad with an approximately height of 18 cm.

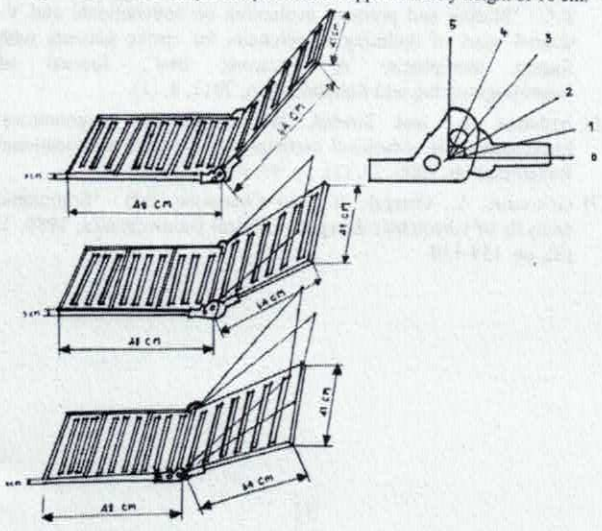

Fig. 5 shows the backrest pad design.

The same experimenter then sat on this add-on seat when it was attached to the wheelchair and a pressure contour map was measured as shown in Fig. 7. It can be clearly seen that the pressure on the buttocks were now reduced from 451.5N to 134.1N. This experimental result does confirm our hypothesis that the s-shaped seat can be employed to reduce the pressure applied to the user's body. However due to the inclined angle, the legs appear to have some small pressure load on both of the legs. The pressure on the legs was evenly distributed on both legs and there was no high-pressure spike or pressure point on both legs.

We then tested this add-on seat with a 67 years old paralyzed patient; male; Thai under a permission of his guardian and interviewed the patient and his caretaker for some feedbacks. The caretaker said without the add-on seat the patient could not sit on a wheelchair for more than 5 minutes due to the pain and the uncomfortability. We then attached the add-on seat on his wheelchair and asked the patient to use the add-on seat. The feedback from the patient was very good. With the add-on seat, he could sit on his wheelchair for 30 minutes comfortably. The patient said he would like to buy this add-on seat and he had expected this sort of products in the market. We see a market opportunity for this product we have therefore patented the design and now seeking for collaborations from marketers and industrial partners to commercialize the design.

Fig. 6 shows the add-on seat attached to a wheelchair through a set of belts and straps.

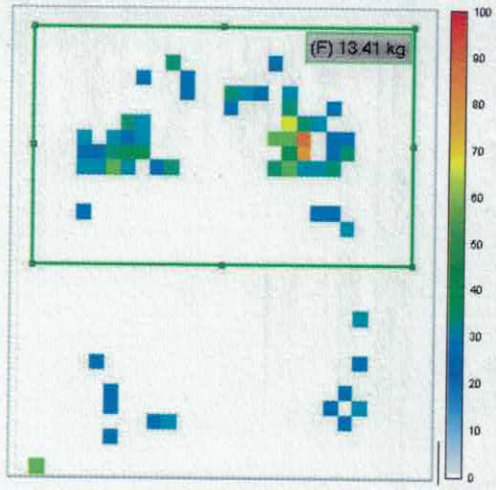

Fig. 7 shows the corresponding pressure contour while seating on the ergonomic add-on seat. The green box indicates the seat pad and the area underneath is the pressure on the legs and its color-coded scale is mentioned.

IV CONCLUSION

In this talk, we have discussed some key issues of the standard wheelchair. We measured a pressure contour map while sitting on the standard wheelchair and found that the pressure applying on the user body was very high and may cause pressure ulcers. We therefore proposed our add-on seat innovation that solves these issues by reducing the pressure due to the seat by factor of 3.36.

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