Risk Reduction in Texting While Walking with an Umbrella-Typed Device for Smartphone

Sohichiro Mori[1(✉)] and Makoto Oka[2]

[1] Meihokan High School, 6-7-22, Kita-Shinagawa, Shinagawa, Tokyo 141-0001, Japan
07o21classsuzu@gmail.com

[2] Tokyo City University, 1-28-1, Tamazutsumi, Setagaya, Tokyo 158-8557, Japan

Abstract. It is widely known that texting while walking is a dangerous behavior. To reduce the risks, we proposed an umbrella-typed device, called ii-kasa to manipulate smartphones. In this paper, we investigated whether ii-kasa reduce the risks in texting while walking. In the experiment, we recorded the gaze patterns using the eye-mark recorder. As the results, the average time and its variance of the eye fixations with ii-kasa were smaller than the ones of the smartphone. The results also showed that the participants in the ii-kasa condition watched the broader areas of their circumstances and paid more attention to their circumstances than in the smartphone condition. These results indicate that ii-kasa makes the risks of texting while walking and human cognitive loads reduce.

Keywords: Texting while walking · Umbrella · Smartphone

1 Introduction

Many accidents involving walking while texting with smartphones such as collusions between a person and a person, a person and a car, and person and a bicycle, have happened and it have become social issues.

Though walking while texting is, of course, a dangerous behavior, people must never cease it, because there are many situations where they need to operate their smartphones while walking. For example, we sometimes go to the destination using navigations system, and we sometimes try to meet our friends exchanging our current places through SNS.

When it is rain, the situations become worse. We have to hold the umbrella in one hand and hold the bag and the smartphone in the other hand. Consequently, we pay more attention to our hands not to drop them and pay less attention to the circumstances.

In texting while walking, our gazes distribute mainly in the low space and our visual fields become narrow. To aiming to make texting while walking safer, we proposed ii-kasa [1] which is the system where the screen of the smartphone is

S. Yamamoto and H. Mori (Eds.): HIMI 2018, LNCS 10904, pp. 572–581, 2018.
https://doi.org/10.1007/978-3-319-92043-6_46

displayed on the canopy of the umbrella and we can manipulate it by the movement of the umbrella by the acceleration sensors. With this system, we can keep our gazes in front and aims to be able to pay more attentions to the circumstan ces. However, we did not still investigate the safety of the system.

In this paper, we investigate the gaze patterns with our umbrella system and with smartphones while walking and also investigate the safety of our system.

2 Related Works

The risks of texting while walking are widely well-known. For example, National Geographic conducted a social experiment [2]. They partition the sidewalk into two lanes, one is lane only for texting while walking, on the other lane texting while walking is prohibited. As the results, only few people who were texting while walking changed the lanes and most of them concentrated on the smartphones and even did not notice the existence of the lanes.

To overcome the risks of texting while walking, some research conducted so far. Wang et al. [3] investigated that crossing the street while texting is more dangerous than doing without the smartphones and proposed WalkSafe. In WalkSafe, the circumstance situations are monitored by the camera on the smartphone, and if a car is approaching, the warning sound and vibration come up. The detections of the car are performed by machine learning with the images obtained by the camera.

Kodama et al. [4] described that people cannot stop texting while walking though people recognize its risks. He also proposed the system that support texting while walking using image processing sensor. In this system, the image obtained by the camera are overlaid on the display of the smartphone. When something are approaching, the center of the upper part of the display become red.

Ito et al. [5] dealt with using a smartphone while riding motor bikes. They mounted the acceleration sensor on the gloves and manipulate the smartphone by the gestures. The output from the smartphone are displayed by the sounds. They confirmed that the vibrations caused by the motor bike do not affect the acceleration sensor and the users can control the smartphone with this system.

3 ii-Kasa

As we mentioned earlier, we proposed the system called ii-kasa [1] aiming to reduce the risks of texting while walking. In ii-kasa, the screen of the smartphone is projected on the canopy of the umbrella (Fig. 1) to keep the gaze point front and not to make the visual field narrow. We can manipulate the smartphone by swinging and moving up and down the umbrella. The acceleration sensor is attached on the frame and detect the actions of the umbrella (Fig. 2). For example, in the map application, the map is zoomed in in moving it upward and it is zoomed out in moving it downward. Scrolling the map is also available by swinging the direction to want to watch.

Fig. 1. Screen of ii-kasa

Fig. 2. Sensor part of ii-kasa

4 Experiment

To investigate whether ii-kasa reduce the risks of texting while walking, we conducted an experiment.

4.1 Method

First, the participants were asked to read the sentences aloud on the screen of ii-kasa while walking on the designated root, and, after that, they performed the same task with a smartphone. Here, the root was about one hundred meters long and the participants had to turn the corners four times in one trial. As this root is in the university campus and a public space, some people sometimes walked. They wore the eye-mark recorder to investigate where they were watching during the experiment. The used eye-mark recorder was NAC EMR-8.

4.2 Participants

Five participants were involved in this experiment. All of them were university students and are 22years old. Two of them were wearing the glasses but all of them are visually healthy.

4.3 Results

First of all, as the results of F-test of the fixation time between ii-kasa condition and the smartphone condition, the variance of the ii-kasa condition is significantly smaller than the one of the smartphone condition ($p = 0.00000152$). We, therefore, also conducted the Welch's t-test of the fixation time, the average time of one fixation in ii-kasa condition is significantly shorted than the one in the smartphone condition ($p = 0.0032$) (Fig. 3).

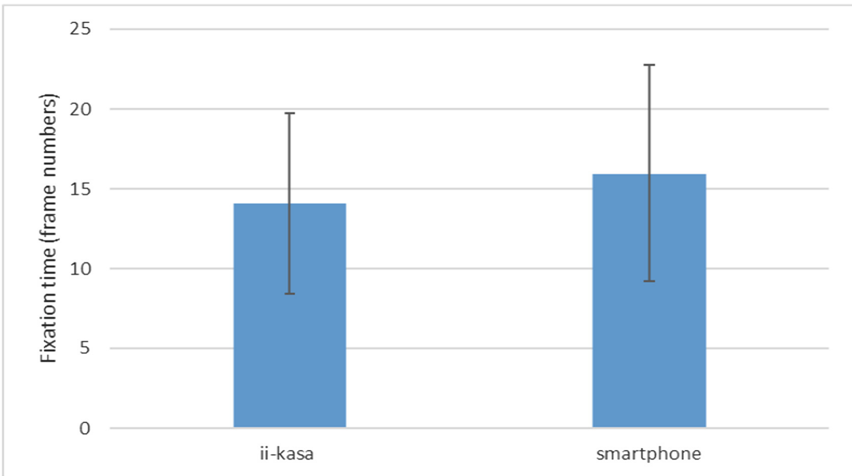

Fig. 3. Average fixation time

This means the participants in ii-kasa condition watched the screen shortly at one time and averagely paid attention to the screen and the circumstances. On the other hand, in the smartphone conditions, being larger of the variance and the average means that very long fixations are happened. As people are hard to notice the change of the circumstances when the fixation time on the screen is long. Actually, in the experiment, despite one participant almost caused the collision with one pedestrian and the pedestrian got out of his way, he did not notice it.

Above results, however, only show the average of all fixation and does not tell whether they watch the screen or their circumstances. Here, the eye-mark data recorded by the eye-mark recorder are pairs of the points of x-axis and y-axis on each video frames. They are on the relative coordinate and we do not know what the participants were watching because they asked to walk and their heads were not locked. So, we divided the pictures by 5° of the gaze and put the fixation point (Fig. 4) on them. From these data, we calculated the fixation time on each cell. Figures 5 and 6 is the heat-map of the ratios of the fixation time to the trial times in ii-kasa conditions and in the smartphone condition respectively. In these figures, the frames on the maps indicate the position of the screen in each condition.

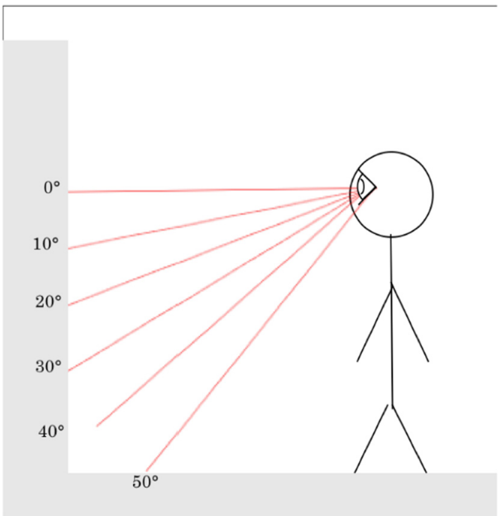

Fig. 4. Mapping to the abstract coordinate of the outside

Figure 5 shows that, in ii-kasa condition, the fixation points are widely distributed and the participants frequently watched the below area of the canopy. This means that they paid attentions both to their front and the screen. On the other hand, in the smartphone condition, (Fig. 6) their fixation points gather on the screen and hardly watch their circumstances. This means that they concentrated to watch the screen of the smartphone and paid less attentions to their circumstances.

Comparing the data in the ii-kasa condition and the smartphone condition within each participant, these trends are shown more clearly, because the set positions of the smartphone were different by the participants. The heat-maps of the fixation time of two participants are from Figs. 7, 8, 9 and 10. While, in Fig. 7, Participant 1 almost

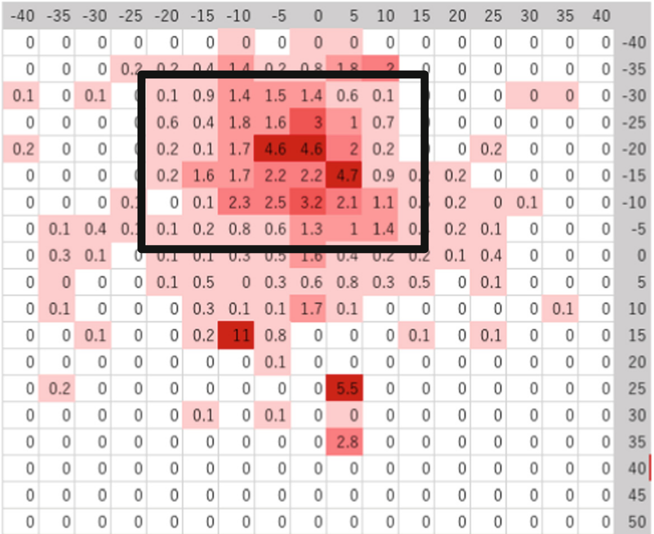

Fig. 5. Heat-map of the average gaze fixation rates in ii-kasa condition

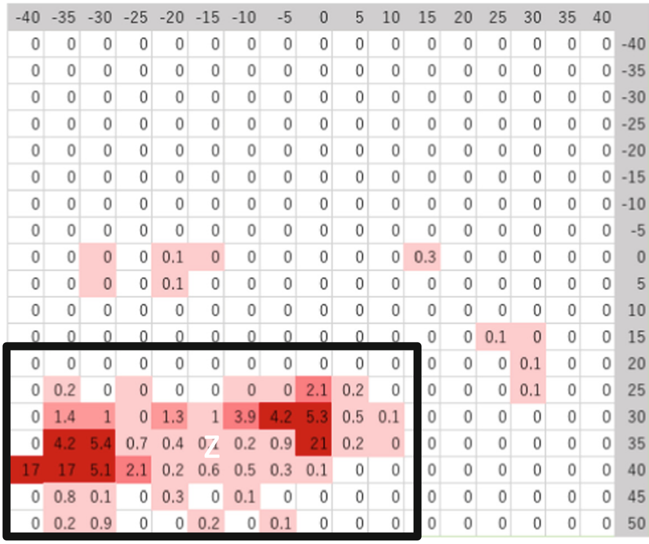

Fig. 6. Heat-map of the average gaze fixation rates in the smartphone condition

watched only the screen, he did not watch only the screen but also the wide area outside of the screen (Fig. 8). Though Participant 2 watched a little bit wider area than Participant 1 in the smartphone condition (Fig. 10), he always watched down the low area and could not pay attention to his circumstances.

-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	
0	0	0	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0	-40
0	0	0	1.18	0.84	0.59	0.42	0.51	1.1	0	0	0	0	0	0	0	0	-35
0.68	0	0.59	0	0	4.22	2.87	6.16	1.94	1.18	0.59	0	0	0	0	0	0	-30
0	0	0	0	2.87	1.52	4.64	5.57	10	2.78	3.38	0	0	0	0	0	0	-25
0.76	0	0	0	1.1	0	2.45	2.53	7.43	3.54	0.84	0	0	0	0	0	0	-20
0	0	0	0	0	0.08	3.29	1.69	6.24	6.41	2.87	0	0	0	0	0	0	-15
0	0	0	0	0	0.42	2.36	0	0.68	0	0.34	0	0	0	0.08	0		-10
0	0	0	0	0	0	0	0.68	0.08	0.17	0	0	0	0	0	0		-5
0	0.17	0	0	0	0	0	0	0	0.84	0	0	0	1.1	0	0		0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50

Fig. 7. Heat-map of participant 1's fixation in ii-kasa condition

-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-40
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
0	0	0	0	0	0	0	0.2	9.9	0.3	0	0	0	0	0	0	0	25
0	0	0	0	6.2	4.8	19	21	25	2.5	0.5	0	0	0	0	0	0	30
0	0	0	0	0	0	0	0.2	9.9	0.3	0	0	0	0	0	0	0	35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50

Fig. 8. Heat-map of participant 1's fixation in the smartphone condition

Here, Fig. 10 shows that his gazes are distributed in the left parts. This was caused he hold the smartphone in the left hand and relatively set it at the left side from him.

-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-40
0	0	0	0	0	0	6.42	0	0.75	8.3	10.2	0	0	0	0	0	0	-35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-25
0	0	0	0	0	0	1.89	14.7	7.92	1.89	0	0	0	0	0	0	0	-20
0	0	0	0	0	7.55	2.64	3.02	0.75	10.6	0	0	0	0	0	0	0	-15
0	0	0	0	0	0	1.13	4.53	5.66	2.64	0	0	0	0	0	0	0	-10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	2.64	0	0	2.26	0	0	0	0	0	5
0	0	0	0	0	0	0	0	0.38	0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	4.15	0	0	0	0	0	0	0	0	0	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50

Fig. 9. Heat-map of participant 2's fixation in ii-kasa condition

-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-40
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-25
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
0	0	0	0.2	0	0	0	0	0.7	0	0	0	0	0	0	0	0	25
0	4	3	0.2	0.3	0	0	0.3	0.3	0	0	0	0	0	0	0	0	30
0	21	27	3.5	1.8	0.3	0.9	2	0	0	0	0	0	0	0	0	0	35
0.3	4.4	12	2	0.2	0.2	1	1.3	0.3	0	0	0	0	0	0	0	0	40
0	4	0.5	0	1.4	0	0.4	0	0	0	0	0	0	0	0	0	0	45
0	1.1	4.3	0	0	0.9	0	0.3	0	0	0	0	0	0	0	0	0	50

Fig. 10. Heat-map of participant 2's fixation in the smartphone condition

This means he would not pay attentions not only to the front to him but also the right side of him.

Bartmann et al. [6] said that the depth of the visual processing and the width of the visual field have the relationship of tradeoff and, if the visual processing are high, much mental load is required and, consequently, the visual field to be able to pay attention to become narrow. Despite the tasks in this experiment were easy and all participants could complete all tasks accurately, the visual field in using smartphone is narrower than the one in ii-kasa. This means people in using ii-kasa require less cognitive load than in using the smartphone

To conclude, these results show ii-kasa reduce not only the risks of texting while walking but also the cognitive load and contributes for people to be able to pay attentions to the circumstances even in using the mobile services while walking.

5 Considerations

We consider that ii-kasa benefits from three aspects, safe, function, and health. From the functional aspects, it is easier to manipulate the smartphone by one hand and ii-kasa prevents the malfunction and the bungles caused by dropping rain droplets on the touch screen. From the healthy aspects, it relieves the loads on the neck and shoulders caused by keeping the head downward.

In this paper, we investigated the safe aspects. In using ii-kasa, we can keep our gazes in front and pay attention to the wider area in our circumstances than the smartphone. In the research for car navigation system [7], it is known that the driver's gazes frequently move from the outside and the navigation system shortly in amounting it at the high position and is safer than in mounting it at the low position. These results and our results show that we will frequently repeat to watch our circumstances and the screen to watch in a short time and it makes us to keep paying attentions to our circumstances when itis located the close area to our head-on the gazes and we can keep our gazes in front. We consider ii-kasa makes us available this behavior and, in this reason, ii-kasa contributes to reduce the risks in texting while walking.

6 Conclusion

In this paper, by analyzing the gaze patterns, we investigate whether ii-kasa reduce the risks in texting while walking. As the results, the average fixation time once in ii-kasa condition is significantly shorter than the one in smartpone condition and its variance is significantly smaller than the one in smartphone condition. This means that people evenly watch the screen and the circumstances shortly at one time, while they gaze the screen deeply in a long time.

The results also showed the gazes were widely distributed not only on the screen but also outside of the screen in ii-kasa condition, while the gaze converged in the narrow area on the screen in the smartphone condition.

It can be said, therefore, that ii-kasa contribute to keep our gaze in front and to pay more attentions to our circumstances than the smartphone and reduce not only the risks of texting while walking but also human cognitive load.

In this research, however, the experiment was conducted in the paths where there is little traffic and which the participants are well known. We also need to investigate the safety in more crowded and the participants' unknown streets.

In this paper, we only investigate the benefits from the safe aspects. In the future works, we need to investigate the benefits from the functional and healthy aspects. From the functional aspect, as we mentioned earlier, we can operate the smartphone by swinging and moving ii-kasa up and down using acceleration sensor. We have already been able to identify the acceleration caused by user's operation from the vibration caused by waling. We, however, we do not investigate its usability. We need to investigate it in the near future.

When we designed ii-kasa aiming to make texting while walking safer, using see-through typed head-mounted display was another candidate. The reason why we did not adopt it is that we do not want the users to immerse the virtual world and the visual distance from eyes to the screen is very short. If it is short, we always need to change our focus and it is hard to recognize both of the information on the screen and the circumstances once. In the near future, we will compare ii-kasa to the see-through typed head-mounted display and hope to indicate the advantages of ii-kasa.

References

1. Mori, S., Oka, M.: Proposal of interaction used umbrella for smartphone. In: Yamamoto, S. (ed.) HIMI 2017. LNCS, vol. 10273, pp. 579–588. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-58521-5_45
2. Cellphone Talkers Get Their Own Sidewalk Lane in D.C. https://www.yahoo.com/tech/cellphone-talkers-get-their-own-sidewalk-lane-in-d-c-92080566744.html
3. Wang, T., Cardone, G., Corradi, A., Torresani, L., Campbell, A.T.: WalkSafe: a pedestrian safety app for mobile phone users who walk and talk while crossing roads. In: HotMobile 2012 (2012). https://doi.org/10.1145/2162081.2162089
4. Kodama, S., Enokibori, Y., Mase, K.: Examination of safe-walking support system for "texting while walking" using time-of-flight range image sensors. In: UbiComp/ISWC 2016, pp. 129–132 (2016). https://doi.org/10.1145/2968219.2971407
5. Ito, A., Yamabe, T., Kiyohara, R.: Study of smartphone operation UI for motorcycles using acceleration sensor. In: DPSWS 2014, pp. 109–114 (2014). (in Japanese)
6. Bartmann, A., Spijkers, W., Hess, M.: Street environment, driving speed and field of vision; Vison in Vehicles-III, pp. 381–389 (1991)
7. Zheng, R., Nakano, K., Ishiko, H., Hagita, K., Kihira, M., Yokozeki, T.: Eye-gaze tracking analysis of driver behavior while interacting with navigation systems in an urban area. IEEE Trans. Hum.-Mach. Syst. **PP-99**, 1–11 (2015). https://doi.org/10.1109/thms.2015.2504083