Canine Reachability of Snout-based Wearable Inputs

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ABSTRACT

We designed an experiment with the goal of assessing wearable reachability for canines. We investigated the effect of placement on the ability of dogs to reach on-body interfaces with their snouts. In our pilot study, seven placements along the front legs, rib cage, hip and chest are tested with six dogs. The results showed that the front leg placements are reachable with the least amount of training and are also the most invariant to small changes in location. With training, the lower half of the rib cage area had the fastest access times across subjects. We hope that these results may be useful in mapping the constraint space of placements for snout interactions.

Author Keywords

Wearable technology; Animal-Computer Interaction

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION AND RELATED WORK

Recognizing the need for working dogs to clearly communicate with their handlers (or other humans), the FIDO project researches wearable technologies to better facilitate this communication. Previous work has examined snout-activated sensor modalities attached to the left side of a working dog vest [5]. One of the most significant findings was the importance of *sensor reachability* for predicting successful interactions. This previous work experimented with different sensor modalities and shapes. To allow for such diverse interactions as bite, tug, and head-wave the rib cage area was selected on the advice of a professional dog trainer. In this way, sensor and dog accuracy were (previously) tested along with *sensor reachability*. We propose analyzing each one of these variables individually, before considering their interdependence.

Since the *reachability* of a sensor-placement influences all performance metrics, we focus on it in the present study. Previously, reachability could be interpreted as analogous to what Gemperle et al. [3] would refer to as *placement* and *sensory interaction* in humans. *Placement* addresses the areas where wearables might be located on the user's body, but this includes components that are not input devices. *Sensory interaction* requires a case-by-case analysis of each sensor design which is not addressed by this metric or this study.

We define *(wearable) reachability* as the user's ability to use one part of the body to touch another. Current canine anatomical data [2] describes limb or head movements with respect to the socket to which they are attached, but few indications regarding reachability can be found. Our approach is inspired by work on prototyping systems with a single purpose [4] which led us to analyze reachability separately from the sensor implementation. This approach allows a low fidelity version of the interaction(s) to be explored before committing resources to a final design that might not be reachable by the users.

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METHODOLOGY

In the present study, we test canine snout reachability along seven on-body locations. These consist of points on the front legs, rib cage, hip and chest. These placements are not meant to be exhaustive, but are an initial attempt at delineating the possible areas for wearable affordances based on observations of current practice. We conducted a within-subject design experiment with six participants.

Quality	S1	S2	S3	S4	S5	S6
Breed	BC	BC	BC	BC	LGX	Pap
Training	Agil	Agil	Agil	Agil	Ast	Agil
Weight (kg)	21.3	15	20.4	15.9	32.6	3.7
Height (cm)	53	51	105	50	65	27
Withers to manubrium (cm)	33	24	24	23	29	12
Circum. at 7th Rib (cm)	67	63	55	54	70	32
Length of 7th Rib (cm)	31	35	31	28	38	18
Ulna/rad length (cm)	20	22	19	22	23	13

Table 1. Demographics with LGX, Pap & BC denoting Labrador-Golden Retriever, Papillon & Border Collies, respectively.

Equipment

The main piece of experimental equipment was a device known as a *target stick* used to instruct dogs to nose-touch the location being pointed to. Since the completion of on-body gestures might be obscured to observers by the dog's head, we created a 63 cm long target stick with a VCNL 4000 proximity sensor to alert both the dog and the handler of the nose-touch completion via a piezoelectric buzzer.

Procedure

Stage 1:Training

First, subjects were familiarized with the target stick and its operation. They learned to use their snout to touch the tip and produce the resulting beeping sound. This familiarization was done by conditioning the beeping noise to a small treat.

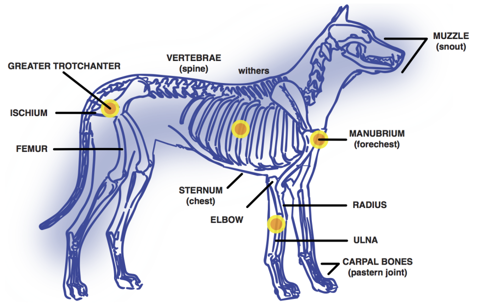

Figure 1. The leg target locations were the front-facing centers of the radius bones. The chest location matched the manubrium. The rib cage locations were the center of the seventh rib. The hip locations on each side were placed on the greater trochanter of the femur. Adapted from Rachel Page Elliott [1].

Stage 2: Testing

For testing sessions, the on-body locations were marked with stickers (⌀=1.9 cm) to aid in the consistent placement of the target stick. The order of the instructions given was specified by a 7x6 counterbalancing arrangement. The independent variable in this experiment was placement along the body. The dependent variables consisted of the number of tries and average reach time. All of the tasks were performed while standing on an elevated platform of 28.6 cm x 122 cm (Figure 2). Trying to reach the target by moving around resulted in dogs stepping off the platform and restarting the trial.

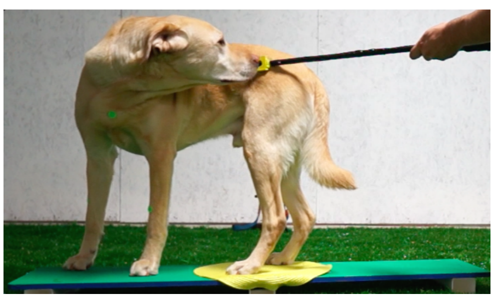

Figure 2. For each subject, an experimenter (different from the handler) placed the target stick on the marked on-body area to be touched next.

RESULTS AND DISCUSSION

For the rib cage locations, any placement above the center of a particular rib was not reachable since the head is angled downwards after a bend. Although other locations along the rib cage were not tested, the path taken by the subjects as they got to the midpoint of the rib seemed to support this observation. For inexperienced dogs, the front placements along the femur have a perceptual advantage over those on the rib(s) and trochanter. Femur placements are simultaneously within the visual field of both eyes while rib cage placements can only be within the visual range of one eye for a short period of time during the bending of the neck. Consequently, this action is less directed and results in a *trial and error* approach. The error rate and reach time decrease substantially with training.

Subjects with previous wearable experience repeatedly attempted reaching familiar placements even if there was no target there (just the sticker). This phenomenon increased their speed on the familiar placements (Table 2) but also the error rate (Table 3) in unfamiliar ones.

Placement	S1	S2	S3	S4	S5	S6	**Mean**
Right Rib	720	590	1024	810	1689	540	**896**
Right Leg	700	900	1269	890	1000	946	**951**
Left Rib	640	910	659	1202	1944	609	**994**
Left Leg	900	700	1053	726	2269	392	**1,007**
Chest	367	502	1268	826	3222	648	**1,139**
Left Hip	1640	1080	1550	1900	2222	783	**1,529**
Right Hip	1210	2000	2024	1310	3538	1108	**1,865**

Table 2. Reach time (ms) for each location from first movement to completion (timed from video recording).

Placement	S1	S2	S3	S4	S5	S6	**Total**
Chest	0	0	0	0	2	0	**2**
Right Leg	0	0	0	0	1	0	**1**
Left Rib	0	0	0	0	0	0	**0**
Left Leg	0	0	0	0	4	1	**5**
Right Rib	0	0	1	0	0	0	**1**
Left Hip	1	1	0	1	0	1	**4**
Right Hip	1	5	6	2	2	0	**16**

Table 3. Number of unsuccessful attempts. The asymmetry in errors between right and left hips is currently unaccounted for.

CONCLUSION AND FUTURE WORK

We believe that the results of this pilot study merit a follow up study with a larger subject population. Placements with large surface areas (chest, rib cage) may benefit from individual analysis detailing which point(s) within that area can most easily be reached. Although reachability might be interpreted strictly as an anatomical measure, our testing has highlighted a non-trivial perceptual component. Finally, analyzing reachability from postures other than standing is necessary when considering many working dogs are trained to alert from a *down* or *sit* position.

ACKNOWLEDGMENTS

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REFERENCES

1. Elliott, R. P. Dogsteps, A New Look. Doral Publishing, 2001.

2. Evans, H. E., and De Lahunta, A. *Miller's Anatomy of the Dog*. Elsevier Health Sciences, 2013.

3. Gemperle, F., et al. Design for Wearability. In *2nd International Symposium on Wearable Computers* (1998).

4. Houde, S., and Hill, C. What do Prototypes Prototype?, Elsevier. *Handbook of Human-Computer Interaction 2* (1997).

5. Jackson, M. M., Zeagler, C., Valentin, G., et al. FIDO-Facilitating Interactions for Dogs with Occupations: Wearable Dog-Activated Interfaces. In *17th International Symposium on Wearable Computers* (2013).