A Study of Citizen Science Supported Wearable and Non-Contact Systems for Quantifying Canine Behavioral and Physiological Response Profiles to Potential Risk Factors of Cancer and Aging in Humans

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ABSTRACT

Animal companions are becoming increasingly common in human life and carry great potential to serve as sentinels to detect potential risk factors for aging and cancer complications, especially in oncology units.

There is a critical need for engineering methods and novel technologies that can enable a quantified understanding of human and canine physiological states. These allow us to objectively probe the dog's ability to identify the aforementioned potential risk behaviors more accurately and efficiently.

Here, we present our preliminary efforts towards the development of wireless sensor systems to simultaneously detect the related behavioral (activity level, movement, vocalizations), physiological signals (heart rate, respiratory rate and their variability), and environmental factors (ambient sound, light, temperature and humidity levels, barometric pressures) around and of humans and animals during their normal interactions.

- These systems are comprised of both wearable and non-contact electronic devices and provide three categories of signals (i.e. behavioral, physiological, environmental) that have profound immediate and potential implications for detecting aging and cancer related phenomena.
- In our preliminary exploration, we assessed these relevant parameters successfully and identified the design challenges towards deployment of these systems in larger clinical studies aimed at instrumenting animals to act as sentinels.

INTRODUCTION

Animal companions are becoming increasingly common in human life as they can be guide dogs, therapy dogs, emotional support animals and many other roles. One unique ability dogs have is the ability to detect cancer in patients and many pet dogs can sense decreased health or affect in their owners.

- This detection can lead to increased sniffing and licking in addition to other behavioral and physiological responses in the dog.
- These response profiles from the dog can warn the dyad to potential early warning signs and, if given access to the relevant information, alert medical staff to an incipient risk event.

This ability allows them to potentially act as sentinels to detect potential risk factors for aging and cancer complications, especially in oncology units.

NON-CONTACT SYSTEM DESCRIPTION

For Humans:
- Chest band EKG and PPG for respiration
- Watch worn for PPG (Pulse transit time) and IMU used to track stroking

For Canine:
- Chest strap houses EKG, PPG and IMU

Overhead camera for computer vision tracking

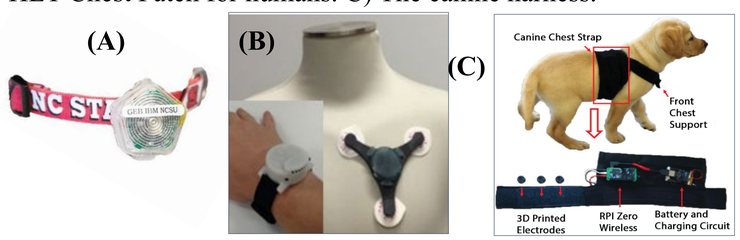
Figure 1. Right: Wrist Watch. Left: Electrode System. Middle: Infrared Camera

WEARABLE SYSTEM DESCRIPTION

For Humans:
- Chest band EKG and PPG
- Watch worn for PPG (Pulse transit time) and IMU
- Watch worn for tracking EDA, Skin Temperature

For Canines:
- Chest strap houses EKG
- Collar with IMU, environmental indicators

Figure 2. A) The smart collar device. b) The HET watch and HET Chest Patch for humans. C) The canine harness.



RESULTS

Figure 3. (Left) The measurement set up with subjects wearing wireless sensors (Right) Non contact electrodes placed on dog to track sleeping behaviors. .

Figure 4. Preliminary data collected on simulated patient and 6 y.o. Male, labrador retriever. Right plot displays R peaks for human and left plot is showing the canine subjects.

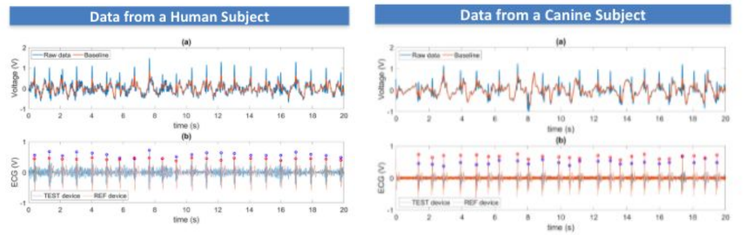
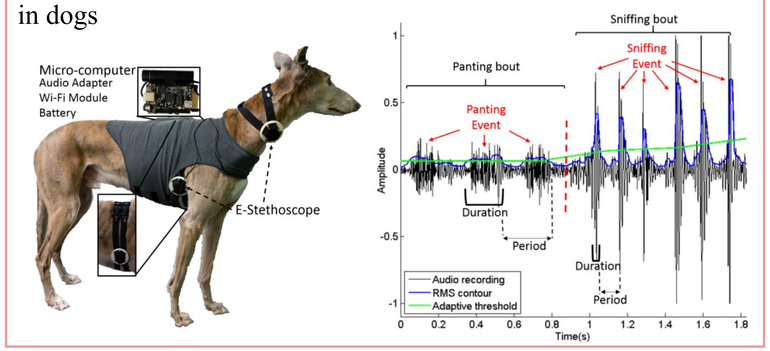


Figure 5. [Right] A Fragment of a panting bout with 3 events and a fragment of a sniffing bout with 6 events. [Left] A system of stethoscopes and microphones to detect sniffing and panting in dogs



NEXT STEPS

- Combine both the non-contact system and the wearable system of devices to allow for data collection of all metrics at once that does not interfere with the canine or humans interaction.
  - Once combined find a way to effectively synchronize the systems with time stamps or synchronized data metrics to allow for more meaningful analysis.
- Conduct a pilot test with dyad pairs to test the systems and troubleshoot issues as they arise in the experimental design.
  - Make any changes as necessary and continue to improve the interaction
- Compare the 2 systems of devices metrics to the results provided by the ground truth in the field.

REFERENCES

[1] Foster M, Beppler E, Holder T, Dieffenderfer J, Erb P, Everette K, Gruen M, Somers T, Evans T, Daniele M, Roberts DL, Bozkurt A. A System for Assessment of Canine-Human Interaction during Animal-Assisted Therapies. Annu Int Conf IEEE Eng Med Biol Soc. 2018 Jul;2018:4347-4350. doi: 10.1109/EMBC.2018.8513384. PMID: 30441316.

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