Towards *Smart Kennels* for Supporting Canine Welfare: an Early Exploration of Requirements

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Clara Mancini[1], Guy Dewsbury[1], Janet van der Linden[1], Gerd Kortuem[1], Daniel Mills[2], Nikki Smith[3]

Abstract. We present the findings of an early requirements elicitation study for a smart kennel supporting canine welfare. We discuss unique challenges posed by the kennel environment in terms of design outcomes and research processes.

1 INTRODUCTION

The necessary constraints of even the best kennel environments have a potential impact on the welfare of kennelled dogs due to contingencies that exist between the occupant and their environment. These include a lack of stimulation for the occupant, together with the degree of control versus predictability afforded by the kennel environment [18]. This impact can be compounded by further limitations (e.g. limited personnel availability, limited monitoring means) and by a tendency to focus attention on welfare parameters which are more easily measured rather than the more indicative. Thus, welfare issues, whether pre-existing or induced by kennel confinement, may remain undetected and/or unaddressed until they become overt, by which time they may be more difficult to resolve. However, recent advances in pervasive computing to enhance human wellbeing [1], might offer the opportunity to revolutionise the way we study and manage the welfare of kennelled dogs by altering the recognition and management of these contingencies and placing the occupant at the centre of the design process [5]. In particular, pervasive sensor systems and ambient intelligence developed to monitor health in humans [2] might make it feasible to record, measure, visualise and interpret welfare-relevant phenomena that are not normally accessible, especially when it is unviable for individual dogs to receive continuous attention. Additionally, embodied and tangible interaction technologies developed to enhance daily life experience for humans [13] might make it feasible to produce contingent responses to meet the dogs' requirements [15], which may be identified from their behaviour and circumstances [9] and to dynamically reconfigure the kennel environment, either as an automatic adaptive response to observed behaviour or by enabling dogs to actively control aspects of their surroundings. We propose the concept of a *smart kennel* which integrates interactive and monitoring technology with ambient intelligence to improve dog welfare by providing a stimulating and fulfilling environment for them, thus fostering positive mood states and resilience, and encouraging desirable traits and behaviours; and to aid welfare assessment by providing kennel carers, and researchers, with on-going welfare-salient information about the occupants. But while technological advances might make smart kennels technically feasible, the question arises as to what features a smart kennel should present and what functionalities it should afford in order to work in practice and actually improve welfare. To answer this question we conducted a *requirements elicitation* study at one of the rehoming centres of the UK's leading canine welfare charity, Dogs Trust. Our research takes a *user-centred* approach to the design of technology intended for animals, regarding them as legitimate stakeholders in and contributors to the design process [5]. Consistent with this, we begun by undertaking an ethnographic study aiming to identify core requirements from both canine residents and human carers who live and work in the rehoming centre, to understand how smart technology could support these users. Here we report on the interim findings of our exploratory work, challenges we have encountered, and possible solutions we have so far identified. Additionally, we outline methodological implications for the design of similar studies.

2 RELATED WORK

Canine welfare in the kennel environment. Taylor and Mills [15] discuss a number of factors affecting the welfare of kennelled dogs, due to limitations on the physical, social, sensory, occupational, nutritional and psychological environment of resident dogs. An important goal for good welfare is to provide an appropriate amount and quality of stimulation with the opportunity to engage in diverse activities. For example, while dogs housed in small barren spaces appear to be inactive most of the time, their activity levels seem to increase with the amount (i.e. dimensions, see [3]) and complexity (e.g. furnishings, see [4]; outdoor access, see [8]) of space available in a positive way. Also, providing dogs with opportunities for appropriate dog-dog and dog-human interactions seems to reduce the occurrence of undesirable behaviours (e.g. stereotypic behaviours, see [8]). Additionally, various forms of stimulation and enrichment, such as music [16] or toys [17], have the potential to improve the dogs' welfare, particularly if the dogs are allowed to physically engage in activities which provide for a manageable level of variation (e.g. as with a toy rotation, see [17]) and which are biologically relevant (e.g. as with an entertaining feeding system, see [3]). An important concern relating to the welfare impact of environmental complexity is environmental controllability and predictability [15]. For example, the ability to hide appears to be beneficial for kennelled animals [10]. Dogs seem to also be distressed by the inability to predict events in their environment, and thus adjust to it, until kennel routines have been learnt [14]. These observations point to the conclusion that, in order to support good welfare, kennels ought to afford resident dogs control over

[1] Dept. Computing and Communications, The Open University, Milton Keynes, MK7 6AA, UK. Email: C.Mancini@open.ac.uk
[2] School of Life Science, University of Lincoln, Lincoln, LN6 7TS, UK
[3] Dogs Trust, London, EC1V 7RQ, UK

an appropriately rich range of stimuli offering consistent responses to the dogs' choices and actions. Such a conclusion is, however, still to be fully supported by experimental findings. As Taylor and Mills [15] highlight, knowledge of the welfare implications of the different aspects of the kennel environment is limited by the historical choice of measures which are non-specific to different welfare states (e.g. heart rate or immune function) or which are quantitative rather than qualitative (e.g. amount of activity over quality of activity patterns, i.e. exploring vs stereotyping). There is therefore the need for interventions which can both enrich the environment of kennelled dogs in a controllable and predictable way, and enable the collection of quantitative and qualitative measures directly relevant to canine welfare states.

Designing technology to support animal welfare. Thanks to advances in pervasive computing, it is now possible to design intelligent technological interventions to monitor and improve quality of life in humans [2]. We are interested in exploring whether such technological capabilities could also be applied to enrich the kennel environment by affording the dogs appropriate stimulation and variety as well as control and predictability, while monitoring, interpreting and responding to welfare-salient measures. To support canine welfare effectively, the design of such interventions would need to be informed by the requirements of the kennels' users, namely the dogs and their carers. In Interaction Design the importance of user-centred design to support users (here, kennelled dogs and those caring for them), has long been established [12]. This entails eliciting user requirements to inform alternative designs which are prototyped and evaluated, in an iterative process involving users throughout. Recently researchers have begun to pursue the methodological development of animal-centred design within the emerging discipline of Animal-Computer Interaction (ACI) [5]. ACI aims to develop user-centred technology to support animals [6] involving them in the design process as legitimate stakeholders and contributors. Although many interaction design methodologies rely on verbal communication (and underpinning conceptualisations) between designers and users, multispecies ethnography has been used to enable animals to contribute to the requirements elicitation process in studies of companion dogs with their owners [7] and working dogs with their trainers [11]. This involved socialising with and observing established human-canine partnerships in their habitual contexts, integrating ethologically informed behavioural observations of dogs with accounts from canine carers, who were familiar with individual dogs and could act as mediators between the dogs and the researchers. For our study, we set out to take a similar approach, but soon found that conducting multispecies ethnography in rehoming kennels poses specific challenges, requiring specific methodological adjustments.

3 METHODOLOGY

Our study took place at Dogs Trust's state-of-the-art Rehoming Centre in Loughborough, aiming to elicit requirements for a rehoming environment which would embed ambient intelligence and canine interactivity to monitor and improve the welfare of resident dogs. We aimed to identify opportunities, needs and constraints that the design of such an intelligent, interactive kennel environment would have to take into account. The field work took place over a period of three months, during which we visited the centre 2 to 3 times weekly for between 3 to 4 hours each time, during which we took video and audio records where allowed, as well as hand notes. We met and worked with many canine carers, sometimes shadowing them (e.g. observing food preparation and feeding) and talking to them (e.g. to get a better understanding of daily routines), and helping with daily activities (e.g. walking dogs, cleaning kennels) where allowed. We took care to always wear the same clothes exclusively for visiting the site, in order to help resident dogs familiarise with our scent. Such an immersive approach gave us the opportunity to gain an in-depth understanding of the processes and practices involved in caring for the dogs from different angles; it also allowed us to blend in with the environment, thus making it easier for the dogs to accept our presence and enabling us to observe them closely during their daily routines. At the same time, due to the inherently stressful nature of the kennel environment and the fact that the close presence of strangers could have affected the dogs' welfare and altered their behaviour, although we spent time in their presence under the carers' supervision, we were unable to come into close contact with them, as that could have compromised the reliability of collected data and threatened our safety. Thus we did not have the benefit that ethnographers normally derive from engaging in extensive direct interaction with their research participants. To complicate matters, due to the canine population's turn-over and unknown background typical of a rehoming kennel, carers had little familiarity with many of the dogs. Nevertheless, given the environmental constraints, the carers were our intermediaries and it is through them that we collected data via informal conversations, or shadowing and helping with care-taking activities. While we were limited in the level of insight that we could attain on individual dogs, through the carers' mediation and accounts on their longitudinal experience in the kennel environment, we were able to begin to assess the impact of that particular kennel on resident dogs in general rather than on specific individuals who happened to be resident at that time (for example, we learnt about events which did not happen to occur during the duration of the study, but which are of critical importance). In our discussions with the carers we followed an interview guide including questions about the wellbeing and behaviour of dogs, carers' and dogs' daily routines and activities, information recorded and methods of recording and managing it, perceived potential roles and benefits of technology for dogs and carers. We deviated from our guide as appropriate to follow emerging discussion threads.

4 FINDINGS

Affording stimulation and control. Due to the many logistical challenges faced by rehoming environments, resident dogs spend significant amounts of time in their kennels, with limited access to external stimulation other than watching staff and visitors, being walked and fed. In an effort to alleviate the effects of isolation, dogs are almost always housed in pairs, and to alleviate potential boredom they are always provided with toys to play with, which are regularly rotated between kennels to maintain a measure of novelty. Nevertheless, the confinement seemed to affect many of the dogs, who displayed a range of undesirable behaviours, ranging from potentially problematic interaction with others (e.g. reacting to other dogs and to staff by barking loudly or biting, lunging towards the kennel's front

glass, guarding of food or toys by growling on approach), to active self-stimulation (e.g. spinning, pacing, self-biting, ripping bedding) and passivity (e.g. withdrawal). Carers suggested that providing additional stimulation to enrich the dogs' daily experience could enhance their welfare. But they also raised the issue that introducing new items of interest in double occupancy kennels might trigger competitive behaviour to the detriment of the weaker individual. Carers also mentioned that different dogs might react differently to the same stimuli, with certain sounds being aversive to a dog while positively stimulating for another. Carers were concerned how over-excitement could induce behaviours such as excessive barking, resulting in a significant increase in noise levels to the detriment of the longer-residing dogs' welfare (e.g. hearing loss may be a common side effect of long-term kennelling). The need to allow dogs to exert a measure of control over the configuration of their own environment also emerged during the study. For example, the dogs in the main rehoming area, housed in glass-fronted kennels to allow the public to see them and to allow the dogs to see each other, appeared to be over stimulated by or averse to such continued exposure (e.g. barking at passers-by or lunging towards the glass), although exposure to the public and other dogs is an essential part of the rehoming process. Also, dogs have currently no way of autonomously exiting their kennels to move to other areas, which may have undesirable effects even at the most basic level, e.g. during the night, when the centre is closed and staff away, dogs may toilet in their sleeping space, which remains soiled until morning. Thus, carers suggested that providing ways for the dogs to voluntarily access toileting or other areas would afford them the possibility to fulfil some of their physiological needs, without compromising the quality of their living space, although unrestricted access to different areas might trigger undesirable behaviours such as aggression.

Monitoring welfare states. When dogs enter the rehoming centre, carers may receive no information about them and, depending on the source, whatever information they do receive might not be reliable. Thus assessing the dogs' personality and welfare upon arrival is a key part of the rehoming process. To this end, dogs are initially placed in a particular area of the centre where they remain under observation and are tested for seven days to profile them. Carers reported that having the means of extending the observation of the dogs out of hours, when nobody is around, would help them make the most of the observational period, e.g. by allowing them to identify behavioural patterns which might emerge when the dogs are alone. Carers also expressed an interest in having indexed records of the dogs' behaviour and social interactions (e.g. in the event of a fight) to be able to quickly access salient events (e.g. the breaking of the fight). Indeed, the possibility of continuous monitoring was deemed potentially very valuable. For example, currently if a dog becomes unwell, he might have to wait for hours before being noticed and receiving attention. Early detection of potential health issues before they become serious, possibly also affecting other dogs, was deemed very important, particularly in the case of highly contagious, life-threatening diseases requiring the application of quarantine protocols (e.g. parvovirus). Carers also saw continuous, ubiquitous monitoring as a way to safely allow the dogs more freedom and autonomy, e.g. by affording them the possibility to be left unattended in fenced outdoor areas. A key requirement for canine carers was to be supported in managing information, both what might be recorded automatically (e.g. physiological data) and what they were already recording manually and sometimes informally (e.g. notes on routine activities). They wished for a centralised system allowing all carers to access detailed records on any dogs or be alerted to any issues requiring intervention, enabling them to work with greater flexibility. Given the dynamic and distributed nature of their work, they also wished to be able to easily record mundane details and observations about each dog (e.g. what happens during a walk) whenever and wherever appropriate, thus contributing to building a richer profile of the animals and making them easier to match with prospective homes.

5 DISCUSSION

Reconciling contrast. Rehoming kennels are complex, dynamic multispecies systems, characterised by tensions and contrasting requirements. A kennel is a place where dogs are sheltered with the intent of improving their lives through rehoming, yet the confinement imposed on them by the rehoming process negatively affects their welfare. The very solutions adopted to combat boredom can cause over excitement, frustration or exasperate social tensions. Combined with confinement, exposure to the public may affect some dogs, yet it is through such exposure that they have the best chance of being rehomed. The efficient running of the whole system relies on a level of standardisation, yet resident dogs are individuals with distinct needs and preferences which mean that interventions benefiting one dog might be unwelcome to their kennel companion. Knowing individual dogs is key to managing their physiological, psychological and social needs, but most dogs have no known history when they arrive. In this respect, ubiquitous monitoring of individual dogs might help, but any monitoring system would have to contend with multiple dogs at once. While interaction designers are familiar with the need to negotiate divergences in technology requirements, the very functioning of the kennel environment seems to depend on the careful balancing of contrasts, posing specific design challenges which any technological intervention will have to resolve. For instance, interactive games (e.g. touch screen challenges), other entertainment (e.g. on-demand audio-visual displays), or stimuli (e.g. toys activated by periods of dog's inactivity) could enrich the dogs' experience. However, any interactive system would have to be able to recognise and respond to the onset of socially undesirable behavioural patterns between dogs (e.g. threats or possessive behaviours), or to the negative response of a dog to a particular stimulus (e.g. an unpleasant sound), and ensure that all dogs had access to desirable resources without facing conflict. Thus any intervention would need to be easily customisable for individual canid pairs. To mitigate the effects of exposure on the dogs, some interactive screening system could be developed allowing the dogs to hide from visitors. But, to ensure the dog to receive appropriate exposure, the screen would need to reopen automatically after set periods or upon the arrival of suitable potential adopters, thus engaging the dog in a negotiation process, where they set a value for their privacy or interaction with the public. Similarly, to allow resident dogs more freedom of movement, a flap-opening mechanism could detect and automatically respond to a dog's intention to exit their kennel into the adjacent running area, during appropriate time windows (e.g. to toilet during the night). However, the system would have to allow different dogs to exit their kennels at different times, in

order to co-ordinate their flow accounting for how different dogs might be affected by one another's presence (e.g. to manage the risk of possible social conflicts). In all these cases, interaction (to provide stimulation and control) and monitoring (to measure welfare states) would have to be tightly coupled, since providing for good welfare requires constant context awareness at the level of individual dogs. Since multiple dogs share the same space, any recording system would have to be able to distinguish between individuals and any indexing system would have to be able to recognise salient behavioural patterns and events, or enable carers to readily interpret recorded data and intervene, possibly locally or remotely. But, not to overload carers, any technological intervention would need to provide efficient access to contextually salient information (e.g. dogs' activities, carers' locations), responding automatically wherever possible (e.g. interrupting a game, alerting a nearby carer); to maximise context relevance, the technology should also allow carers to easily access and input relevant information on the go (e.g. through a mobile app), supporting real-time analysis, context assessment and feedback.

Smart ethnography. As mentioned, the characteristics of the context in which our study took place strongly constrained our methodological approach by posing challenges not encountered in previous multispecies ethnographic studies with dogs [7,11]. In these studies, researchers were able to spend time amongst human-canine social nuclei, directly interacting with both species, and the dogs were well adjusted to their daily routines and environments, and tolerated the presence of the researchers, demonstrating a keen interest in interacting with them. Co-location and direct interaction are key parts of ethnographic work, allowing researchers to gain in-depth understanding of their research participants' perspective; and when it comes to canid participants, humans who are closely associated with them can significantly facilitate the process by providing access to detailed contextual information about individual dogs, thanks to their close long-term relationship with them. This was not so in our case, where the canine carers were not in a position to act as individual mediators in the same way as long-term human companions could. Instead, the carers possessed a high level of canine welfare expertise and their insight on general welfare issues and care practices was crucial to identify requirements in relation to those aspects. Still, eliciting design requirements from individual users, i.e. dogs, is a key aspect of user-centred design. When access to them is restricted, ethnographic observation of individual dogs might need to be achieved through technological mediation, e.g. by introducing early prototypes (e.g. interactive toys) and remotely monitoring responses (e.g. with telemetry). Thus the smart technology envisaged as the solution may need to be part of the process leading to such a solution. For the next phase of our research we envisage introducing a combination of existing technologies for monitoring (e.g. Voyce), stimulation (e.g. iCPooch) and control (e.g. SureFlap) to further investigate the requirements emerged during our early explorations and to start exploring specific design concepts.

6 CONCLUSIONS

The careful balancing of contrasts is at the core of a functioning kennel environment, thus any smart technology aiming to foster canine welfare will need to support the fine-tuned negotiations characterising the constrained but dynamic environment in which human and canine actors live and operate. This will require the combination of subtle forms of context awareness with distributed multimodal interaction mechanisms. As designers enter the kennel's complex system of contrasts, they too need the mediation of smart technology to shed light on the context they are designing for. Our future work will explore the use of smart technologies as methodological tools in the design process. Further studies of different kennels or other containment models for other species (e.g. zoos) will need to explore the extent to which requirements and solutions can be generalised.

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