Tracking small artists

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Abstract. Tracks of small animals are important in environmental surveillance, where pattern recognition algorithms allow species identification of the individuals creating tracks. These individuals can also be seen as artists, presented in their natural environments with a canvas upon which they can make prints. We present tracks of small mammals and reptiles which have been collected for identification purposes, and reinterpret them from an esthetic point of view. We re-classify these tracks not by their geometric qualities as pattern recognition algorithms would, but through interpreting the 'artist', their brush strokes and intensity. We describe the algorithms used to enhance and present the work of the 'artists'.

Keywords. Rats, reptiles, footprints, image processing, pseudo coloring.

1 Introduction

Tracks of animals have been used since humans were first hunter-gatherers as a means of identifying and stalking species of interest, historically for food [5], but more recently in application for environmental surveillance [7]. Animal tracks are a useful means of confirming species presence, and hence community composition at sites. Tracking methods are particularly useful as they are non-invasive, using inked tracking cards in tracking tunnels, thus providing very little disturbance to an animal's normal behavior (cf. methods such as trapping). After an individual walks through a tunnel and across the inked pad of the card, it leaves some footprints on the white part of that card (see Fig. 1, left). Those cards are later collected, and the "canvas" parts are visually scanned for species identification (see Fig. 1, right). Recent applications of pattern recognition methods have also shown that a geometric approach to such tracks (namely, of various species of rats) can allow very accurate (about 80%) confirmation of the species responsible for leaving the print [9, 11]. However, this is not the subject of this paper.

We have collected tracks of many small animal species such as rats, lizards and insects over the course of our work. When presenting this research at various occasions, these tracks also attracted interest from an esthetic point of view, with comments such as 'similar to an abstract painting', 'looks like an alien visited Earth', or 'having that printed on a T-shirt would certainly sell well'. Building on those comments, we present and comment here on a selection of

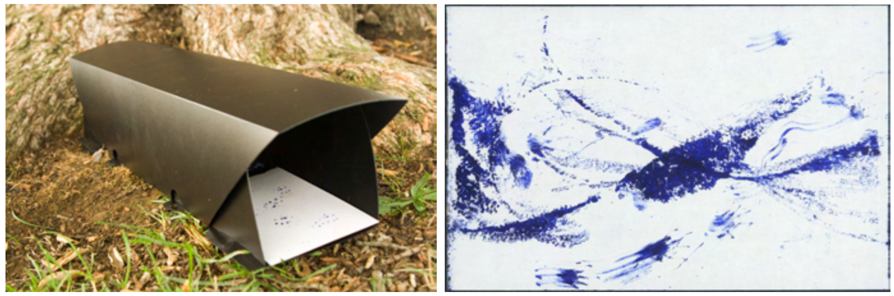

Fig. 1. Left: Tracking tunnel system - the artist's canvas. Right: Original print of a robust skink *Oligosoma alani*.

image-processed footprints of some species, with a brief characterization of those species (introducing the 'artist') and of the selected processing techniques. The shown processed images can also be seen online at [3] (in color, and reasonable resolution).

We treat the cards by performing different algorithms upon them, much as one would do for photo processing. Our treatments can be broadly classified by pseudo-colorings (i.e., mapping of the given gray-scale into a set of selected colors), posterization (i.e., reduction of gray levels), removal of artifacts (i.e., elimination of small dark regions by assigning a brighter gray-value or color), or some kind of contrast enhancement or blurring; however, in any case we aimed at being careful to stay close to the artist's strokes or patterns, and the processed result may just provide another interpretation of the given original (see Fig. 2). The paper is organized at follows. We present some of the artists with samples of their work in Section 2, and then discuss the overall collection of works in Section 3.

2 The Artists

From our large gallery of available expressions, we only present here a few New Zealand-based artists in this short paper; introduced rats and native New Zealand skinks and geckos.

2.1 Rats

Rats are by far the most wellknown of the artists we consider here. Three species of rats (*R. rattus, R. norvegicus and R. exulans*) have been introduced around the world [1]. The tracks of rats have previously been used in medical studies as a measure of damage to sciatic nerves, via a functional index [6]. More recently, rat tracks have been used to identify new arrivals on rat-free islands [8]. The genus *Rattus* is quite morphologically conserved, so differences between species can be cryptic to identify, although recent work has found subtle geometric differences [9]. The process of a rat walking across an inked card can introduce significant variability into the tracking ('artistic') process however. Biological differences among the rats such as age, size and sex can all play a role, while the quality and amount of ink and canvas will also affect the work. Together these factors interact, with the speed and agility of the rat upon the ink, leading to a myriad of patterns, such as foot-sliding and tail-dragging.

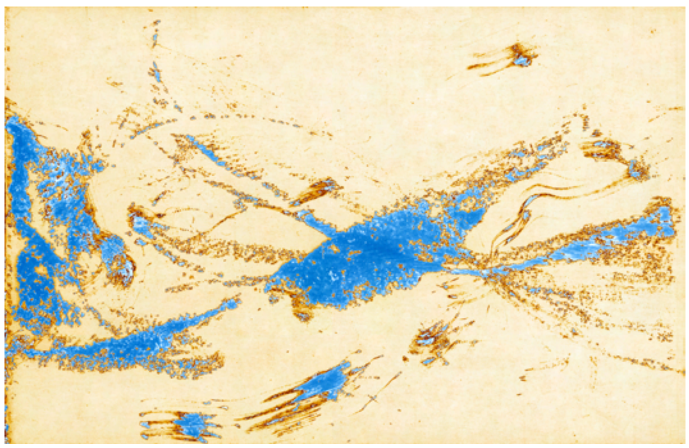

Fig. 2. Processed print of a robust skink *Oligosoma alani* using contrast enhancement and subsequent pseudo-coloring; for the original scan see Fig. 1, right.

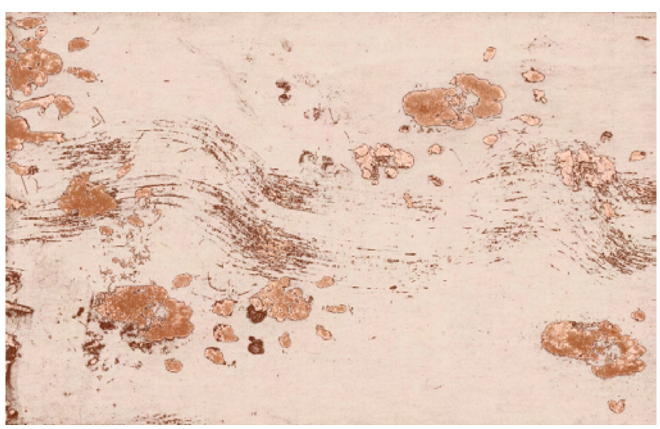

Fig. 3. The work of a large Wistar-strain male laboratory rat *R. norvegicus*. Pseudo-colored in earthy tones.

We present here (see Fig. 3) the work of a large Wistar-strain male laboratory rat (*R. norvegicus*). The footprints themselves remain discrete, founding the background of the work, while body-drag of the individual draws unifying links among the footprints, indicating more precisely the exact course the artist took across the canvas. The final touches include lighter footprints of the animal as it re-explores the canvas for a second time. The movement from left to right across the canvas provides a logical flow for the work, facilitated by our ability to readily identify the geometric orientation of the footprints. We have further processed this print by applying an earthy pseudo-coloring to the original scan.

2.2 Skinks

In contrast to our introduced rats, lizard populations display remarkable diversification in morphology among species as adaptations to their environments [10]. The New Zealand skink fauna, by example, is incredibly diverse, having radiated from a mono-phyletic lineage into a large number of species and variations in morphological characters [2]. We follow the revised nomenclature of [2].

The robust skink (*Oligosoma alani*) has been a victim of introduced rats in New Zealand. Once widespread, it is currently restricted to small islands off the north-eastern coast of New Zealand. Its large size is evident from its work where its body has dragged across the canvas, and the usually clear differentiation between footprints and body is diminished in this example (see Fig. 4). When viewed in a particular way an emblematic print of an entire gecko body can almost be made out on the canvas, as if the artist has left an impression of himself - perhaps a record lest they be forgotten as their range diminishes. Minimal

Fig. 4. Robust skink *Oligosoma alani*. Small artifacts have been removed from original scan, followed by pseudo-coloring.

Fig. 5. Moko skink *Oligosoma moco*. Inverted gray scale. Posterization and pseudo-coloring.

processing has been applied to this print so as not to detract from the uniqueness of its character in comparison to other works. The artist has been allowed to 'speak for himself'.

Like the robust skink, the moko skink (*Oligosoma moco*) is also most commonly found on islands off north-eastern New Zealand. The characteristics of its distinctly long and slender toes and tail are clearly reflected in this print (see

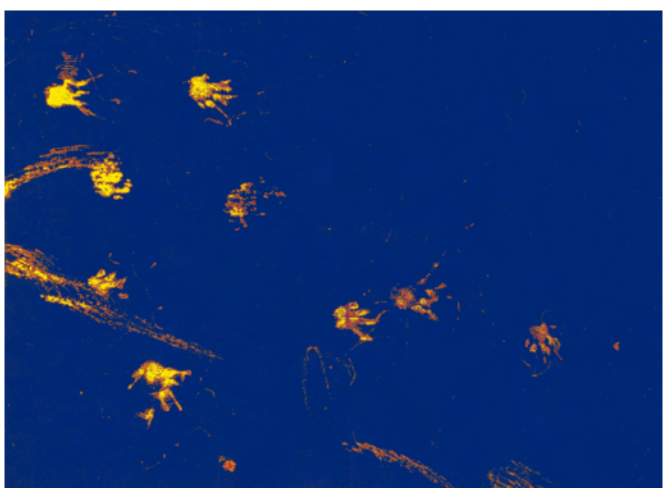

Fig. 6. Print of an Otago skink *Oligosoma otagense*, after applying pseudo-coloring only.

Fig. 5). We have gray-scale-inverted this print and processed it for minor simplification and coloring. This abstraction of the details removes the artist from its morphological reality and almost lifting it into a third dimension. Such prints can occur naturally however in softer substrates such as mud or soil, where water flow softens the print.

In comparison to its northern island coastal relatives, the Otago skink (*Oligosoma otagense*) is found in the southern inland areas of New Zealand; it is intimately linked with schist rock formation habitats. In contrast to the previous two artists, the pattern of this one is less decisive (see Fig. 6). The artist appears to be exploring the canvas, and to reflect this different approach we chose strongly contrasting pseudo-coloring.

2.3 Geckos

Similarly to their close relatives, the skinks, geckos in New Zealand have displayed a remarkable diversification. Subtle differences in their morphology are already clear when comparing prints between the skinks and geckos. Geckos have much fatter digits, allowing them great adaptability in their more arboreal environments. Geckos prefer to work by night, and we have chosen to emphasise this by using darker tones, if not outright black, in the prints.

The forest gecko (*Hoplodactylus granulatus*) is found throughout most of New Zealand, although is very secretive and often not found unless actively searched for. In this case the artist has made a direct path across the canvas, perhaps reflecting a determined curiosity of the canvas but only passing over once (see Fig. 7). We have only 'illuminated' the print against a dark background, highlighting once again the boldness of this individual in its nocturnal habitat - not afraid to stand out.

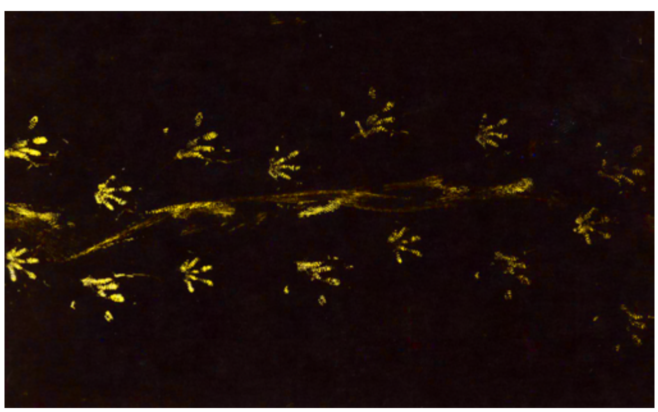

Fig. 7. Forest gecko *Hoplodactylus granulatus.* An enlightening color scale has been applied after gray-scale inversion.

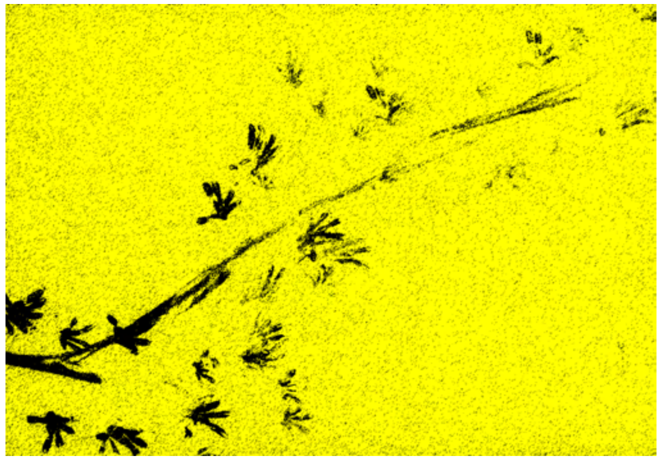

Fig. 8. Common gecko *Hoplodactylus pacificus*. Coloring of background of original print, and contrast enhancement.

The common gecko (*Hoplodactylus pacificus*) is found throughout New Zealand, and is the most widespread and abundant of geckos. As with other New Zealand geckos the mother gives birth to twins once a year but provides no parental care. As if reflecting this wandering off from the offspring, we can see the fading prints in this work (see Fig. 8). Small artifacts have not been removed, and they create a uniform noise pattern on the yellow background. This noise could be much like life for common geckos among so many other individuals, where time to raise offspring is more valuably spent elsewhere such as protecting your own survival.

Duvacel's gecko (*Hoplodactylus duvaucelii*) is restricted to a very small number of undisturbed islands in the north-east of New Zealand, but has been raised in captivity and reintroduced to many other island locations following pest eradication [12]. As if reacting to this intense human management, we can see that the artist has almost stomped his way around the print (see Fig. 9). Only one or two truly clear impressions have been left, the remaining work being destroyed almost immediately after it was made. Minimal change (gray-scale inversion only) is required to present this work.

3 Discussion

The works we have presented here share much in common with [4], where small animals are naturally encouraged to create works. In contrast to that school of work however, we consider it as being important for the presented work that artists were able to produce these prints within their natural habitat. Without such control over the process of artistic impression however, the work here must necessarily draw upon post-processing digital techniques, much as digital pho-

Fig. 9. Duvacel's gecko *Hoplodactylus duvaucelii*. Gray-scale inversion only.

tography does today when conditions for the original work cannot be controlled much as in a laboratory setting.

The nature of this post-processing also overlaps significantly with our other work in pattern recognition algorithms [9]. Within an educational setting these overlaps may not be so mutually exclusive, where children could both select tracks for identification, while simultaneously 'coloring them in'. A school class could, for example, move fluidly from learning about conservation by collecting prints from a field trip in the wild, to learning about the mathematics of algorithms for identifying prints in the class, and then finally create artistic souvenirs to take home for themselves or their parents.

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