Biometric identification of toads with digital image processing

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Goal: Find the matching pictures

Mark-recapture studies require a way to recognize animals. Visual recognition is a non-invasive alternative to physical tagging.

Date: June 2, 2010
Toe clip ID: ?

Date: Aug 18, 2010
Toe clip ID: ?

Date: July 27, 2009
Toe clip ID: 3003

Date: June 2, 2008
Toe clip ID: 280

Date: July 29, 2010
Toe clip ID: ?

Date: June 28, 2010
Toe clip ID: ?

Date: June 7, 2011
Toe clip ID: 2704

Date: Aug 17, 2010
Toe clip ID: ?

Date: June 5, 2008
Toe clip ID: 264

Date: Aug 23, 2010
Toe clip ID: 24

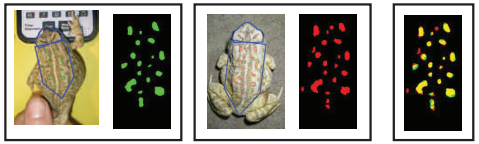
Date: Aug 20, 2010
Toe clip ID: 2536

Date: June 1, 2011
Toe clip ID: 2536

Date: June 6, 2010
Toe clip ID: 24

Did you find all the matching pairs? Are you sure? Now imagine trying to find all the matches in 1,592 pictures. Wouldn't you rather have a computer do it?

Solution: Use spot patterns as "fingerprints" and look for similar patterns



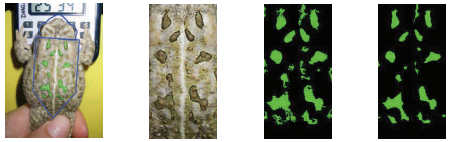
A digital recipe for spots

Mark the position of the toad in each picture

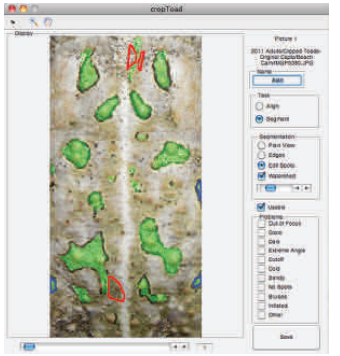
cut out the part of the back with spots

find dark patches

clean them up



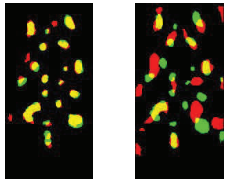
Biologists can use this GUI in the field



Judging similarity: matching patterns should have more overlapping pixels

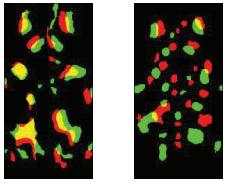
These match

These don't



Problem: pixels only overlap if patterns are aligned well

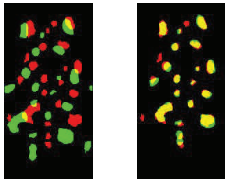
These match. If only I could covince my computer...



Solution: use math to transform each pair to improve alignment

Before

After



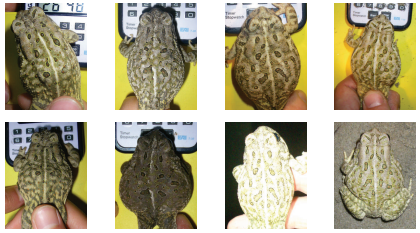
This solution can deal with unreliable picture conditions

Angle

Color

Lighting

Setting



Results: the software out-performs physical tagging

I tested the software with 1,592 pictures taken in 7 years of field work. I judged the accuracy by comparing it with toe clipping, a popular kind of physical tagging.