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Livestock Brand Identification in Zimbabwe Using Image Processing

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Abstract:
Recent research suggests that mobile applications have become more efficient than traditional methods. This has led to improvements of many traditional systems into more reliable and efficient systems. This project presents the use of mobile applications in the image-processing field specifically for object recognition through feature extraction and matching. The paper presents the detailed software requirements, use case modelling, and software design of the system and illustrates it in action through systematic examples. A comparison with related work and a set of possible directions of future exploration are also included.

Keywords: *Livestock branding, image processing, feature extraction, feature detection*

1. Introduction

`Cattle branding is a technique for marking cattle to identify the owner and is one of the oldest and best ways to permanently identify livestock**.** It serves as an excellent safeguard against livestock theft, loss or dispute**.** The main purpose of branding is in proving ownership of lost or stolen animals [1] .Cattle branding in Zimbabwe is done using a hot iron rod with a unique symbol at the end. This hot iron rod is placed on the animal to put a permanent mark, which is easily recognisable. The brand is registered or applied for at the veterinary to make sure that no one is using the same brand. As long as the brand is registered, it then becomes the primary proof of ownership of the cattle when they are lost and found.

One of the threats to the growth of the national cattle herd is stock theft and cattle branding is an effective way in curbing stock theft as it enables farmers to easily identify their cattle. This research project comes with a solution, which will work hand in hand with cattle branding to reduce stock theft and stray animals along the high ways with image processing. Image processing is the study of any algorithm that takes an image as input and returns an analysed or processed image as output. Usually in image, processing the main aim is to extract unique features or key points from the image, which can then be used to compare and match two images. Image matching is also part of image processing, involves using the features extracted from the image, and compares them with the images in the database in order to find an exact match or a similar image.

Livestock branding and image processing are brought together in this project to achieve one goal, which is to identify livestock owners through the registered unique brands that are put on the cattle. The system to be developed during this research project is an android-based mobile application that processes images taken of the cattle brands and goats' brands, searches for an exact match of the brand in the database and displays information about the livestock owner.

1.1. Current Zimbabwean Situation

Farmers are losing their cattle and each day there are cases that are reported at police stations of missing cattle. Every six months domestic animals that have been kept for long without the owner reporting for them are auctioned at a very cheap price, as the owners would have not been identified by then. In Zimbabwe, there is an increasing rate of stock theft especially cattle and there is no an effective way of identifying who the real owner is, as the culprits would easily forge the ownership papers. This has led to people buying stolen property without knowing and the culprits actually getting away with it freely. Nowadays livestock owners use a method called branding of marking their cattle using identification marks or signs to distinguish them from the others. However, these brands are very useful because the owner can easily recognize his livestock but it is difficult and may take time to find the owner through the brand when his livestock are lost. This method alone is not efficient or good enough when the cattle go missing or stolen. There is need of a way to identify the owner using the method of cattle branding and image processing so that he can be identified even if he is not around to confirm if he is the rightful owner.

1.2. Justification

This application after successful implementation will be very useful to the Zimbabwean cattle ranchers and the police since currently there is no an effective way of quickly identifying owners of stray or stolen livestock. The mobile penetration rate and the use of android phones is quite big in Zimbabwe therefore developing an

android application will be very useful to the majority of Zimbabweans. The use of image processing on the cattle brands to identify and notify the cattle owners is faster as it only involves a few steps on a mobile phone. Image processing of the cattle brand is very accurate in identifying the livestock owner as long his information is in the database. The application will actually solve a problem that is currently there in Zimbabwe and I have decided to focus on cattle, as Zimbabwe is a cattle country.

2. Types of Cattle Branding and Identification Methods

There are three different types of identification marks that are put on cattle and these include hot iron branding, ear or nose tagging and freeze branding. Freeze branding, similar to hot branding, involves the use of branding irons, with letters and numbers, being chilled in liquid nitrogen or dry ice and alcohol [1]. In Zimbabwe, only two are used which are the hot iron branding and putting identification tags on the nose or the ear. These methods have been used for quite a while and they serve their purpose very well especially in those areas where cattle ranching is done and a single person having close to a thousand cattle. This practice started in Europe and later on spread to Africa. This project will only focus on Zimbabwean used cattle brand, which is the hot iron branding. The ear/nose tags are difficult to work with for an image-processing project but the brands from hot iron branding are clearer and have boundaries that can be easily worked on as far as image-processing algorithms are concerned.

Besides branding there is also another identification method called Electronic Identification. This kind of identification is only used by a few in Zimbabwe and even in Europe, not so many farmers use this technology. There are many different forms of electronic identification used in the world today. Of these, the most common include electronic ear tags, microchips, and electronic collars. When using electronic ear tags, it is best to use an additional method of identification, in case the tag becomes lost. Microchips are a form of identification that involves the implanting of an electronic chip, with a miniature radio transponder and antenna, under the skin of an animal .The most common implant site is near the neck, between the shoulder blades, or near the base of the ear. The transponder can also come in the form of a bolus that can be ingested by ruminant animals. A benefit of using microchips is that they are permanent and relatively painless to implant.

Drawbacks to microchips include:

- the possibility that the chip may migrate into the meat of a market animal
- Specialized equipment is needed to read and implant the chips
- They are not readable from a distance.

Electronic collars are similar to neck chains, except they have an attached tag with an electronic number that can be read by a scanner. Electronic collars are easy to use, but they can become a nuisance and can cause choking if they are not adjusted properly to the growth of the animal or if they become hooked on protrusions. With each of these electronic ID methods, a scanner interprets the radio signal from the tag or implant as a numerical code, which brings up a corresponding computer file for that particular animal .Thus, a production history can be located quickly by scanning the electronic chip. Electronic identification can be used to automatically dispense feed to animals, and can be beneficial in the milking parlour by providing and recording valuable information during each milking. Electronic identification systems will become more refined and industry accepted in the future. These systems have a distinct advantage of being able to store the increasing amount of data the progressive animal manager has to interpret.

Animal identification methods differ, and each has its own benefits. All methods can be useful when used in the correct manner and under the right conditions. Oftentimes, more than one method is used for maximum accuracy. With these stipulations in mind, it is best to determine the needs and expected uses of animal identification on an operation, before choosing the best method(s) of identification.

This research tries to improve the identification method that is already there that is the iron brand mark by using image processing. These brands are registered at the veterinary so it will not be possible to find two farmers having the same brand on their cattle. Since each brand will be different then it will become easier to find a single match from the database. In Zimbabwe usually the ear tags put on cattle are there to differentiate and identify the regions from where the cattle are from whilst the hot iron brands are there to identify the owner.

2.1. Feature Detection

In computer vision and image processing the concept of feature detection refers to methods that aim at computing abstractions of image information and making local decisions at every image point whether there is an image feature of a given type at that point or not. The resulting features will be subsets of the image domain, often in the form of isolated points, continuous curves or connected regions. Before matching of images there has to be detection of features that will then be used in the matching process. Several techniques are used in feature detection depending on the type of image. In this project the cattle brands images are unique in their own way and have a technique that best suits them as far as feature extraction is concerned. The best feature to use on cattle brands are the edges, the edges on a brand image are unique and can give accurate results in image matching.

2.2. Feature Extraction

This research covers the computer vision aspect of image matching to recognize cattle brands from images using mobile devices. To recognize and match images it is necessary to extract unique features and patterns that can be used for later matching. This task has been a major topic of research in computer vision. The idea is to gather the features and patterns from one image and store them in a database so they can later be compared against features from other images

and then decide which images are similar and if a match exists. Furthermore, the fast and robust feature extraction from images is crucial for much application in computer vision such as image matching. [2]

Harris Corners Detector is one of the most well-known feature extraction algorithms. [3] There are many studies and extensions that show how useful this algorithm is in the real world. Harris algorithm detects change of intensity; if an image is flat, there is little change of intensity. On the other hand, if there is a great change of intensity in the image, it means there is an edge or a corner. They proposed an algorithm to extract the corners and edges of an image so this can be used for matching against other images based on Moravec's corner detector [3]

However, Harris and Stephens argue that their algorithm resolves many issues found in the Moravec's corner detector, such 16 as only a set of shifts at 45 degree are considered, noise response using rectangular a binary windows and finally the operator responds to fast to edges because only the minimum changes of intensity is taken into account. Even though the algorithm proposed by Harris and Stephens is still used today in many applications and in many areas of research, it has numerous issues. [3]

For instance, Lowe[4] states that this algorithm is not only selecting corners, but instead any image location that has large changes of intensity at a predetermined scale and indicates that this algorithm is not a good base to match images at different sizes. Furthermore, Dufournaud, Schmid, and Horaud [5] also state it does not work in different image scales. Lowe [4] proposed an algorithm called "Scaled Invariant Feature Transform (SIFT)" that resolves many issues found in the Harris Corner Detector algorithm. It consists of four steps, including, Scale-space extrema detection, Key point localization, Orientation assignment and Key point description. This is one of the most successful image matching algorithms and is widely used for research purposes and many commercial applications. It extracts features from images that are highly distinctive, invariant to image scaling, rotation, partially invariant to change in illumination and different points of views.

3. Methodology Tools

- SQLite database- This is a database that would be used to store the image descriptors and farmer details Programming languages (java and c++)
- Android studio-The IDE for client side application development. The one used to develop the android application
- Open CV-computer vision library

3.1. Measuring System Accuracy

The accuracy of the system was evaluated against two (2) major errors of brand identification technology that a system may exhibit. These metrics are measured as a percentage of the total number of instances (brands) available in the database.

3.2. Performance Testing

Performance testing is in general, a testing practice performed to determine how a system performs in terms of responsiveness and stability under a particular dataset. It can also serve to investigate, measure, validate or verify other quality attributes of the system, such as reliability and resource usage. The performance of the system was evaluated against two (2) major errors of image processing technology that a system may exhibit:

3.2.1. False Acceptance Rate

This is a situation where the brand identification system recognizes an unknown brand(unregistered) as known for example one owner of livestock is given the wrong data of another owner of livestock. This is also called False Match, False Positive or Type I error. FAR is calculated as following

$$FAR = \frac{\text{Number of false Acceptances}}{\text{Number of identification attempts}}$$

	Frequency	Percentage	Valid Percentage
Valid number of FAR	1	5	5
Recognized brands	19	95	95
Total Number of brands in the scene.	20	100	100

Table 1: False Acceptance Table (FAR)

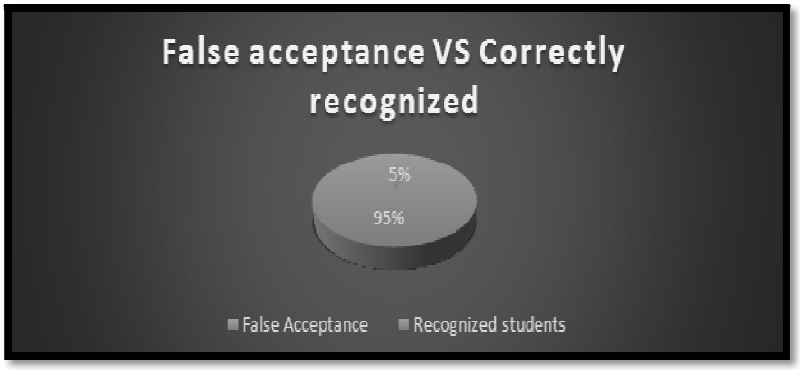

Figure 1: Acceptance VS Correctly Recognized

The table 1and figure 1 shows the false acceptance rate of the system as a percentage. Given trained dataset of 20 brands, 19 were recognized thus the system attained 95% effective in recognizing brands and the false acceptance rate was 5%, which is very small for the overall system. Quantitative statistics obtained on False Acceptance Rate shows that the system is not much prone to false Acceptance Rate since the rate is low.

3.2.2. False Rejection Rate

A known brand stored in the database is regarded as unknown at this rate. False rejection occurs when a brand is not matched to the one in the database. This is also known as Type II error or False negative calculated as FRR=Number of false rejected brands / Total number of brands in database

	Frequency	Percentage	Valid Percentage
Valid number of FR	2	10	10
Recognized brands	18	90	90
Total Number of live stocks in the scene.	20	100	100

Table 2: False Acceptance Table (Far)

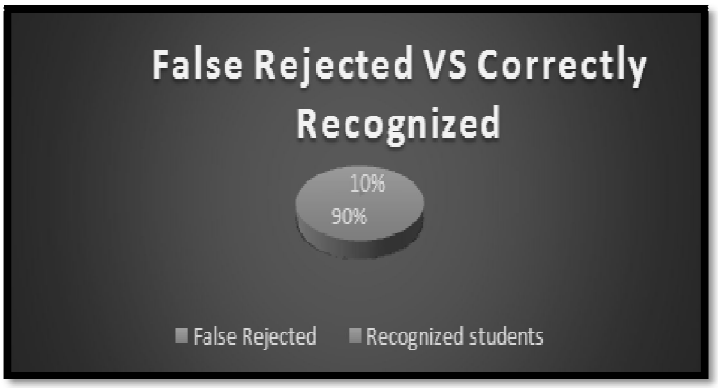

Figure 2: False Rejection Vs. Correctly Recognized

The system attained a false rejection of 10% which means only 2 brands were rejected and 18 were correctly recognized which represents the largest portion of the population sample.

3.3. Computational Time

CPU time (process time) is the amount of time for which the central processing unit was used for processing instructions of a computer program or operating system as opposed to for example. Waiting for input/output operations or entering low-power mode. CPU time is measured in seconds calculated as follows:

$$\text{CPU Time} = \frac{\text{Average period of background task with no load}}{\text{Average period of background task with some load}}$$

The system's computation was tested on a Dell Machine with 2BG ram, core i3 and 2,6GH processor and the computational time for the system is given in table 4.6. Computational time obtained means that the more number of training images available in the database the more computational time but generally the system is efficient.

Number of Training Set in Database	Time Taken for Recognition
60	840ms
80	890ms

Table 3 Computational Time

4. Summary

The system attained lower rates of false rejection and acceptance and higher brand identification rates this means that the system is accurate in matching every brand to the one stored in the database. The research was aimed at designing and implementing a Livestock brand identification using image processing.

This research explored two main areas of computer vision, which are features extraction from images and features matching. To extract features from images, SIFT algorithm is one of the most popular due to its properties that makes it a solid choice in any image matching application. On the other hand, for features matching the RANSAC method is the standard. These two methodologies were used to develop the cattle brand identification system.

The architecture of the system is a server-client model with the server implementing the image recognition engine providing an API to clients to connect. In other words, the implementation of the feature extraction and matching is in the server side. The server is running Flask framework, SQLite and OpenCV.

The client is a mobile app developed in Android. The app takes a picture of the brand, resizes the image and sends the picture to the server for recognition, when a response is received from the server the apps displays relevant information about the cattle owner.

5. References

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