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Design of an Embedded Detection System Based - Convolutional Neural Network for Swine Status and Health Assessment

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Abstract

The internal state of animals can be expressed through their behavior—changes in such behaviors can possibly be used to assess immediate signs of problems, such as animal well-being, more particularly in livestock. Appetite, movement, and activeness are factors that can be considered in assessing the swine status. Intrinsically, technological advancement in computer vision based on these behaviors are quite limited especially in open field monitoring. This paper presents the design of a Swine Status Assessment utilizing an embedded detecting system based on Convolutional Neural Network that classify each pig, record real-time activities and determine the swine's status. Using this kind of computer vision captured from real-time video acquisition and object-oriented programming, the implementation of the design seeks to create a monitoring system which will assess the health of the pig by monitoring their behavior within specified parameters. The design is deemed practical commercial settings since it renders continuous observation of behavior with reference to several pigs at a time to validate livestock status assessment. This method will enhance the monitoring system of livestock in the swine industry in terms of their health, welfare and pig farming.

Index Terms: *Automated Monitoring System, Behavior, Machine Learning, Neural Network, Pig Monitoring*

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I. OBJECTIVES

Philippines is a country with mass production and large amount of consumption of livestock. And among these livestock and poultry industry, swine production is considerably the largest. With the 60% of total animal meat consumption of the Filipinos, the countries food security is directly relative to swine production as the second largest provider to the national agriculture next to rice [1]. In the Philippines, considering that pig production is a major livestock industry, losses are crucial. In 2018, there are about 1,020,729 deaths and losses [2].

Monitoring the behavior of animals, specifically livestock, bids insight into the change of animal states. The corresponding behavior change can be caused by changes in their environment, or in health and welfare challenges [3]. Behavioral assessment is

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one of the major considerations in identifying problems in pigs [4] and they give constantly signals about their health, well-being also, performance [5]. However, it is impractically to observe ordinarily, because of the huge work information, and it might make pressure man and creature. With the larger livestock, high likely that the effective intervention is hindered as obtainable time for monitoring and surveillance with animals has eschewed significantly [6].

Based on the issues above, automated monitoring systemcan overcome those encounters [7]. Greatly reduced labor availability and modern farming methodology, have changed the daily routine and procedure in caring for livestock. Monitoring with computer vision can help in identificati on of a certain behavior, through optical flow patterns measurement within the allotted scope [8]. Although pig movement takes place on the surface plane, three-dimensional following empowers estimation of standing conduct [9].

Computer vison imitates human intelligence and vision by constructing rules in the structure, ensemble and alterations of image pixels by the use artificial intelligence. [10]. Nonetheless, animals cannot be determined sick with just one behavior [7], hence the cameras must have full potential to measure all the behaviors with validity. Over the last decade, improvements in digital technology have employed the use of videos for studying wildlife [11].

In changing the levels of success and human involvement, machine learning techniques were utilized in classification of animals in camera trap images [12]. Preparing such models normally requires broad PC programming abilities and apparatuses for learner software engineers are restricted.

The objective was to develop a Design of a Convolutional Neural Network for Swine Status Assessment that aims to create a monitoring system to assess the health of a pig by getting monitoring their behavior as an alternative to traditional methods. This will provide earlier detection of possible pig sickness and prevent the spread of diseases to grower and fattener pigs and have them quarantined and cured in the pig hospital.

II. METHOD

The figure 1 illustrates the general square chart of the framework of the Design of a Convolutional Neural Network for Swine Status Assessment. It demonstrates the progression

of the proposed plan originating from the Real-time Video Feed which acts as an input, followed by the Deep-Learning process and the output user interface.

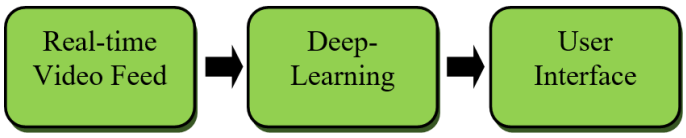

Figure 1. Level 0 Block Diagram

The Deep-learning process consists of the implementation of the Convolutional Neural Network as well as the following methods provided below.

A. Random Forest Classifier

Random forest classifier, as its name suggests, comprises of number of distinct decision trees that function as a group. Every one of these trees in the random forest yields a predicted class [13].

$$f = \frac{1}{B}\sum_{b=1}^{B} f_b(x') \quad (1)$$

The equation shows the general equation of the prediction scheme for the hidden samples of *x'* through taking the average of the expected psredictions from each of the distinct regression trees. The prediction equation of the random forest came from the bagging equation of bootstrap [14].

Based on the equation set above, Random Forest can be able to classify and detect pigs in connection with the Convolutional Neural Network.

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B. Multiple Linear Regression

The problem with identifying whether the pigs are possibly sick or not can be resolved by the Multiple Linear Regression. Multiple Regression deals greatly with the correlation of continuous variable—response—to two or more independent predictor variables [15].

Since data sets with continuous response variable are evaluated by Multiple Regression, other regression approaches, such as logistic regression, are mostly suitable and essential in discrete response variable [16]. In this case, examining the pigs' behavior with two or more independent variables based on the pig's activity using Multiple Linear Regression confronts the challenges and flaws of Simple Regression.

The condition (2) underneath speaks to as the needy variable, the estimation of the foreseen reaction chooses the best-fit plane of relapse. β speaks to the parameters, x represent the independent variables and as the error. ε

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon \quad (2)$$

The equation (2) shown above approximates the effect of x_{i1}, x_{i2}, x_{ip}, when added on the response. It denotes that the relation of each predictor in the response is considered linear with its regression coefficients, b1 and b2 (i.e., the "slopes"). Since simple linear regression weighs its linearity by taking consideration at the plot of the information focuses, various relapse assesses disperse plots of Y and its residuals with every one of the indicator factors. On the off chance that non-linearity exists, integrating a model for linearization such as linearizing transform or nonlinear regression can be used [15,17].

III. DEEP LEARNING PROCESS

This section will be discussing the architecture of the object recognition specifically the pig identification system. The proponents utilize the use of Python as their programming language used.

Neural systems have been a dynamic zone of study about numerous decades due to their conceptual ability to show any relationship between input and output, linear or non-linear, given with adequate information from which to generalize. Deep learning, and CNN approaches in specific, combine both the highlight extraction and classification stages of object recognition, by preparing and training of a completely associated classifier and datasets back through the convolutional layers in arrange to choose the best output classification [18].

A. Convolutional Neural Network

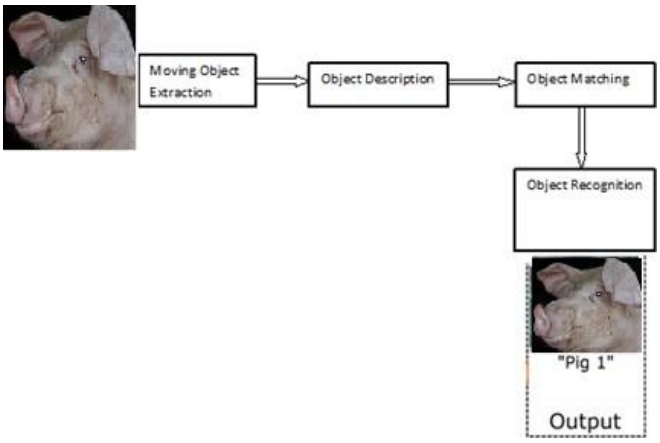

Figure 2. Pig Recognition Training Phase

The convolutional neural system was utilized to arrange and recognized each pig.

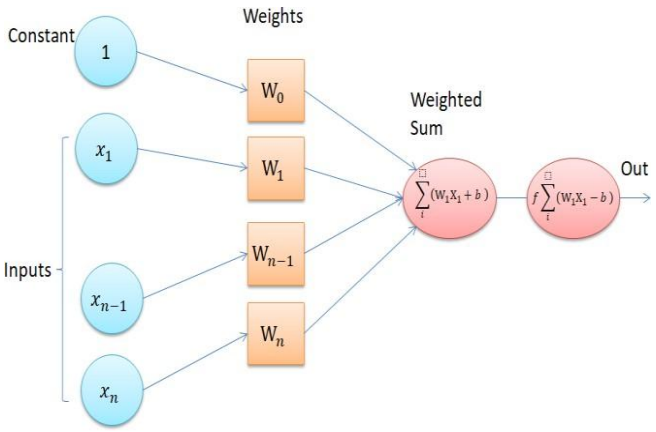

Figure 3. Convolutional Neural Network Mathematical Model

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a.) Datasets. The training set used in the experiment are set of images and videos taken from the farm located at Tanay, Rizal, Philippines. This will be the reference or basis of the neural network whether there is a pig or none and records it activities [19]. This will also classify which is which pig is present.

Figure 4. Sample Pig Images Acquired from Tanay, Rizal

b.) Object Description and Matching. Each image from the datasets will go through processing called object description and matching. This process will match the input data to the datasets and will make a conclusion depending on the acquired datasets.

c.) Object Recognition. The system will then recognize the input from the camera by a predicted label. It concerns what object or specific identity is present in the input image or the ability to perceive the current object that is existing in the image [20].

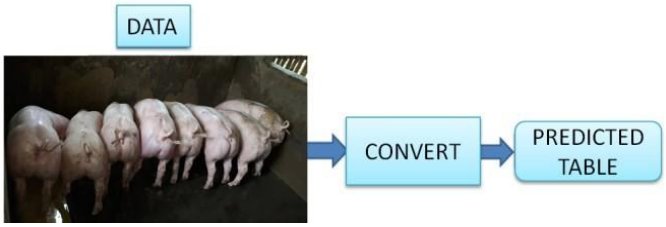

Figure 5. Object Recognition Model

B. Machine Learning

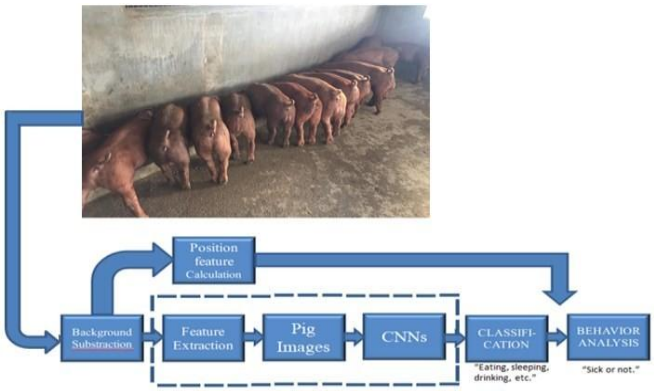

Figure 6. Behavior Classification Model

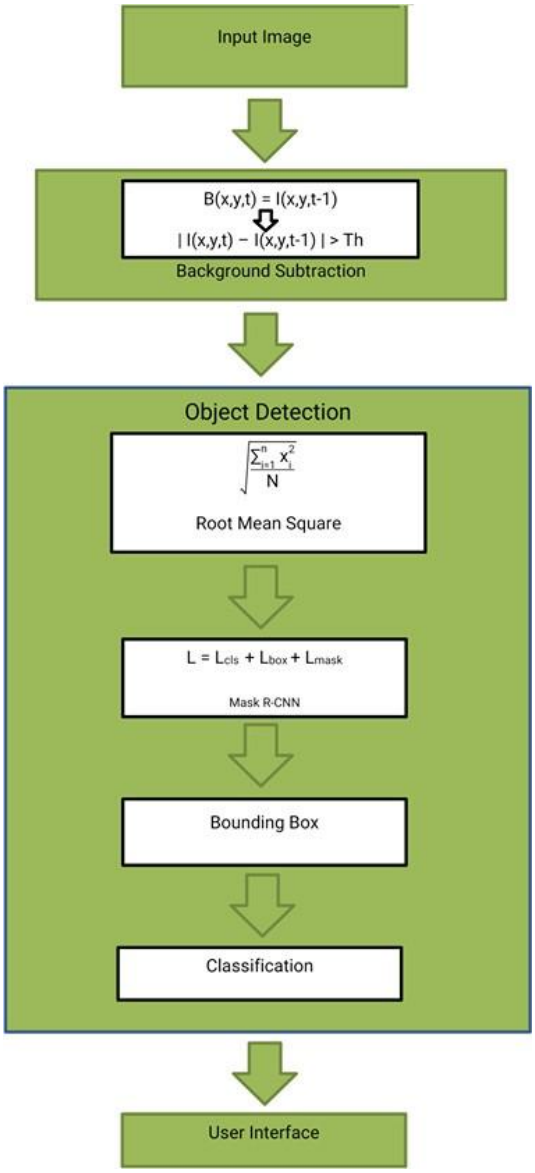

Figure 7. Behavior Classification Mathematical Model

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a.) Background Subtraction. The main task of the foundation subtraction is to produce a closer view veil with the use of a camera. Background subtraction is a technique that is widely used in ascertaining the closer view veil and to subtract the present edge from the foundation model that contains the static piece of the scene [21]. It isolates the moving pigs in a scene by segmenting it into background and foreground.

b.) CNN based classifier. CNN based classifier is responsible for the acceptance of the input image from the camera, then classify it according to its class. The input image will pass through a series of neural network programs, particularly convolutional layers that would then generate a particular output [22]. By using CNN based classifier in machine learning, we can classify what behavior/s the pig/s are doing. It first extracts the video feeds into images that will then be processed by our CNN.

c.) Classifier and behavior analysis. It analyzes each frame of the video independently, perceive most pieces of the bodies, and from that point onward, it use the recognized parts as reason for further conduct examination. The framework perceives the conduct state from the perceived parts instead of perceiving the activity or outward appearances from the picture straightforwardly. In real life acknowledgment, it is imperative to perceive the distinctions in posture and the connection between the item and the foundation. While in item acknowledgment, different poses of the object do not change the object's class.[23]. Based on the results in the CNN classifier, the system will then classify what behavior/s the pigs are doing then classify it and would produce an output whether the pig is sick or not.

IV. EXPERIMENTAL RESULTS

The following images are acquired from Rodriguez and Tanay Rizal. These were the results of the object recognition specifically for pigs:

Table I. Multiple Samples of Pig Recognition

FIGURES	DATA	RESULTS
Figure 1		10 out of 10 detected pigs.
Figure 2		3 out of 4 detected pigs.
Figure 3		4 out of 5 detected pigs.
Figure 4		7 out of 10 detected pigs.
Figure 5		2 out of 3 detected pigs.
Figure 6		4 out of 4 detected pigs.
Figure 7		7 out of 8 detected pigs.
Figure 8		4 out of 7 detected pigs
Figure 9		2 out of 2 detected pigs.
Figure 10		3 out of 3 detected pigs.

Table II. Accuracy Testing

Image (Sample Data)	Detected Pig	Total Pig	Accuracy (%)
1	10	10	100
2	3	4	75
3	4	5	80
4	7	10	70
5	2	3	66.67
6	4	4	100

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7	7	8	87.50
8	4	7	57.14
9	2	2	100
10	3	3	100
Overall Accuracy	47	57	83

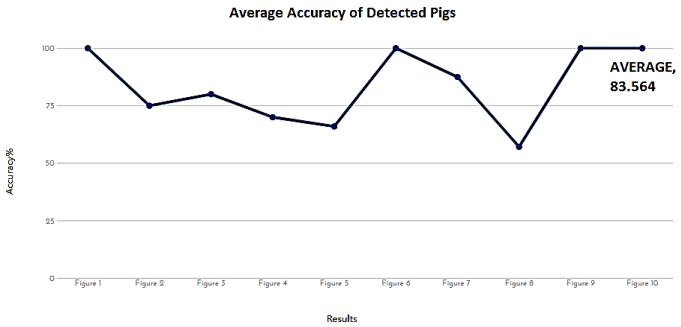

Figure 8. Accuracy of Detected Pigs

Figure 8 display the graph of the average accuracy of detected pigs having a 10 different samples of images shown in table 1.

V. CONCLUSION

Pig detection is a way of identifying pigs through pictures or video streams. A pig detection system uses technology to detect pigs. In this paper present the technique used to detect, classify and localize pigs using Convolutional Neural Network we got a total of 83% accuracy from 10 sample image data with a total of 47 detected pigs out of 57 total pigs present in the image. The model has been trained with different classes of pigs to capture the similarities that would be fed to the system. It will localize one or more objects within an image and classify each object in the image as pigs. It will locate and draw a bounding box around each pig in an image, and object classification that was localized.

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