

Currency Classification Using Deep Learning

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ABSTRACT: As of late, profound learning has turned into the most famous exploration heading. It fundamentally prepares the dataset through brain organizations. There are various models that can be utilized in this exploration project. All through these models, exactness of cash acknowledgment can be moved along. Clearly, such examination strategies are in accordance with our assumptions. In this paper, we basically utilize Single Shot MultiBox Detector (SSD) model in light of profound advancing as the system, utilize Convolutional Neural Network (CNN) model to extricate the highlights of paper cash, so we can all the more precisely perceive the group of the money, both front and back. Our primary commitment is through utilizing CNN and SSD, the typical exactness of money acknowledgment depends on 96.6%;

I. INTRODUCTION

An imperative job in the acknowledgment cycle and can work on the precision of the general preparation through utilizing CNN model [11]. We use CNN as an element extractor under the system of Single Shot Multi Box Detector (SSD) model.

During the time spent currency classification, we first need to consider whether the size of the dataset is adequate, on the grounds that our information assortment was from the pictures by parting the video into a solitary edge, however all the while, it might have contortion or obscuring may happen, so it is first important to alter the pictures and make the picture more clear partially, which likewise adds to the exactness in the wake of preparing.

During the time spent profound picking up, overfitting is additionally inclined to happen. It is not difficult to make the preparation cycle more confounded, increment preparing trouble and preparing time; the preparation likewise permits us

to concentrate on drop innovation and stay away from overfitting.

II. LITERATURE REVIEW

2.1. Currency detection and recognition

Previously, individuals could confirm cash, yet the perception capacity of the natural eyes are restricted, and they are troublesome to recognize reality or phony without the innovation. In spite of the fact that UV acknowledgment innovation is as of now in presence, with the improvemen of duplicating innovation, this innovation isn't sufficient to assist individuals to recognize the fake money with further developed misrepresentation methods. Be that as it may, presently, in light of picture acknowledgment, various perspectives were shared by dissecting the money tone, plan elements and explicit information of cash, then, at that point, explicit distinguishing proof techniques were given [1]. Money acknowledgment techniques for information argumentation through variety examination of cash pictures, picture upgrade, turn point, etc were given [15, 16, 17].

Profound learning has a place with a brain organization. To begin with, it needs a bunch of large information. By breaking down preparing dataset, the precision of money acknowledgment could be constantly improved and our assumptions for trial results could be accomplished. Convolutional brain organization (CNN) plays During the time spent cash identification, it is important to initially decide from which viewpoint to begin testing. In 2001, it was proposed to perform cash discovery in light of neighbourhood edge data of the money. By recording the anchor lines of cash designs in the dataset, consolidating them into a layout and afterward blending the money datasets and formats that should be

distinguished into in the handling, notice the degree and distinction to perform money location [2].

Cash identification in view of packed degree was proposed in 2008. In view of the ANN climate, clamor is eliminated from the foundation as per an exceptional straight change capability without influencing the component picture [16]. The first grayscale range planning is set somewhere in the range of 0 and 125, and the edge discovery strategy is utilized to give better strength to location [14]. Furthermore, another three-layer back propagation brain network is proposed, which is actually identified by various orders [4].

Involving MATLAB for cash identification is likewise a possible strategy. In 2008, involving MATLAB for money identification, we first need to utilize the HSV variety space in order to remove the shade of the money in the dataset, and apply various varieties to distinguish various tones [12].

In 2003, a continuous money identification strategy was proposed for the absence of cash order innovation in the Chinese market [3]. Taking the picture on the money as a component of cash discovery, while taking the money size of various sections as one of the separated elements, we put this data into the Kohonen network for preparing [15].

This strategy actually enjoys the benefits of rapid and high acknowledgment exactness [17].

2.2. Deep Learning

Profound learning is a brain network comprising of different layers that can get familiar with various pictures as the dataset. It has been primarily utilized in the fields of discourse, vision, picture acknowledgment, and article discovery. Profound learning is to gauge the loads of each layer through backpropagation calculation.

The handling impact of various layers is different [1]. Albeit the cycle is tremendously confounded, it has been effectively applied to picture acknowledgment and picture handling.

In fake brain organizations (ANN), managed learning (SL) and unaided learning (UL) are undeniably related intently. In 2015, a brain network framework in light of MaxPooling Convolution has been proposed, which could be utilized for picture acknowledgment, object location is grouped by various datasets.

Through profound learning, every neuron could be actuated, yet the intricacy will be expanded as the levels go up [10].

Contrasted with conventional AI techniques, the exhibition of profound learning is greatly improved at tackling commonsense issues.

On account of an ever-increasing number of huge information, profound learning is expected to examine and learn in a lot of agreeable information, which is to join profound learning and enormous information advancements.

The degrees of intricacy and layers in profound learning are for this various information, however with additional information, the more layers of a brain organization, the less difficult it becomes, which is one reason why profound learning has turned into a mainstreaming innovation in registering. Simultaneously, the utilizations of profound learning are a lot more extensive than that of AI [8].

2.3. Single Shot Multi Box Detector (SSD)

Single Shot Multi Box Detector (SSD) is an enormous edge model for object acknowledgment. It produces bouncing boxes from include maps on various layers, the result of these jumping boxes is gotten. It will frame different bouncing boxes as indicated by various classifiers; after the order, we could figure out what the article is. It is additionally utilized progressively identification, yet it is quicker than Faster R-CNN and ResNets. Nonetheless, SSD ensures the speed of recognition, yet in addition guarantees the exactness of location.

For SSD, the result of the jumping box is discretized to shape a default box, which is dispersed at various situations in the picture. Profound brain networks consolidate highlight guides of various goals to rapidly recognize pictures of various sizes more. In the identification cycle, the SSD wipes out the requirement for resulting highlight extraction after the pixel issue. It saves the computation consequences of various stages in each layer, which shows that the SSD is not difficult to prepare and could be the articles that should be tried are coordinated into the framework and can likewise ensure high exactness [7].

Multi Box in SSD requires a Region Proposal Network (RPN) model for expectation to decide the bouncing box that isn't connected with the objective grouping [6].

2.4. Convolution Neural Network (CNN)

CNN is a back-engendering brain network with a two-layered (2D) weight bit. The picture input into the CNN is produced by two sorts of ROIs, one is averaging and subsampling, and the other is include extraction in view of surface. It is then organized lastly placed into the CNN model. In 1996, CNN was utilized to lead mammograms to explore whether ROI can group typical tissues [9]. In this cycle, Receiver Operating Characteristic

(ROC) is additionally used to assess the exactness of CNN for order precision. After CNN highlight extraction and boundary combination, the outcomes could be identified utilizing ROC diagram.

The outcomes demonstrate the way that CNN can recognize and arrange the substance of X-beam photographs.

As of now, the improvement of CNN is still extremely fast, its ease of use is still exceptionally high, however the advancement of the clinical field is still moderately sluggish. In 2016, CNN was proposed for two explicit issues lymph hub (LN) identification and interstitial lung illness (ILD), through five cross approval strategies [5]. It was found that the CNN model has a better exhibition for the order of clinical imaging.

Against CNN in 2015, MatConvNet was proposed to assist CNN with carrying out opensource tool stash, and the climate for profound reconciliation was carried out in MATLAB. MatConvNet can help the CNN structure in all honestly, making it simpler to perform under the activities utilizing MATLAB capabilities, while giving channels to convolution tasks.

Utilizing MATLAB codes makes it simple for CNN to introduce the structure. This strategy could be utilized to prepare huge datasets on PCs with both CPU and GPU designs [11].

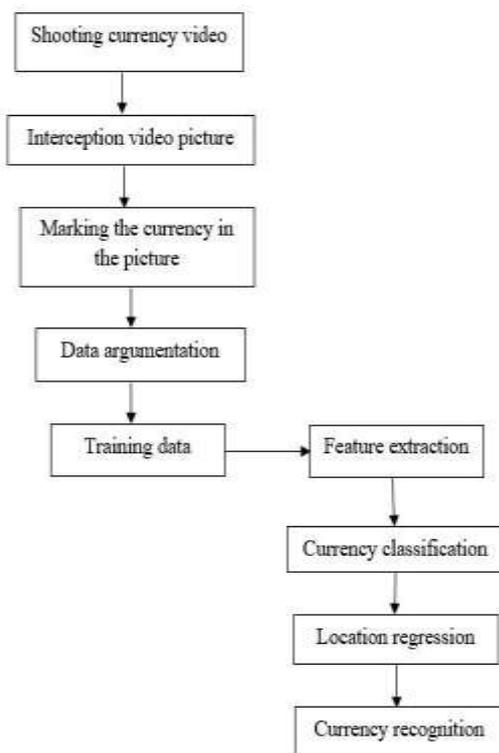


Figure 1. The flowchart of the steps of currency recognition

In 2014[6], the utilization of CNN's elite presentation to tackle the issue of trouble in distinctive message data from foundation in complex messages was proposed. CNN anomalies could be recognized from the by and large literary data, including foundation bunches and items behind the scenes, while utilizing Maximally Stable Regions (MSERs) and sliding window strategies.

MSERs can decrease the quantity of windows being filtered, and the sliding window can recognize the associations of numerous characters in the identified text. Along these lines, solid strength could be accomplished.

III. METHODOLOGY

3.1. Research Design

Our principal research is money acknowledgment. Before we start, we want to make a plan of the examination project. Before we officially start our undertaking, we really want a few essential thoughts for the particular substance of each part.

As displayed in Fig. 1, this flowchart shows the fundamental idea of the particular examination process. With respect to acknowledgment, gathering datasets is the most essential activity; we gained a solitary casing of the video to get the information picture of the money. Prior to preparing the information, the information picture should be separated, the picture that meets the trial prerequisites was chosen as a dataset to direct the information argumentation utilizing the obvious pictures to build the size of the dataset. After satisfied the work, we send them to the MLP layer for money arrangement, at long last we complete the cash acknowledgment.



Figure 2. The dataset of the currency

3.2. Data Collection

To guarantee the amazing skill and meticulousness of our exploration, we at last decided to involve genuine cash as our information source. We have picked 5NZD, 10NZD, and 20NZD as the financial category of our money acknowledgment. The money of every category will have front and posteriors. We originally shot recordings of each side of these three divisions. During the video shooting process, we want to ensure that the cash is level, and the money could be completely shown in the recordings. At the same time, we pushed the money ahead, in reverse, left, right, and slope, which enhanced the substance of the dataset. We additionally need to guarantee that when we are shooting video, there is sufficient light around it, since we hope to plainly catch the subtleties of money more. We put these recordings into six organizers, we named the envelope as 5NZD-F, it implies that this organizer is the front side of 5 New Zealand dollars.

After taken the video of cash, we really want to alter the video and screen each edge to guarantee that the money is clear and complete in each image, there isn't any parts out of the containers. For this situation, we get 50 photos of every group, we have gotten a sum of 300 pictures as a dataset, the goal of each image is 1280×720 as displayed in Fig. 2.

3.3. Data Argumentation

Up to this point we realize that after the information assortment, we have completed the strategy of information manual stamping; we gathered every one of the gathered information into

six classes, and we got a sum of 300 legitimate cash crude pictures with the end goal of acknowledgment. Yet, this number of tests is deficient, supporting the preparation of profound learning is troublesome. Hence, to accomplish better preparation of the information, we have satisfied information argumentation on the first information, and produced new information; the general information volume is expanded by this strategy. During the time spent information argumentation, we have five stages by zooming the picture size, haphazardly cutting or extending, arbitrary turning, or arbitrarily variety changing [13].

After the information expansion, every one of the first video edges can get 25 money improved pictures. the quantity of datasets will be extended from the past 300 to 7,500, consequently it extraordinarily works on the proficiency and uprightness.



Figure 3. The dataset of the currency

The dataset after information argumentation can make our exploration tests more exact. Along these lines, we can advance the position, size and point of the cash, and change the shade of the money picture to make our exploration work a lot of extensive. Fig. 3 is an upgraded impact of a crude information in the dataset after information argumentation.

3.4. CNN Model

As the information preparing advances, the preparation layer constantly refreshes the boundaries of each layer, so we can see the association of the preparation layer in Fig.1

Simultaneously, each layer utilizes an irregular introductory boundary esteem and interfaces with the underlying layer, we save the refreshed boundaries to the save layer on the hard circle. At long last, the got information is

contribution to the legitimate layer, and it is confirmed with the prepared dataset to decide if the dataset is completely prepared.

In this paper, money discovery, as a subtask of cash recognizable proof, should be partitioned into two sections in preparing; that is, situating and characterization in MLP, the general learning structure is TensorFlow. In particular, we split it into convolutional layers and fully connected layers.

IV. RESULTS AND ANALYSIS

While the preparation of our organizations is finished, we have gotten the results. For the money, other exploration results are essentially founded on the precision of four models, the preparation dataset and the confirmation dataset as well as the characterization and situating. The investigation prompts a model with high precision. Likewise, we additionally dissected the precision and misfortune capability of the model.

At a higher precision rate, the information was completely prepared, and overfitting issue was stayed away from during the preparation. It likewise shows that the CNN model we picked can complete a steady employment. For the aftereffect of money acknowledgment, we want to perceive the front and rear of the cash's ethnicity and certainty, toward the end we will show and make sense of the outcomes.

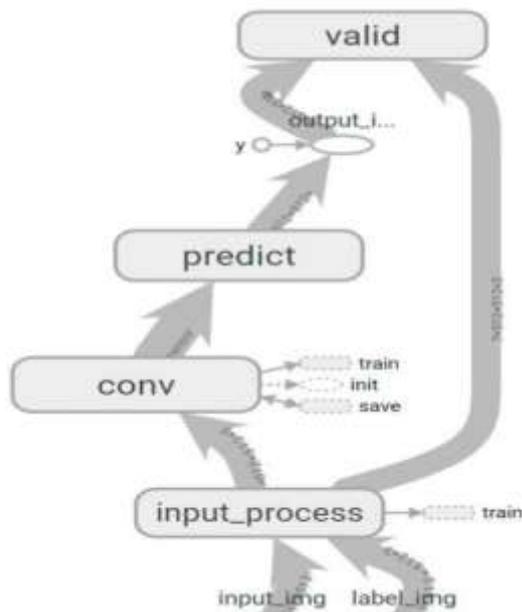


Figure 4. The CNN model

4.1. Results

When we design the model, we chose to use two ways of quadrilateral coding, $box_1 = [x_1, y_1, x_2, y_2, x_3, y_3, x_4, y_4]$ and $box_2 = [\frac{x_1}{w}, \frac{y_1}{h}, \frac{x_2}{w}, \frac{y_2}{h}, \frac{x_3}{w}, \frac{y_3}{h}, \frac{x_4}{w}, \frac{y_4}{h}]$, then we can get two different training models. In order to compare and select the optimal model, we set the weight using $w \in \{1, 10\}$ for training.

One more element in the CNN model is the issue of learning rates. In the choice of learning rate, assuming the learning rate is too enormous, the right rate will cause huge vacillations when the model meets, which will prompt lower accuracy.

From Table 1, we naturally see that the precision pace of each model in the four preparation models is above 90%. From this perspective, each of the four models were completely prepared during the preparation cycle. There isn't overfitting in the preparation. However, the precision depends on the check set, we at last picked box1 as the quadrilateral code and weight 1.0 on the grounds that the general exactness of this model is the most elevated among the four models.

Table 1. The flowchart of the steps of currency recognition

model	main	train	valid
b-1-w-01	0.9660	0.9638	0.9507
b-1-w-10	0.9631	0.9634	0.9453
b-2-w-01	0.9335	0.9480	0.8753
b-2-w-10	0.9248	0.9548	0.8447

To additional look at the preparation cycle of the four models, we made an examination of the four models from the misfortune capability of the preparation dataset and the confirmation dataset, the right rate, the misfortune capability worth of the situating and characterization.

In Fig. 5, we obviously see that the worth of the bend of the misfortune capability is diminishing and in the long run is just about nothing. This demonstrates that there is no tremendous distinction between the outcomes got subsequent to preparing through utilizing the brain organization and the outcomes anticipated by the framework in the check layer of this model. This likewise shows that after our information has been handled through utilizing a progression of convolutional and MPL tasks, the information has been completely prepared, and these outcomes

meet our unique examination objective of cash acknowledgment.

The information were listed in view of Model 1; utilizing Model 1 to prepare 5 New Zealand dollars, 10 New Zealand dollars and 20 New Zealand dollars, the preparation results were explicitly broke down beneath. To start with, the general outcome can be partitioned into three sections:

- The square marker confine the figure is utilized to check the specific boundary of the money.
- The encasing square shape of the quad is utilized to check the region involved by the cash in the picture.
- To more readily recognize the front and back of the cash, we decided to utilize different variety acknowledgment boxes to demonstrate the front and back of various groups.

In currency recognition, accurate classification of currency can be shown in the final experimental results. In this



Figure 6. The dataset of the currency paper, we bunch the cash into six classes, the front and rear of the 5NZD, the front and posterior of the 10NZD, and the front and rear of the 20NZD. At the point when the cash shows up in a single shot, the model can naturally identify the classification of the money and show the particular class in the sort box. This piece of the substance isn't just a high necessity for characterization, yet additionally a high prerequisite for money situating. Precisely situating can all the more likely group and recognize, there is an intelligent connection between them.

How about we utilize the 5NZD money as an illustration to examine the currency classification results. This is to examine the acknowledgment aftereffects of 5 New Zealand dollar. According to the perspective of the acknowledgment outline, the pink acknowledgment

outline is chosen on the front side and the blue acknowledgment outline is chosen on the posterior, so the outcome after money acknowledgment could be all the more plainly seen. From the characterization name, '5 NZD' demonstrates that the money has a presumptive worth of 5 New Zealand dollar, 'F' and 'B' show the front and back, and '1.00' shows that the precision is perceived. As show in Fig. 6.

4.2. Limitations

For cash acknowledgment, involving CNN as the element extractor, SSD as the fundamental model of the general system, profound brain organizations can carry out the discovery and acknowledgment of money; however, there are still a few impediments.

As of now, our examination just targets money acknowledgment, and distinguishing the credibility of the currency is unimaginable. Our examination just targets cash acknowledgment, and recognizing the realness of the currency is unthinkable.

Since the cash picked by our trial is restricted, we just select three categories. We likewise need to think about additional monetary forms with various divisions.

V. CONCLUSION AND FUTURE WORK

The primary reason for this paper is to do money acknowledgment. It incorporates the section of money, truth be told. We prepared the SSD structure, tried four distinct models lastly chosen the best one. These models depend on experimental techniques. We have additionally gotten agreeable outcomes. In the wake of finishing cash acknowledgment, we additionally summed up the fundamental commitments of this paper.

We decided to make a 6-layer CNN model as a component extractor. After highlight extraction, we decided to utilize quadrilateral box1 set the underlying loads to 1.0 for our money acknowledgment preparing. At long last, the prepared model could arrive at 98% precision, which shows that our dataset has been completely prepared. From the misfortune capability, we see that our model doesn't have overfitting during the preparation cycle.

The last examination results are agreeable, including deciding the cash range in the characterization mark, money group, cash front and back; cash acknowledgment exactness could be communicated, the precision is extremely high.

After analysis, we found that when the cash is in a reasonable state on the whole screen

and the points are equal, our acknowledgment speed is quicker, and the accuracy is higher. At the point when the money moves at a plain to see point or shows up on the screen far away from the camera, the precision of the acknowledgment will diminish somewhat, but since the dataset is completely prepared, the examinations of cash acknowledgment can in any case be directed well.

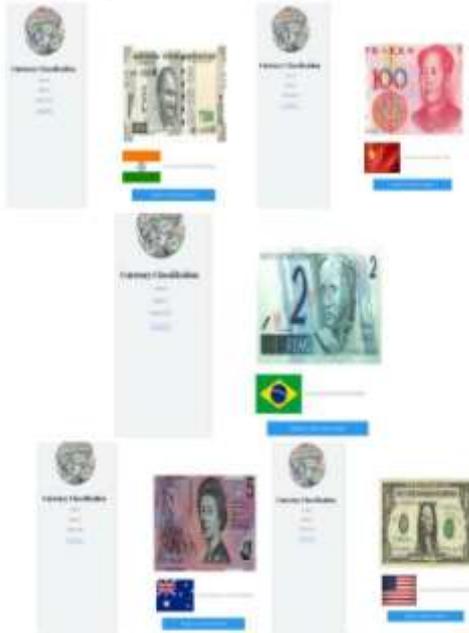


Figure 7. Output Window

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