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Smart Mathematics Tutor Using Machine Learning

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Abstract: ***A study has found that students have lack of interactive learning and does not show much interest in learning things. Interactive Learning is a pedagogical approach that incorporates social networking and urban computing into course design and delivery. Interactive Learning has evolved out of the hyper-growth in the use of digital technology and virtual communication, particularly by students. To solve the above-mentioned problem, we are building a GUI which helps the students in learning maths and they can easily remember all the formulas. They can draw the shapes in the application which recognizes the shape gives all the related information like list of formulas. This helps the students to learn interactively.***
Keywords: CNN, Tensorflow and Dense Layers

I. INTRODUCTION

Nationally, the average age at which kids get a phone of their own is 10.3 years. One thing expert agree on is that later is better. Once you open the door, it can be very difficult to close. A 2016 study found that most kids are getting their first social media account between the ages of 10 and 12. This ich will ultimately lead to unproductive work. Due to lack of interactive learning students doesn't show much interest in learning things. Interactive Learning is a pedagogical approach that incorporates social networking and urban computing into course design and delivery. Interactive Learning has evolved out of the hyper-growth in the use of digital technology and virtual communication, particularly by students. Beginning around 2000, students entering institutes of higher education have expected that interactive learning will be an integral part of their education. The use of interactive technology in learning for these students is as natural as using a pencil and paper were to past generations.

To solve the above-mentioned problem, we are building a GUI which helps the students in learning maths and they can easily remember all the formulas. They can draw the shapes in the application which recognizes the shape gives all the related information like list of formulas. This helps the students to learn interactively.

Smart Maths tutor system is a web based graphical user interface where a user gets to draw shapes of mathematical figures such as square, triangle, circle etc. for which the output would be related formulas to the drawn figure.

Our project 'Smart Mathematics Tutor' includes shape recognition system. The aim of our project is to create tutoring assistant which will prove to be effective in helping students to practice shape recognition exercises. For the assistant to provide the needed guidance to a student who are learning to recognise the shapes, it is necessary to take into consideration both the shape that is needed to be recognised, as well as the name of the shape proposed by the learner.

This tutoring assistant will use a shape generator designed to test the knowledge of the student. This shape generator is created by our team to form different shape so that the students can try guess the name of the shapes and find if their answer was correct or not which will help them build their knowledge in an easy way. Shape detection is the identification of a shape in the image along with its localisation and classification. It has wide spread applications and is a critical component for AI based software systems. And by using this shape detection our tutor will help students learn about different shapes.

A. Problem Statement

Shape detection is the identification of a shape in the image along with its localization and classification. It has wide spread applications and is a critical component for AI based software systems. This report seeks to perform a rigorous survey of modern shape detection algorithms that use Machine learning. As part of the survey, the topics explored include various algorithms, quality metrics, speed/size trade-offs and training methodologies. This report focuses on the two types of Shape detection algorithms - CNN and Data Pre-processing. Techniques to construct detectors that are portable and fast on low powered devices are also addressed by exploring new lightweight convolutional base architectures. Ultimately, a rigorous review of the strengths and weaknesses of each detector leads us to the present state of the art.

B. Objectives

The Objectives of our project are:

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1) Know fundamental concepts and techniques of Convolutional Neural Network along with GUI creation and basic of OpenCV.
2) Gain a broad understanding of image data.
3) Know how to pre-process the data as per the requirements.
4) Know how to build a web application using Flask framework.

C. *Proposed System*

"Shape Matching and Object Recognition Using Shape Contexts", proposed shape detection method using a feature called shape context. Shape context describes all boundary points of a shape with respect to any single boundary point. Shape recognition can be achieved by matching this feature with a prior knowledge of the shape context of the boundary points of the object.

II. LITERATURE SURVEY

1) Jose Paladines and Jaime Ramirez " A Systematic Literature Review of Intelligent Tutoring Systems With Dialogue in Natural Language" (2020). Intelligent tutoring systems (ITSs) are computer programs that provide instruction adapted to the needs of individual students. Dialog systems are computer programs that communicate with human users by using natural language. This paper presents a systematic literature review to address ITSs that incorporate dialog systems and have been implemented in the last twenty years.
2) Lu Guo, Dong Wang Fei Gu, Yazheng Li, Yezhu Wang and Rongting Zhou "Evolution and trends in intelligent tutoring systems research:a multidisciplinary and scientometric view" (2021). Intelligent tutoring systems (ITSs) are a promising integrated educational tool for customizing formal education using intelligent instruction or feedback. In recent decades, ITSs have transformed teaching and learning and associated research. This study examined the evolution and future trends of ITS research with scientometric methods. First, a dataset comprising 1173 relevant publications was compiled from the Web of Science Core Collection databases (including the Science Citation Index Expanded and the Social Science Citation Index). Then, the publication distributions by time, author, institution, country/ region, and knowledge sources were analyzed to reveal the multidisciplinary integration paths. Dataset co-occurrence and co-citation analyses were conducted to identify the most popular research issues, the research chronology, and the emerging trends.
3) Nour N AbuEloun, Samy S Abu Naser "Mathematics intelligent tutoring system" (2017). In these days, there is an increasing technological development in intelligent tutoring systems. This field has become interesting to many researchers. In this paper, we present an intelligent tutoring system for teaching mathematics that help students understand the basics of math and that helps a lot of students of all ages to understand the topic because it's important for students of adding and subtracting. Through which the student will be able to study the course and solve related problems. An evaluation of the intelligent tutoring systems was carried out and the results were encouraging.
4) Calvin L. King, Vincent, Kelvin, Harco L. H. S. Warnars, Nurulhuda Nordin and Wiranto H. Utomo "Intelligent Tutoring System: Learning Math for 6th-Grade Primary School Students" (2021). This paper proposes a web-based application designed to help elementary school students who have difficulty learning online independently and also their parents who are currently having difficulty teaching their children to study at home online, especially at this time of difficulty with a pandemic outbreak like COVID-19; this time does not allow for physical meetings for the learning process in primary schools. In this paper, we only focus on mathematics because based on several other studies, it is very difficult and important to learn mathematics at the beginning of educational activities such as at the elementary school level. In this paper, the system is modeled using the Unified Modeling Language (UML) tool in the form of a use case diagram which is used to describe the proposed business process and uses class diagrams to describe the database model diagram. In this case, the class diagram is used to describe the data in the class diagram where each class refers to a table in the database.

5) Janvi Madhok, Kashmira Mathur, Goutam Gupta, Deepika Gupta "A LITERATURE SURVEY ON ONLINE PLATFORM: BRIGHT SPARKS TUTORING" (2022). This paper introduces Bright Sparks Tutoring, along with their typical architecture, and concludes with a broad discussion on wide-spanning focus areas for future developmental research. This Platform is a combination of various micro services for the overall development of a student's academic advancement. It consists of all the information that a developer should have while working on a project and for the enhancement and sharpening of the developer's skill as well. This platform can be used by beginners to advance coders. Those who are willing to start a carrier in this field,

They will also get all the required information and those who already have a strong back can sharpen their skill set more and can take it to a more advance level. Moreover, Users will also get placement opportunities via us and can attend webinars on tech topic. They will also get 24 x 7 supports from the admin using our community channels.

6) Dimitrios Mastorodimos and Savvas A. Chatzichristofis "Studying Affective Tutoring Systems for Mathematical Concepts" (2019). Students face difficulties in learning mathematical processes. As a result, they have negative emotions toward mathematics. The use of technology is employed to change the student's attitude toward mathematics. Some methods utilize intelligent tutoring systems to recognize student's emotional state and adapt the learning process accordingly. These systems, known as affective tutoring systems (ATSs), sense the emotional state of a student and then intelligently attempt to suggest appropriate strategies that can guide the learning process and ultimately shift the negative attitude of students toward mathematical learning. This article presents a survey of ATSs, which teach mathematic content, and tries to find common elements among them. It examines the kind and the number of student's emotions that can be recognized and the strategies and methods that these ATSs use to recognize student's emotional state. There are findings that agree with other studies about the recognized emotions and the methods that are used.

7) Richard West, Chair, Peter J. Rich, Stephen Yanchar "Richard West, Chair, Peter J. Rich, Stephen Yanchar" (2017). This paper sought to accomplish three goals. First, it provided a systematic, comparative review of several intelligent tutoring systems (ITS). Second, it summarized problems and solutions presented and solved by developers of ITS by consolidating the knowledge of the field into a single review. Third, it provided a unified language from which ITS can be reviewed and understood in the same context. The findings of this review centered on the 5-Component Framework. The first component, the domain model, showed that most ITS are focused on science, technology, and mathematics. Within these fields, ITS generally have mastery learning as the desired level of understanding. The second component, the tutor model, showed that constructivism is the theoretical strategy that informs most ITS. The tutoring tactics employed in the ITS stem from this paradigm. The third component, the student model, describes the several ways ITS infer what a student knows. It described the variety of data that is collected by an ITS and how it is used to build the student model. The fourth component, the interface, revealed that most ITS are now web-based, but vary in their capacity to interact with students. It also showed that user experience is underreported and ought to be included more in the research. Finally, the fifth component, learning gains, demonstrated that ITS are capable of producing learning gains equivalent to a human tutor. However, reporting learning gains does not seem to be a focus of the literature.

8) Lorella Giannandrea and arilena Sansoni "A literature review on Intelligent Tutoring Systems and on student profiling " (2019). Personalization represents a discussed topic among the scientific community that deals with Intelligent Tutoring Systems (ITS). To allow a meaningful personalization ITS requires good procedures to generate detailed user profiles. User profiles are built referring to different models that focus on various characteristics of the students, related to various aspects that are considered crucial during the learning process. The aim of this paper is to outline a detailed overview on the main progresses made in the field of user modeling and user profiling.

III. SYSTEM DESIGN

A) System Architecture

The figure 1 depicts the architectural diagram of proposed system. System designs the main aim of this structure incorporated in study can fetch out data from economic news and propose this sets into prognosticate model. Major phases in formulated system include data collection and pre-processing, feature and factor selection and price appraisal and prediction. In the initial hand, news, financial and market data are gathered and processed. In Further aspect, unstructured documents are modified into structured extract by CNN classification. Data retrieval and pre-processing in data retrieval, datasets can be fetched such of news data, black gold price data and market data. Dataset from news can be retrieved through headlines as it is easier to obtain and justifies in one line. Factors that affect the reduction are expert business, stock market and later business. Sentimental Analysis In this era of modernization, big data is also assisting through study of sentiment analysis which focuses on retrieving data through news and proposing prediction model. In this kind of analysis dictionary-based approach is accounted to gather the data regarding markets and essential factors affecting it. In case of trend prediction, the sentiment and prediction models are considered as variables. Back Propagation Back-propagation is considered as an algorithm which can be used for the purpose of training feed forward neural networks for prognosticate learning model. This leads to the attainably use gradient methods to teach multi – layer networks, by modifying weights to minimum loss.

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The process fetches the inputs and outputs and modify its inner state that will be capable enough to calculate the output that will be very precise to the expected output. Back propagation can also be described as "backward propagation of errors." It is a natural function to teach artificial neural networks. The forecasting can be done with Tensorflow which is followed by getting the data, generating features, generating ML model, training the ML model and testing and predicting with ml model. Movement of the price which can fall and rise can be termed as the outcome of CNN classification. Generally the activity of price can be specified by: Mt = {0 , pt < pt-1 }{1, pt >= pt- 1}.

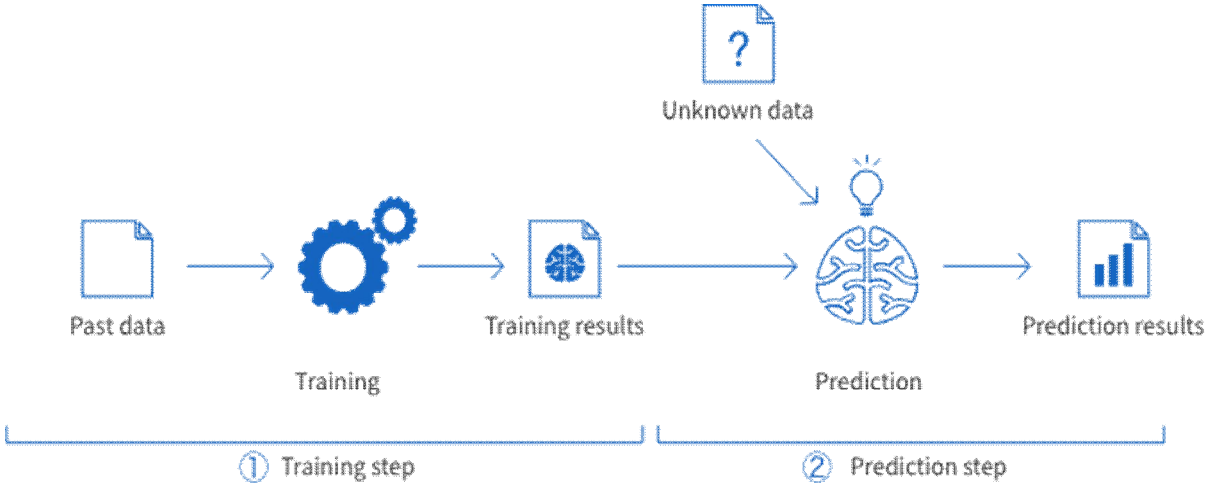


Fig 1 Architecture of proposed System

B. Flowchart

1) *Data Collection :* ML depends heavily on data, without data, it is impossible for a machine to learn. It is the most crucial aspect that makes algorithm training possible. In Machine Learning projects, we need a training data set. It is the actual data set used to train the model for performing various actions. Collect datasets from different open sources like kaggle.com, data.gov, UCI machine learning repository etc. The dataset contains three classes: 'circle', 'square' and 'triangle'.
2) *Image Pre-processing:* Image data augmentation is a technique that can be used to artificially expand the size of a training dataset by creating modified versions of images in the dataset. The Keras deep learning neural network library provides the capability to fit models using image data augmentation via the ImageDataGenerator class. Import the ImageDataGenerator class fromkeras.
3) *Model Building:* Building Convolutional Neural Networking which contains a input layer along with the convolution, maxpooling and finally a output layer. Add CNN Layers. Add a convolution layer with activation function as “rely” and with a small filter size (3,3) and number of filters (32) followed by a max pooling layer. Maxpool layer is used to down sample the input. Flatten layer flattens the input. Does not affect the batch size.
4) *Add Dense Layer:* Dense layer is deeply connected neural network layer. It is most common and frequently used layer. Keras provides a simple method, summary to get the full information about the model and its layers.
5) *Compiling the Model :* The compilation is the final step in creating a model. Once the compilation is done, we can move on to training phase. Loss function is used to find error or deviation in the learning process. Kera requires loss function during model compilation process. Optimization is an important process which optimize the input weights by comparing the prediction and the loss function. Here we are using Adam optimizer. Metrics is used to evaluate the performance of your model. It is similar to loss function, but not used in training process.
6) *Train the Model:* Now, let us train our model with our image dataset. fit_generator functions used to train a deep learning neural network.
7) *Save the Model:* The model is saved with .h5 extension. An H5 file is a data file saved in the Hierarchical Data Format (HDF). It contains multidimensional arrays of scientific data.
8) *Test the Model:* Evaluation is a process during development of the model to check whether the model is best fit for the given problem and corresponding data. Load the saved model using load_model. Taking an image as input and checking the results. By using the model, we are predicting the output for the given input image. The predicted class index name will be printed here.

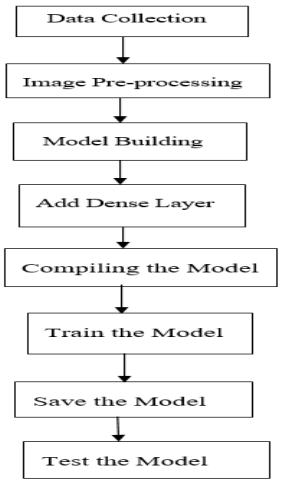


Fig. 2 Flowchart of Smart Mathematics Tutor system

IV. IMPLEMENTATION

ALGORITHM

Convolutional Neural Network (CNN)

Convolutional neural framework is one of the principal categories for the photo's affirmation and pictures portrayals. Articles disclosures, affirmation faces, etc., are a bit of the regions where CNNs are commonly utilized. The fig 3 shows the Neural Network with various convolutional layers. 1n certainty, the possibility of significant learning CNN models t can be used for train and attempted, every data picture will be adhered to the course of action of convolution layers with procedures (Kernals), Pooling, totally related layers (FC) by applying Soft max work can arrange an article with probabilistic characteristics runs some place in the scope of 0 and 1. The underneath figure is a complete stream of CNN to process an information picture and requests the articles subject to values.

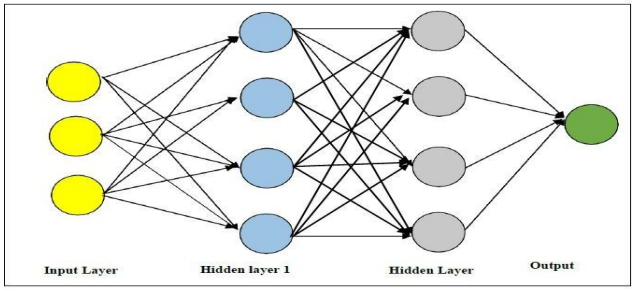


Fig 3 Neural Network with numerous convolutional layers.

V. RESULTS AND SCREENSHOTS

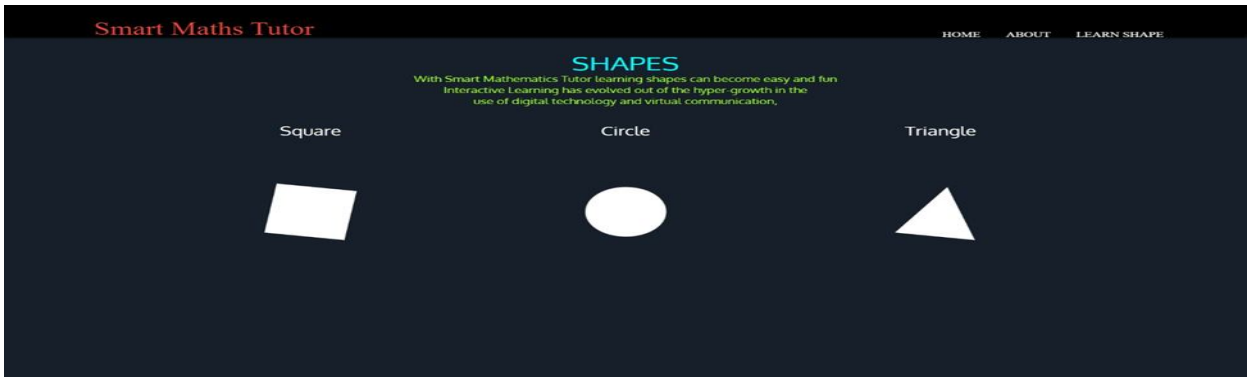


Fig 4 Home page

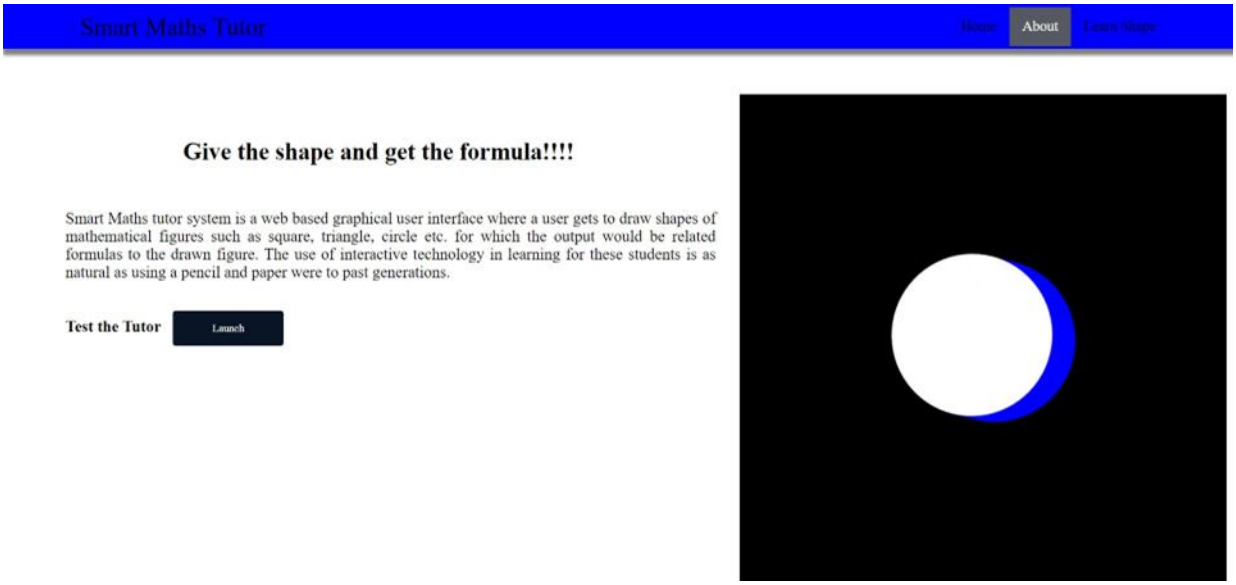


Fig 5 About page

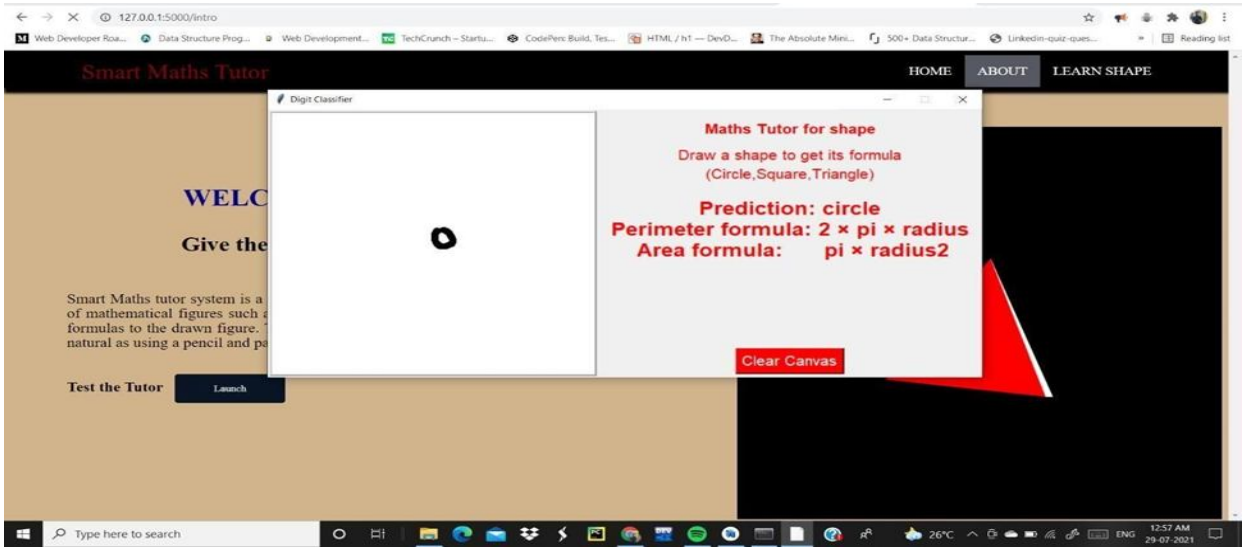


Fig 6 Prediction of circle

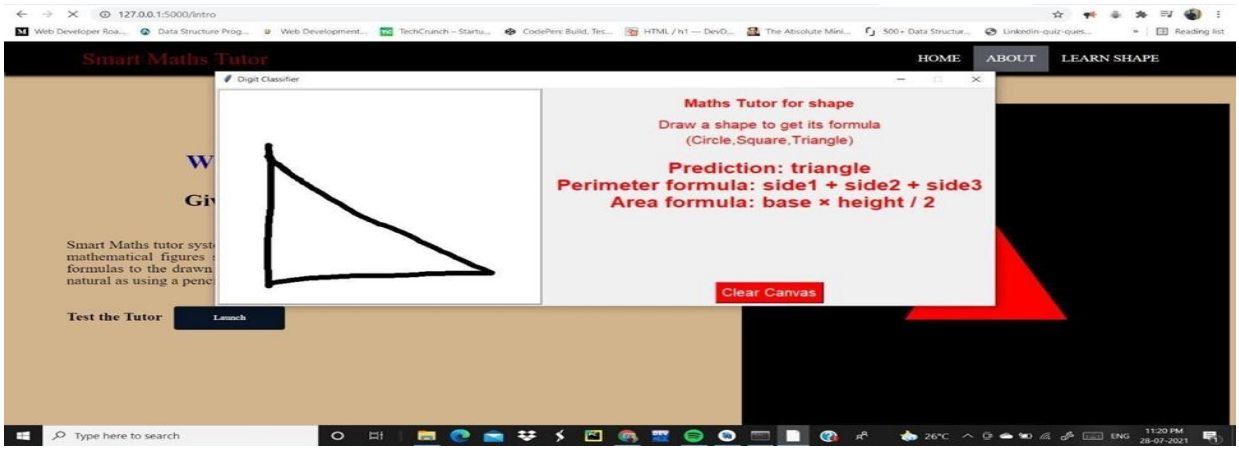


Fig 7 Prediction of triangle

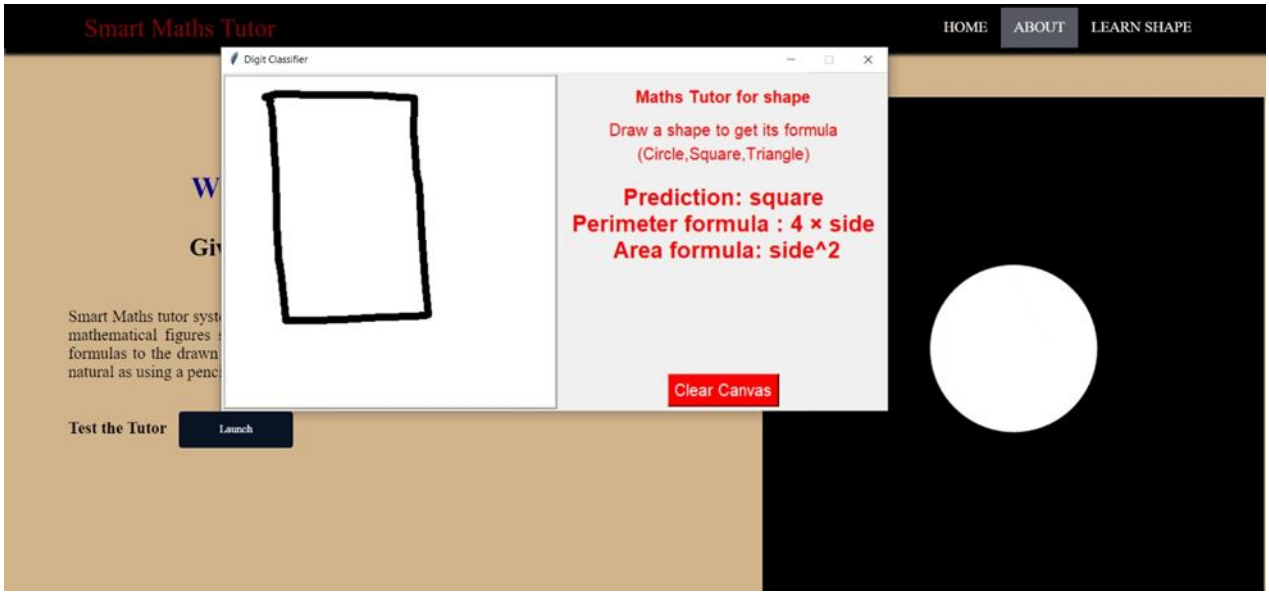


Fig 8 Prediction of square

VI. CONCLUSIONS

We presented a new shape description and classification method. Key characteristics of our approach are the compound descriptor and classifier that join the region and contour-based features. We suggested an online learning method to extend the representative set and increase performance. We proposed a representative set optimizing algorithm as well.

The core idea behind our method is the two-level description and classification: for an input shape, low-level, global statistical information is extracted to roughly select the set of similar objects and to reject obviously different templates. In the second stage, local edge information is investigated to find the closest known shape but with the ability to reject the match. The refusal is based on the acceptance radius that is specified individually for every item in the representative set according to the properties of the local proximity in the feature set.

Results demonstrate a high precision rate (99.83%) and an acceptable recall rate (60.53%), which fulfil the requirements for a safety-oriented visual application processing an image flow. The reason to have lower cover is that input frames contain highly deformed shapes, which, for sake of reliability, are classified as nonrelevant inputs. The recall is acceptable, as long as a continuous input is available. Compared to other classifiers, none of the tested ones could outperform the AL-NN in precision, and the same recall could only be reproduced with significantly lower precision. If a final decision is made based on multiple input frames and multiple clues, the false-positive error can be minimized to be practically negligible.

VII. FUTURE SCOPE

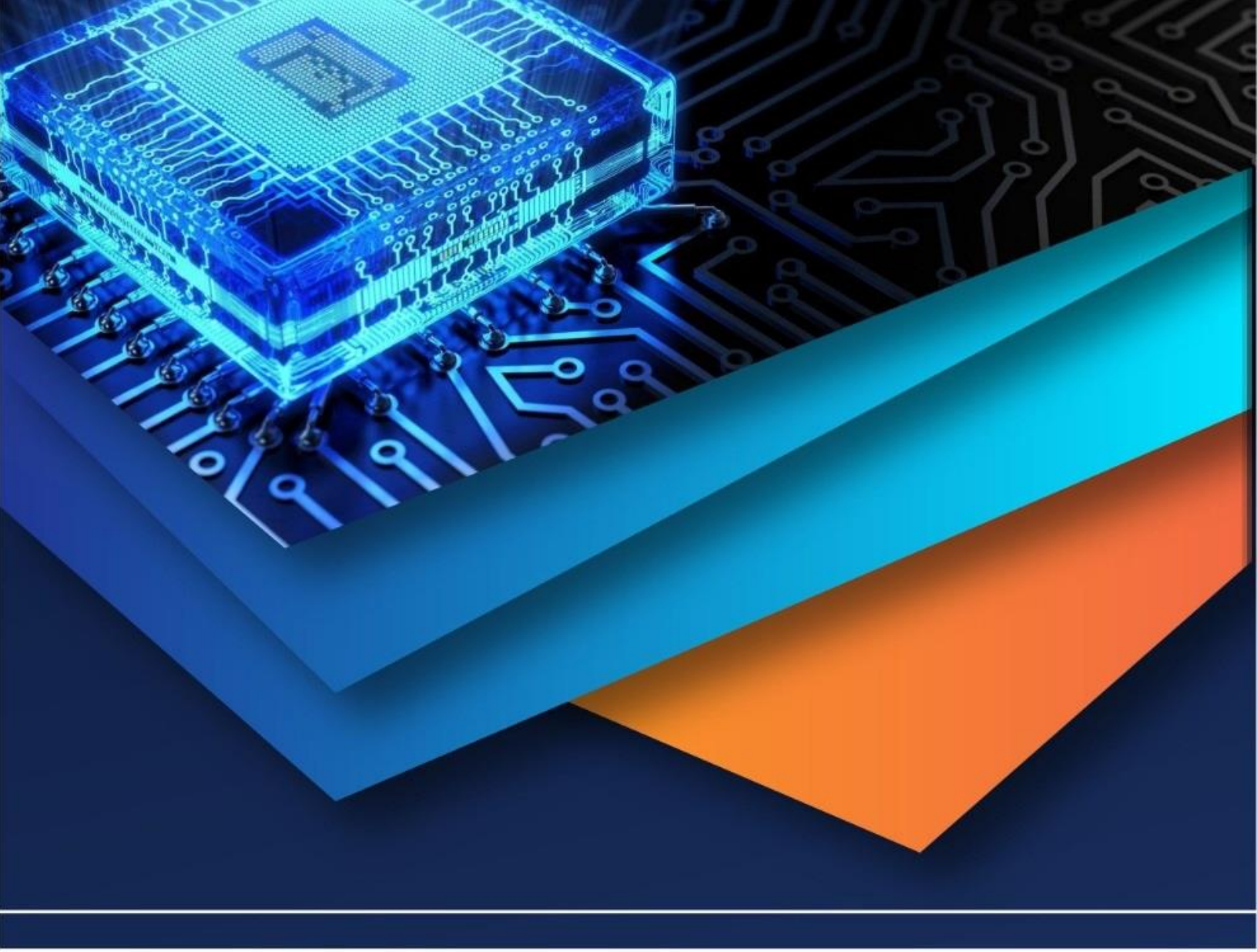
This report elucidates shape detection, one of the highly computational applications that has become possible in recent years. Although detecting shapes in a given image or video frame has been around for years, it is becoming more widespread across a range of industries now more than ever before. Shape detection in images and video has received lots of attention in the computer vision and pattern recognition communities over recent years. We have had great progress in the field, processing a single image used to take 20 seconds per image and today it takes less than 20 milliseconds. Of the problems related to these fields, analysing an image and recognizing all shapes remains to be one of the most challenging ones Although the possibilities are endless when it comes to future use cases for shape detection, there are still significant challenges remaining. Herewith are some of the main useful applications of shape detection: Vehicle's Plates recognition, self-driving cars, tracking shapes, face recognition, medical imaging, shape counting, shape extraction from an image or video, person detection. The future of shape detection technology is in the process of proving itself, and much like the original Industrial Revolution, it has the potential to free people from menial jobs that can be done more efficiently and effectively by machines. It will also open up new avenues of research and operations that will reap

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additional benefits in the future. Thus, these challenges circumvent the need for a lot of training requiring a massive number of datasets to serve more nuanced tasks, with its continued evolution, along with the devices and techniques that make it possible, it could soon become the next big thing in the future.

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