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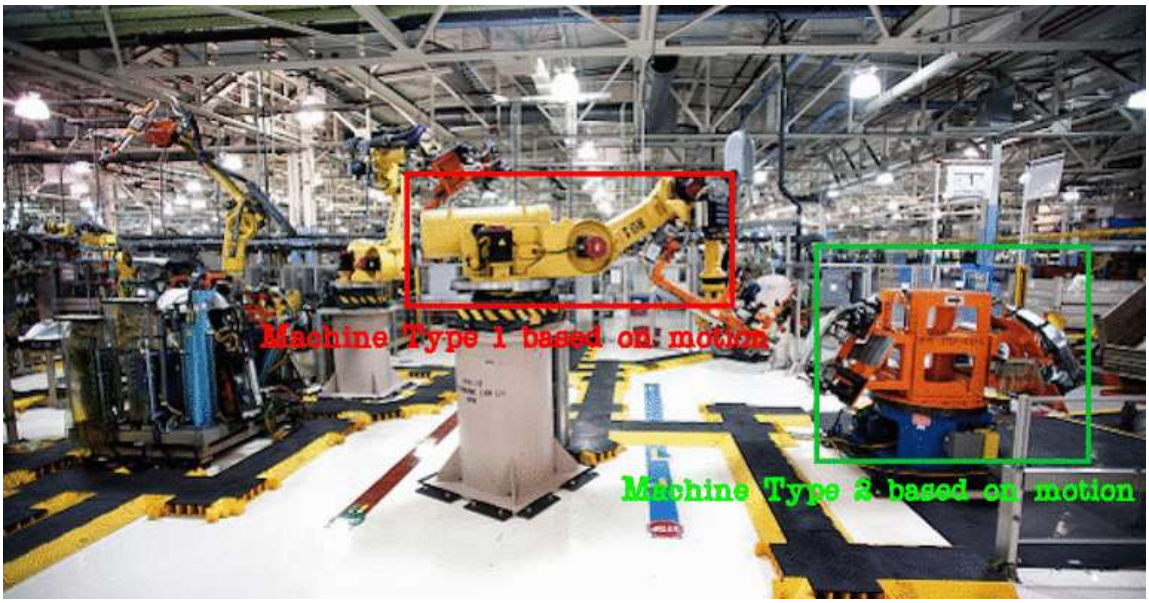
ABSTRACT

The fundamentals of computer vision have been used in this project to track six different shades: red, blue, green, white, black, and yellow. When the code is run, a window will open using the webcam, so if there is any colour from Red, Blue, Green, White, Black, and Yellow or all six simultaneously, we will see a rectangular box of Red colour for tracking of Red, Blue rectangular box for tracking of Blue, Green colour for tracking of Green, White colour for tracking of White, Black colour for tracking of Black, and Yellow colour for tracking of Yellow bound the corresponding colour object and there will be text on the top of the object showing the name of colour. This will be helpful in colour identification and robotics. This type of system is also used in driverless cars to detect traffic lights and vehicle backlights and determine whether it should stop, start, or keep driving. This has many applications in various industries, which include picking and placing different coloured objects with a robotics arm. OpenCV is a large open-source library for computer vision, machine learning, and image analysis, and it currently plays a critical function in real-time operations, which are crucial in today's systems. It can be used to detect items, faces, and even human writings in pictures and recordings. Python can process the OpenCV array structure for examination when it is combined with other modules such as NumPy. OpenCV is the computer vision library that I used in this project with Python.

INTRODUCTION



(Object detection using Python OpenCV)

OpenCV typically records photos and videos in BGR format, which is an 8-bit unsigned integer. Blue, green, red, white, black, and yellow matrices having integer values ranging from 0 to 255 is being used to represent captured images. The HSV colour space is made up of three matrices: hue, saturation, and value. The value ranges for 'hue,' 'saturation,' and 'value' in OpenCV are 0-179, 0-255, and 0-255, respectively. 'Hue' is the colour, 'saturation' is how much of that colour is combined with white, and 'value' is how much of that colour is mixed with black.

The amount of red, green, and blue contained in a colour is described by the RGB colour space. Colours are described in terms of Hue, Saturation, and Value in the HSV colour system. In companies where products are mass-produced on a big scale, sorting of objects is required in instances where colour description

is critical. Automation makes this procedure easier. Image processing techniques can be used to create mechatronics systems. Different properties such as shape, colour, and weight are used to classify objects. Our goal is to categorise items based on their colour. Many industries, such as crayon factories and agricultural machinery such as rice sorters, beans sorters, and peanut sorters, use colour-based sorting.

The usefulness and research of computer vision in the field of industrial, academics is on the rise these days. Any such design can be utilised for a variety of applications based on vision through a computer for the goal of identifying, distinguishing, and collecting diverse objects based on colour, shape, and size, which are the major factors in the industrial environment. With the aid of an OpenCV, this can be achieved. This design approach can be used in a variety of fields, including defence, industrial applications, games, automation, security, and monitoring. Even in the fields of radar and navigation, such as recognising and tracking a moving coloured object, these systems can be extremely useful. Even in the medical profession, colour detection plays a vital function, such as detecting the colour of skin, identifying a face. The main goal in factories is to determine the colour of packages travelling via a conveyor belt and to provide the quality of a specific colour package by outnumbering them. This is accomplished with a processing device, such as a Raspberry Pi, in conjunction with a USB camera for capturing the package, and a display unit for displaying the count as well as the packaging's colour. OpenCV is used to accomplish this.

WHY PYTHON?

Python is a high-level programming language for general-purpose programming that was created by "Guido van Rossum" and first released in 1991. Python has a design philosophy that emphasis code readability, as well as a syntax that allows programmers to express concepts in fewer lines of code, with significant whitespace. It has structures that allow clear programming at both small and large sizes.

Python has a dynamic type system and memory management that is automated. It features a big and extensive standard library and supports several programming paradigms, including object-oriented, imperative, functional, and procedural. For a wide range of operating systems, Python interpreters are available. Python's reference version, as well as nearly all of its variant implementations, is open-source software with a community-based development process. The Python Software Foundation is a non-profit organisation that manages Python.

Python is a dynamic, high-level, and interpreted programming language with a wide range of applications. It facilitates the development of applications using an object-oriented programming style. It's simple and straightforward to learn, and it comes with a plethora of high-level data structures. The Application Programmer's Interface to Python provides C and C++ programmers with various levels of access to the Python interpreter. The API can also be used from C++, however for the sake of brevity, it is referred to as the Python/C API. The Python/C API is used for two fundamentally different reasons. The first reason is because extension modules, which are C modules that enhance the Python interpreter, can be written for specialised applications. This is most likely the most

prevalent application. The second reason is to utilise Python as a component within a bigger application; this is known as embedding Python in an application.

VERSIONS OF PYTHON

Python 2.0 was launched on October 16, 2000, with a number of significant new features, including cycle detection, garbage collection, and Unicode support. The development process got more transparent and community-supported with this version.

After a lengthy testing process, Python 3.0 (also known as Python 3000 or py3k) was published on December 3, 2008. It is a significant revision of the language that is not fully backwards compatible with prior versions. Many of its important features have been backported to Python 2.6.x and 2.7.x, and Python 3 releases contain the 2 to 3 utilities, which simplifies the conversion of Python 2 code to Python 3. The end-of-life date (also referred as the sunset date) for Python 2.7 was originally intended for 2015 but was subsequently pushed back to 2020 due to concerns that a significant corpus of existing code would be difficult to transfer to Python 3. Google said in January 2017 that it was working on a Python 2.7 to replace Tran's compiler in order to increase performance under concurrent workloads. Changes to UTF-8 were made in Python 3.6 (on Windows, PEP 528 and PEP 529), and Python 3.7.0b1 (PEP 540) introduces a new "UTF-8 Mode" feature (and overrides POSIX locale).

PERKS OF PYTHON

- **There are numerous libraries and frameworks available:** Many libraries and frameworks are included with the Python language, making development a piece of cake. This also

helps you save a lot of time. NumPy, which is used for scientific calculations; SciPy, which is used for more complex computations; and scikit, which is used to study data mining and data analysis, are the most popular libraries. TensorFlow, CNTK, and Apache Spark are just a few of the sophisticated frameworks that these libraries work with. When it comes to machine and deep learning applications, these tools and frameworks are crucial.

- **Convenient:** Python code is concise and legible even by inexperienced programmers, which is advantageous for machine and deep learning projects. When compared to other programming languages, Python allows for faster application development due to its simple syntax. It also allows the developer to test algorithms without having to implement them. For collaborative coding, readable code is also essential. On a large project, many people can collaborate.

- **The extensive online support:** Python is an open-source programming language with a wealth of tools and high-quality documentation available all over the world. It also has a huge and active developer community that offers help at any stage of development. Most scientists use Python for Machine Learning and Deep Learning projects, which means Python communities are home to the world's best minds.

- **Integrations that are adaptable:** Python projects can be easily integrated with systems written in a variety of computer languages. This makes blending it with other AI projects written in other languages much easier. Python can also be used to perform cross-language jobs because it is extendable and portable. Python's versatility makes training machine learning models simple for data scientists and developers.

- **Visualization tools:** Python includes many libraries for visualisation. Some of these frameworks provide excellent visualisation features. It's critical in AI, Machine Learning, and Deep Learning to display data in a human-readable style. Python is thus an excellent choice for implementing this feature. Data scientists can use libraries like Matplotlib to create charts, histograms, and plots to better convey data and visualisation. Additionally, Python's various APIs aid in the visualisation process.

- **Rapid code tests:** Python comes with a plethora of code review and testing tools. Developers can easily verify the code's correctness and quality. Because AI projects are time-consuming, a well-structured environment for testing and bug detection is required. Python is the best language for this because it has these features.

APPLICATION BACKGROUND

PyCharm

PyCharm is a computer programming integrated development environment (IDE) that focuses on the Python programming language. Jet Brains, a Czech business, developed it. It includes code analysis, a graphical debugger, an integrated unit tester, version control system integration, and support for Django web development. PyCharm is a Python programmers' cross-platform integrated programming environment (IDE). It has everything a Python programmer needs to be productive, such as a great programming text editor, syntax highlighting, code completion, project navigation, database tooling, and web development project options. PyCharm is a Python integrated development environment (IDE) that allows you to write programmes and/or build software. It was created by JetBrains and includes an assistive toolkit and built-in capabilities similar to those found in most IDEs, such as eclipse. It also supports JavaScript, Coffee Script, Typescript, CSS, and other scripting languages.

IDLE Python

Python's Integrated Development and Learning Environment is known as IDLE. IDLE is a Python 2.x or Python 3 integrated development environment (IDE) for editing and running scripts. With the Python interpreter, the IDLE GUI (graphical user interface) is installed automatically. IDLE was built from the ground up to work with Python. IDLE includes sophisticated syntax highlighting as well as other capabilities to aid in the development of Python programmes. The Shell window and the Editor window are the two main window kinds in IDLE. Multiple editor windows can be open at the same time. A subclass of edit window is the output window, which is used for Edit / Find in Files. They have the same top menu as Editor windows, but their default title and context menu are different. The menus in IDLE alter dynamically depending on whatever window is currently selected. Each of the menus listed below is labelled with the window type it is linked with.

Jupyter Notebook

Jupyter Notebook is an interactive computing environment in which code execution, rich text, mathematics, graphs, and rich media can all be combined. The notebook takes interactive computing in a qualitatively new direction by providing a web-based application for capturing the entire

computation process, including designing, documenting, and executing code, as well as conveying the results.

NumPy

NumPy is a Python library that adds support for huge, multi-dimensional arrays and matrices, as well as a large number of high-level mathematical functions to operate on these arrays. Numeric, NumPy's forerunner, was built by Jim Hugunin with help from a number of other people. Travis Oliphant built NumPy in 2005 by heavily modifying Numeric and combining features from the competitor Numarray. NumPy is an open-source project with a large number of contributors. NumPy is a financially supported NumFOCUS project.

The Python programming language was not created with numerical computation in mind, but it quickly caught the interest of the scientific and engineering communities. The special interest group (SIG) matrix-sig was created in 1995 with the goal of developing an array computing package; among its members was Guido van Rossum, the Python author and maintainer, who improved Python's vocabulary (especially the indexing syntax) to make array computing easier.

OS MODULE

The Python OS module allows the user and the operating system to communicate with one another. It includes a number of helpful OS functions for performing OS-related operations and retrieving information about the operating system. The operating system is covered by Python's basic utility modules. This module provides a portable mechanism to access operating system-specific functions. We can operate with files and directories using the Python OS module.

OpenCV

Python is a general-purpose programming language created by Guido van Rossum that has quickly gained popularity due to its simplicity and readability of code. It allows the programmer to communicate his thoughts in fewer lines of code while maintaining readability. Python is slower than other languages like C/C++. Python may also be easily expanded with C/C++, which is a significant feature. This capability allows us to build computationally complex C/C++ code and wrap it in a Python wrapper, which we can then utilise as Python modules. This provides us with two benefits: one, our code is as fast as original C/C++ code (due to the actual C++ code running in the background), and second,

Python is incredibly simple to code. OpenCV- Python is a Python wrapper around the original C++ implementation. Numpy's assistance makes the work even easier. Numpy is a numerical operations package that is highly efficient. All array structures in OpenCV are translated to and from Numpy arrays. So, whatever Numpy operations you can perform, you can combine them with OpenCV to expand your arsenal of weaponry. Other libraries that support Numpy, like as SciPy and Matplotlib, can also be used with this.

IMPLEMENTATION

Technology Used

Python is a high-level programming language that is interpreted, interactive, object-oriented, and general-purpose. Guido van Rossum designed it between 1985 and 1990. Python source code is also available under the GNU General Public License, just like Perl (GPL). This tutorial provides sufficient knowledge of the Python programming language.

Python is a scripting language that is high-level, interpreted, interactive, and object-oriented. Python is intended to be a very understandable language. It typically uses English terms instead of punctuation, and it has fewer syntactical structures than other languages.

Machine Learning

Machine learning is an application of artificial intelligence (AI) that allows a system to enhance and develop on its own without having to be explicitly programmed. Machine learning is concerned with the creation of computer programmes that can acquire information and data on their own.

It arose from the premise that computers may learn without being programmed to perform certain tasks. It is a type of data analysis that automates the creation of analytical models. Depending on whether a learning system has access to a learning signal or feedback, machine learning tasks are often divided into two categories: Learning that is supervised. A teacher gives the computer examples of inputs and desired outcomes, with the purpose of learning a general rule that

maps inputs to outputs. The input signal can be just partially available or confined to particular feedback in special cases: Learning that is only partially supervise. Only an incomplete training signal is sent to the computer: a training set with some (typically several) of the target outputs missing.

Regression Analysis

The study or measurement of the relationship between one variable (the dependent variable) and one or more other variables (the independent variables), usually expressed as an equation with parametric coefficients for the independent variables, which can be used to predict future values of the dependent variable.

Regression analysis is a type of predictive modelling technique that looks into the relationship between a dependent (target) and an independent (s) variable (predictor). Forecasting, time series modelling, and determining the causal effect link between variables are all done with this technique. Consider the link between airplane mechanical failure and the number of airplane accidents.

RGB Colour Model

The RGB colour model is an additive colour model that combines red, green, and blue light in various ways to create a wide range of colours. The following is a list of primary colour combinations that can be used to create secondary colour:

1. Yellow is made up of the colours red and green.
2. Cyan is made up of two colours: green and blue.
3. Magenta = Blue + Red

White light is created when red, green, and blue are combined in an equal amount.

HSV Colour Model

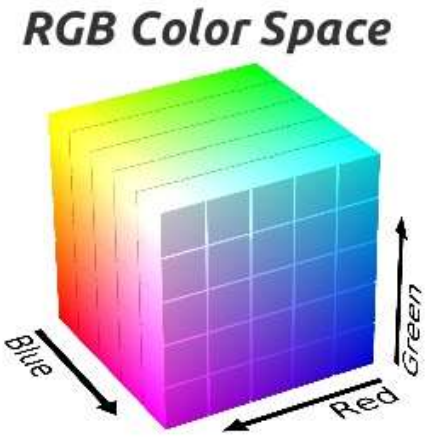
The three components of the HSV colour space are as follows:
H stands for hue (Dominant Wavelength).
S stands for Saturation (purity / colour shades)
V stands for value (Intensity).

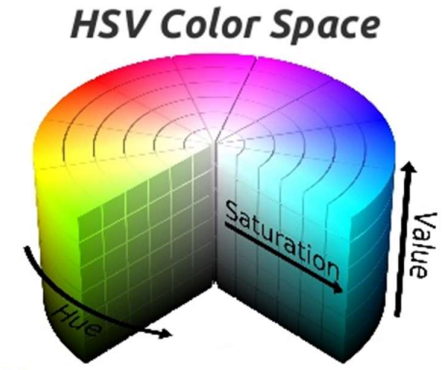
The color's hue (H) is what defines it. Saturation (S) is the percentage of grey in a colour that ranges from 0% to 100%. The value (V) component captures the quantity of light falling on it, therefore it fluctuates in response to variations in illumination. Because HSV just uses one channel to express colour, specifying colour is fairly simple.

RGB and HSV Colour Space

Pixels are the basic elements that make up a computer image. The number of pixels in an image is determined by its resolution. Each pixel in a grayscale image is defined as an 8-bit unsigned value. Three of these 8-bit unsigned values are used per pixel in a colour image. Only one channel is present in a grey image, but three channels are available in a colour image, therefore one pixel in an RGB image receives RGB values ranging from 0 to 255. If one pixel has RGB values of (255,0,0), the colour pixel is pure "RED." If a pixel's RGB values are (0,255,0), that pixel's colour is pure "GREEN." If a pixel's RGB values are (0,0,255), that pixel's colour is pure "BLUE." If a pixel's RGB values are (70,255,255), that pixel's colour is pure "YELLOW." If all of the pixels have the value (255,255,255), the colour pixel is "WHITE," and if all of the pixels have the value (0,0,0), the colour pixel is "BLACK". HSV stands for another colour space, which was created by Alvy Ray Smith in 1978. Hue, Saturation, and Value are abbreviated as HSV. Saturation represents the amount that that respective colour is mixed with white, and Value

represents the amount that that respective colour is mixed with black. Hue represents the colour, Saturation represents the amount that that respective colour is mixed with white, and Value represents the amount that that respective colour is mixed with black. It resembles human vision more closely than RGB. It's made using a non-linear RGB transformation. The HSV colour space is utilised in this project to detect the colour of packages travelling on a conveyor belt, commonly known as HSB. H and S have the same meaning in HSB as they do in HSV, while B stands for Brightness. The HSV colour space was discovered by Alvy Ray Smith in 1978. It is more analogous to human eyesight than RGB colour space. It's made via a non-linear RGB colour space transformation. In this research, the colour of the packages travelling on the conveyor belt is detected using the HSV colour space.



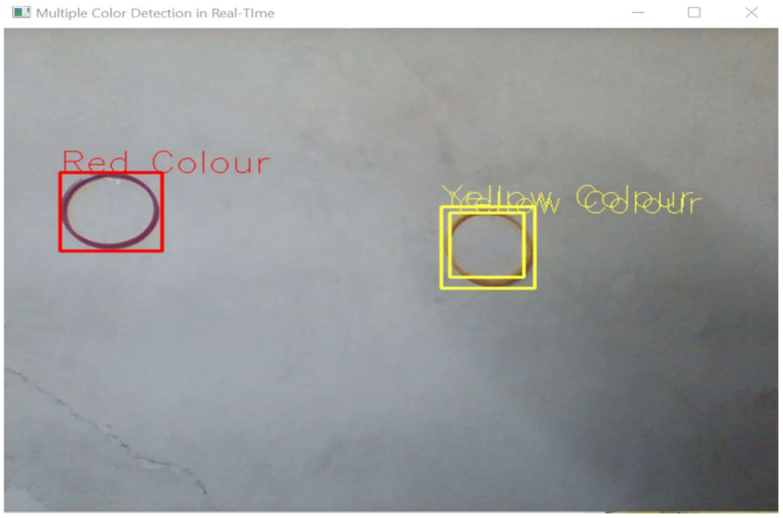


Software

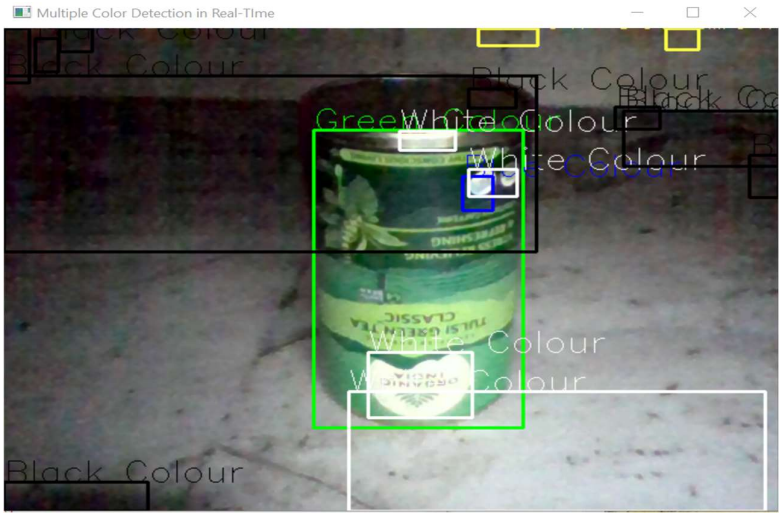
The OpenCV 3.0, Python 2.7, and Numpy Python libraries are required for this project. The OpenCV library is a computer vision library. Since the camera's input is in BGR (blue, green, and red) colours, we must convert it to HSV (hue saturation value). OpenCV collects images and videos in 8-bit, unsigned integer, and BGR formats most of the time. Blue, green, and red matrices having integer values ranging from 0 to 255 can be used to represent captured images.

The hue, saturation, and value matrices make up the HSV colour space. The three matrices' value ranges in OpenCV are 0-179, 0-255, and 0-255, respectively. Color is represented by hue, whereas saturation denotes how much of that colour is combined with white, and value denotes how much of that colour is mixed with black. The RGB colour paradigm divides colours into three categories: red, green, and blue. The HSV colour model is frequently favoured over the RGB colour model in circumstances where colour description is critical. Because we're using the HSV colour model in this project, we'll need to get the HSV of red, blue, green, white, black and yellow first. It`s important that none of the values overlap with other colours in this area.

RESULTS


Multiple Color Detection in Real-TIme
Red Colour
Yellow Colour


Multiple Color Detection in Real-TIme
Blue Colour
White Colour
White Colour


Multiple Color Detection in Real-TIme
Black Colour
White Colour
White Colour
White Colour
Black Colour

CONCLUSION

The area of colour feature detection has been explored in this project through methodologies and techniques. The RGB-value fluctuations due to the image generation process are explained by the dichromatic reflection model. Various colour models with a given amount of invariance can be generated using the model. Colour derivative vectors can be described using tensors.

I also used colour to convey importance. After colour saliency boosting, it was discovered that (less attractive) black and white structures in the image are disregarded, whereas more intriguing colour structures are identified. Finally, a classification framework based on photometrical and geometrical information has been developed to detect and classify local image structures. Simple learning algorithms yield high categorization accuracy.

This Project concludes with a discussion of strategies for resolving key difficulties in the field of colour feature detection. I'm hoping that these low-level image feature detection techniques can help with the difficult process of performing higher-level computer vision tasks like object recognition and tracking.