Real-time Upper Body and White Shirt Detection Using OpenCV in C++: A Case Study for USTP CDO

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We would like to extend a special thank you to my parents and friends for their unwavering support throughout this journey. Their unconditional support, provision of resources, and patience have been invaluable. I am grateful for the love and encouragement they have showered upon me, enabling me to overcome challenges and complete this final project for my first year in USTP CDO's Bachelor of Science in Computer Science program.

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Chapter 1: Introduction

1.1) Background of the Study

As we advance through the world with technological advancement, AI arises as one of the most amazing and intriguing advancement of humanity. A sub field that AI has is Computer Vision, in which in this field gadgets with capabilities to see through the human world are provided by algorithms and or datasets that can distinguish a certain thing from one another. As per recent technological advancement base on AI or Computer Vision some known would be Transformer-based models, Self-Supervised learning in which the computer will learn on its own, video understanding and real time applications like Augmented reality and facial recognition.

With the development and advancement of computers in this generation, open sources can be found everywhere within the internet in which anyone can have access to algorithms, data structures or to anything that they are truly interested in. By this means, due to it being open to the public, different minds from around the world have access to this data in which they can also use and develop their very own advancement in which others may also have access to and because of that publicity, the field of technology from AI to Mathematical modeling and or Computer vision are rapidly growing. With the use of basic knowledge and access with public data similar with this project, this project was possible and made done; and aside from that this study is targeting to develop a Computer vision based shirt color detector for USTP.

1.2) **Statement of the problem**

The advancement of technology has greatly benefited society, but a lack of technological understanding poses challenges for researchers and developers working on a specific project. This project requires time, dedication, and discipline, making it unsuitable for individuals lacking experience, knowledge, and commitment.

The project involves the use of C++ and the implementation of OpenCV within CPP. However, there are difficulties arising from the lack of appropriate libraries and outdated existing ones. This limitation hampers the development process of the project.

These are some points regarding the project:

•The object detection code uses haar cascade to detect the upper body of a person, with it depends the quality of the trained data and the chosen parameters. The accuracy of this project totally depends on the conditions of the user's device and area.

•Performance Considerations of this project, the current implementation processes each frame sequentially, which might limit the real-time performance, especially if the processing requirements increase.

1.3) Objectives of the Project

The objective of this research project is to develop an efficient and robust system for real-time upper body and white shirt detection in video streams. The system leverages the Haar cascade classifier for accurate identification of upper body regions in the video frames. By analyzing the regions of interest (ROI) extracted from the upper body detection, the system incorporates a white shirt detection module. The aim is to accurately identify and label white shirts within the upper body regions.

To enhance the robustness of the white shirt detection, the system addresses the challenge posed by varying lighting conditions. It incorporates techniques such as adaptive thresholding, which adaptively determines the threshold value for segmenting the white shirts from the background. This approach helps to compensate for lighting variations and ensures accurate detection of white shirts irrespective of the lighting conditions in the environment.

The performance evaluation of the system involves defining appropriate evaluation metrics, including precision and recall to measure the correctness and completeness of the detected upper bodies and white shirts. Ground truth data is collected for comparison against the detection results, enabling a quantitative analysis of the system's performance.

The results and findings of this research contribute to the advancement of real-time upper body and white shirt detection systems, particularly in scenarios where lighting variations are common. The developed system demonstrates its capability to detect upper bodies and white shirts in real-time video streams, providing potential applications in various domains such as surveillance, human-computer interaction, and fashion analysis.

1.4) Scope and Limitations

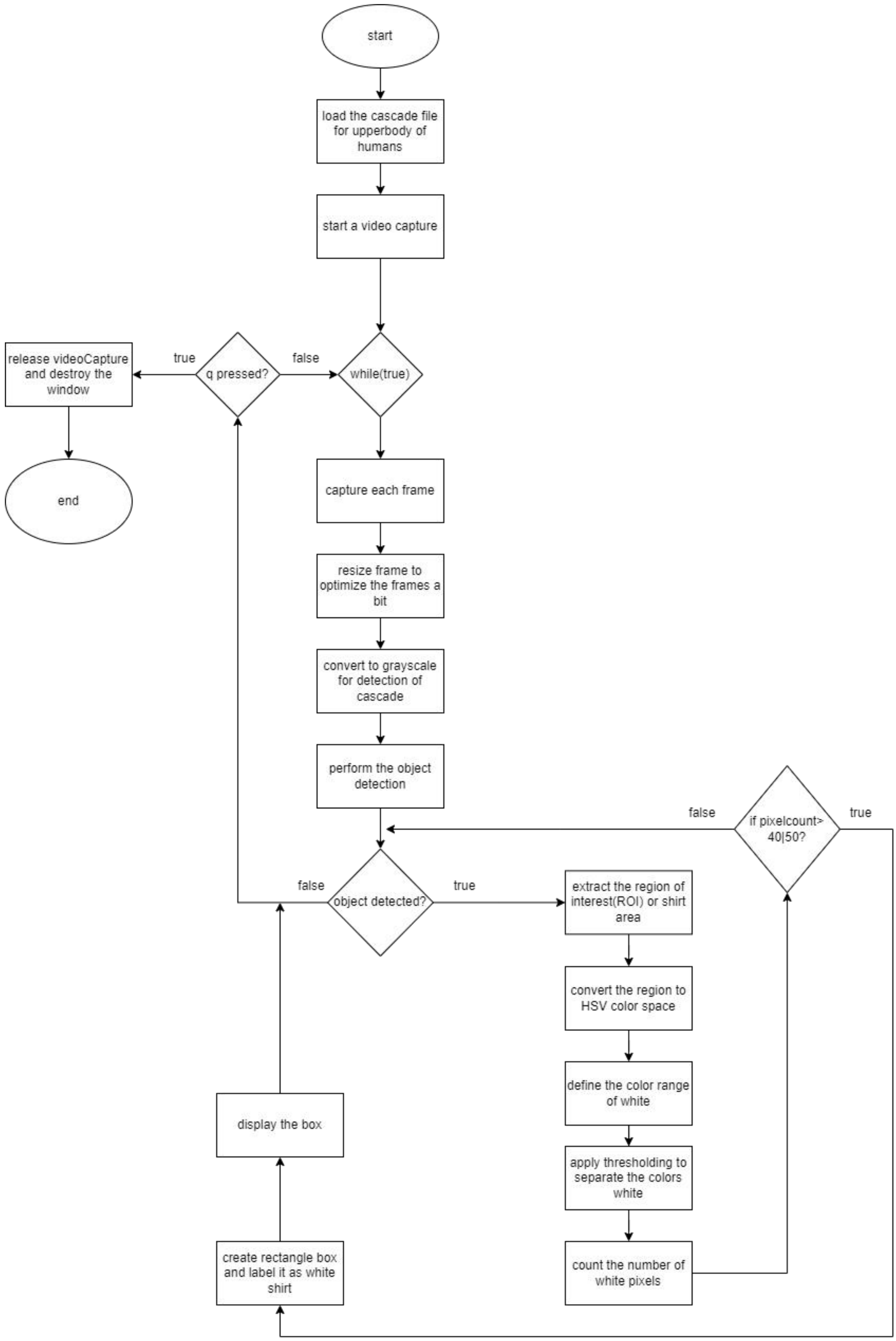
It is important to know that this research project on object detection, specifically focusing on the grounds of USTP CDO, aims to develop a modern and advanced system that can be utilized for project development and implementation in the future. The primary objective is to create an open-source code that can be accessed and tested by anyone interested in further developing and improving its functionalities. By making it open to the public, this research encourages collaboration and collective efforts to enhance the accuracy and effectiveness of the system for the benefit of its users.

However, it is crucial to acknowledge the limitations associated with this research. Firstly, the testing and implementation of the object detection system will be confined at the USTP CDO campus. This restriction is necessary as it serves as a test run, development and conceptualization for the utilization of real-world artificial intelligence (AI) or computer vision in an educational environment.

Additionally, the object detection system developed in this research will be specifically designed for identifying the colors of white for shirts. While this aspect promotes discipline within the university, it also limits the scope of the system's applicability to other scenarios or objects. The system's accuracy and reliability may be influenced by factors such as variations in lighting conditions and image quality. Also with the lack of libraries of C++ for flexibility, it limits the researcher's capabilities to implement an accurate object detection project.

Understanding these limitations is essential for researchers, developers, and potential users of the system. It allows for a realistic expectation of its capabilities and encourages further improvements and adaptations to expand its functionalities. By recognizing the constraints and considering the specific context of USTP CDO, this research project aims to lay the foundation for the development of a robust and effective object detection system that can be potentially scaled and applied in various real-world scenarios.

Chapter 2: Developer's Flowchart



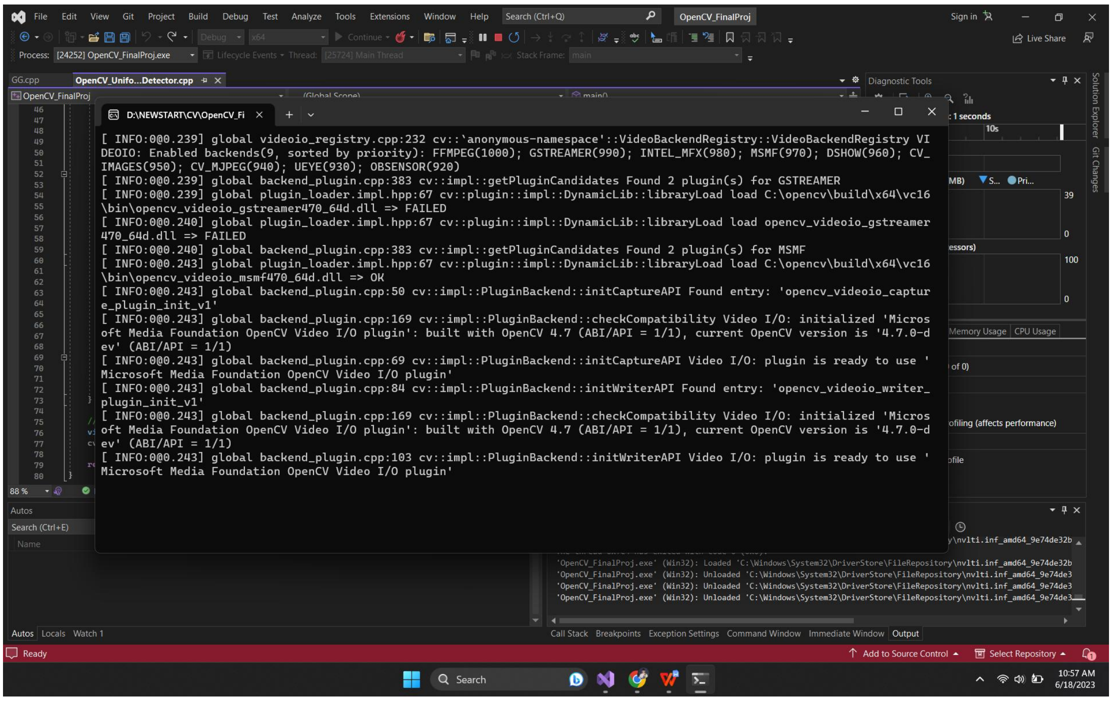
Chapter 3: Source code

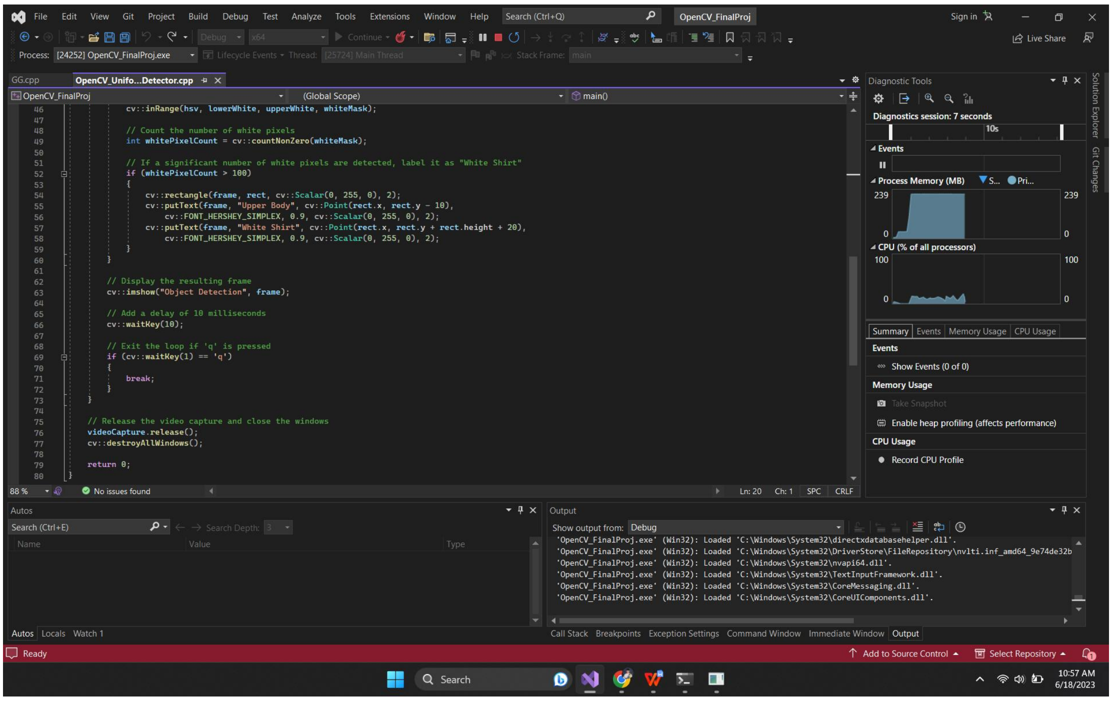
```cpp
#include <opencv2/opencv.hpp>

int main()
{
    // Load the Haar cascade XML file for the object you want to detect
    std::string cascadePath = "haarcascade_upperbody.xml";
    cv::CascadeClassifier cascade;
    cascade.load(cascadePath);

    // Start the video capture
    cv::VideoCapture videoCapture(0);

    while (true)
    {
        // Capture frame-by-frame
        cv::Mat frame;
        videoCapture.read(frame);

        // Resize frame to half the original size
        cv::resize(frame, frame, cv::Size(), 0.5, 0.5);

        // Convert the frame to grayscale for cascade detection
        cv::Mat gray;
        cv::cvtColor(frame, gray, cv::COLOR_BGR2GRAY);

        // Perform object detection
        std::vector<cv::Rect> objects;
        cascade.detectMultiScale(gray, objects, 1.05, 3, cv::CASCADE_SCALE_IMAGE, cv::Size(30, 30));

        // Detect and label white shirts
        for (const auto& rect : objects)
        {
            // Extract the region of interest (shirt area)
            cv::Mat shirtROI = frame(rect);

            // Convert the shirt region to HSV color space
            cv::Mat hsv;
            cv::cvtColor(shirtROI, hsv, cv::COLOR_BGR2HSV);

            // Define the range of white color in HSV
            cv::Scalar lowerWhite = cv::Scalar(0, 0, 200);
            cv::Scalar upperWhite = cv::Scalar(180, 30, 255);

            // Apply color thresholding to isolate white regions
            cv::Mat whiteMask;
            cv::inRange(hsv, lowerWhite, upperWhite, whiteMask);

            // Count the number of white pixels
            int whitePixelCount = cv::countNonZero(whiteMask);

```

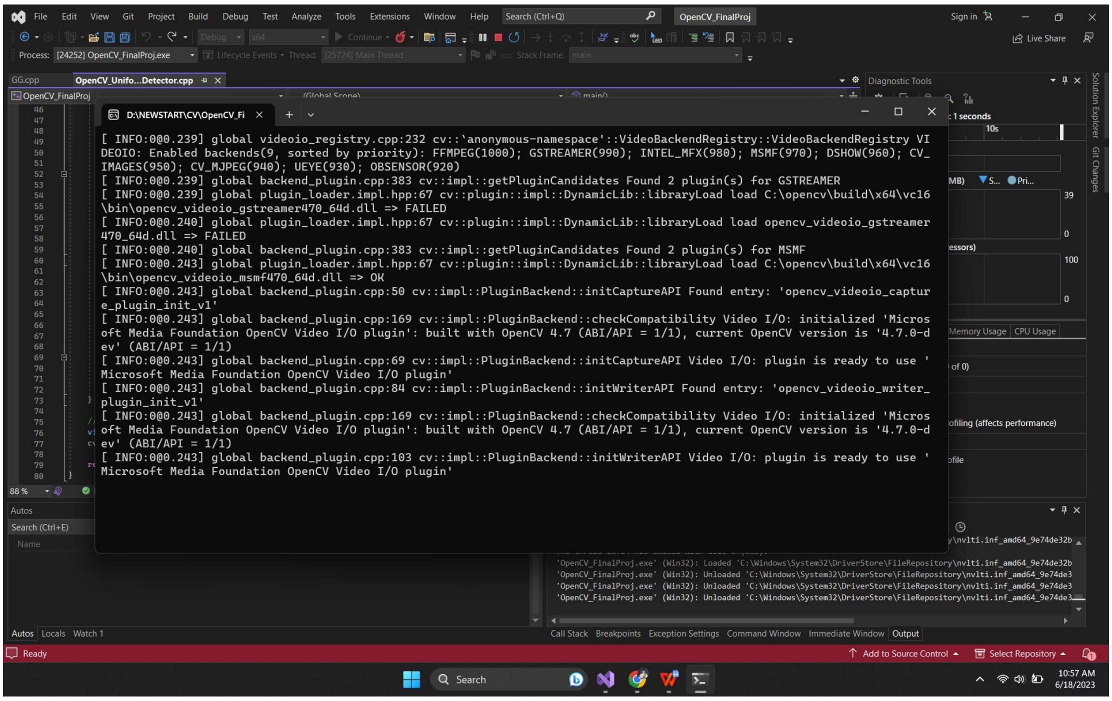

```cpp
            // Count the number of white pixels
            int whitePixelCount = cv::countNonZero(whiteMask);
```


```cpp

            // If a significant number of white pixels are detected, label it as "White Shirt"
            if (whitePixelCount > 100)
            {
                cv::rectangle(frame, rect, cv::Scalar(0, 255, 0), 2);
                cv::putText(frame, "Upper Body", cv::Point(rect.x, rect.y - 10),
                    cv::FONT_HERSHEY_SIMPLEX, 0.9, cv::Scalar(0, 255, 0), 2);
                cv::putText(frame, "White Shirt", cv::Point(rect.x, rect.y + rect.height + 20),
                    cv::FONT_HERSHEY_SIMPLEX, 0.9, cv::Scalar(0, 255, 0), 2);
            }
        }

        // Display the resulting frame
        cv::imshow("Object Detection", frame);

        // Add a delay of 10 milliseconds
        cv::waitKey(10);

        // Exit the loop if 'q' is pressed
        if (cv::waitKey(1) == 'q')
        {
            break;
        }
    }

    // Release the video capture and close the windows
    videoCapture.release();
    cv::destroyAllWindows();

    return 0;
}
```

Chapter 4: User Interface






D:\NEWSTART\CV\OpenCV_Fi
[INFO:0@0.239] global videoio_registry.cpp:232 cv::`anonymous-namespace'::VideoBackendRegistry::VideoBackendRegistry VIDEOIO: Enabled backends(9, sorted by priority): FFMPEG(1000); GSTREAMER(990); INTEL_MFX(980); MSMF(970); DSHOW(960); CV_IMAGES(950); CV_MJPEG(940); UEYE(930); OBSENSOR(920)
[INFO:0@0.239] global backend_plugin.cpp:383 cv::impl::getPluginCandidates Found 2 plugin(s) for GSTREAMER
[INFO:0@0.239] global plugin_loader.impl.hpp:67 cv::plugin::impl::DynamicLib::libraryLoad load C:\opencv\build\x64\vc16\bin\opencv_videoio_gstreamer470_64d.dll => FAILED
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[INFO:0@0.243] global backend_plugin.cpp:50 cv::impl::PluginBackend::initCaptureAPI Found entry: 'opencv_videoio_capture_plugin_init_v1'
[INFO:0@0.243] global backend_plugin.cpp:169 cv::impl::PluginBackend::checkCompatibility Video I/O: initialized 'Microsoft Media Foundation OpenCV Video I/O plugin': built with OpenCV 4.7 (ABI/API = 1/1), current OpenCV version is '4.7.0-dev' (ABI/API = 1/1)
[INFO:0@0.243] global backend_plugin.cpp:69 cv::impl::PluginBackend::initCaptureAPI Video I/O: plugin is ready to use 'Microsoft Media Foundation OpenCV Video I/O plugin'
[INFO:0@0.243] global backend_plugin.cpp:84 cv::impl::PluginBackend::initWriterAPI Found entry: 'opencv_videoio_writer_plugin_init_v1'
[INFO:0@0.243] global backend_plugin.cpp:169 cv::impl::PluginBackend::checkCompatibility Video I/O: initialized 'Microsoft Media Foundation OpenCV Video I/O plugin': built with OpenCV 4.7 (ABI/API = 1/1), current OpenCV version is '4.7.0-dev' (ABI/API = 1/1)
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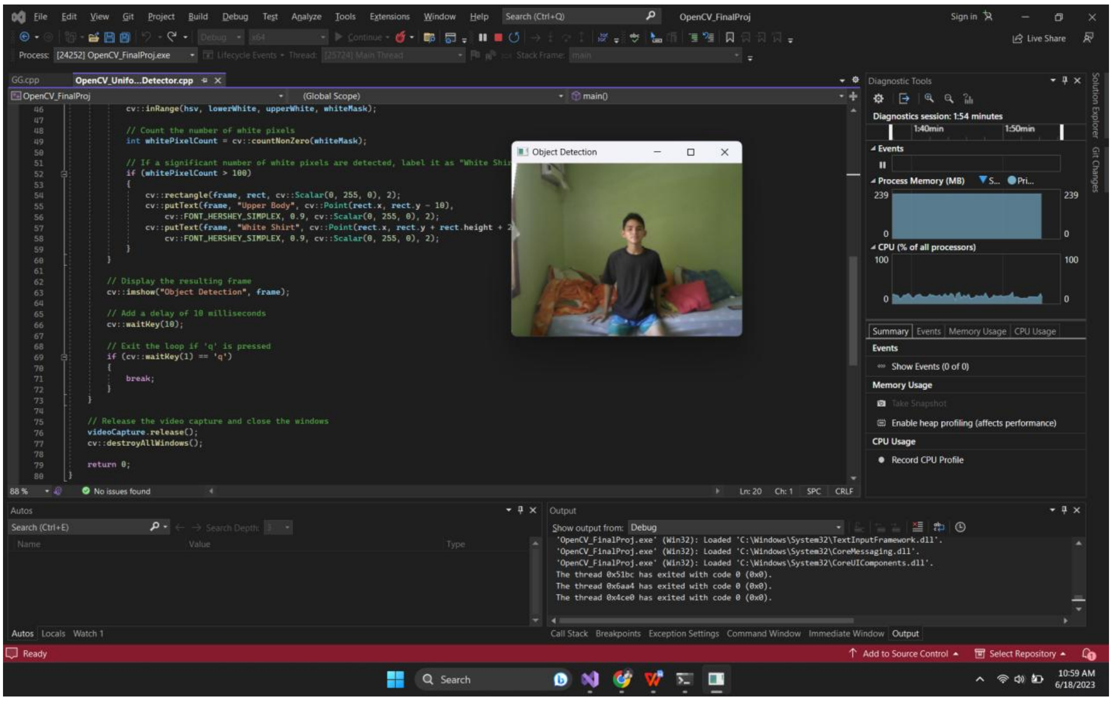
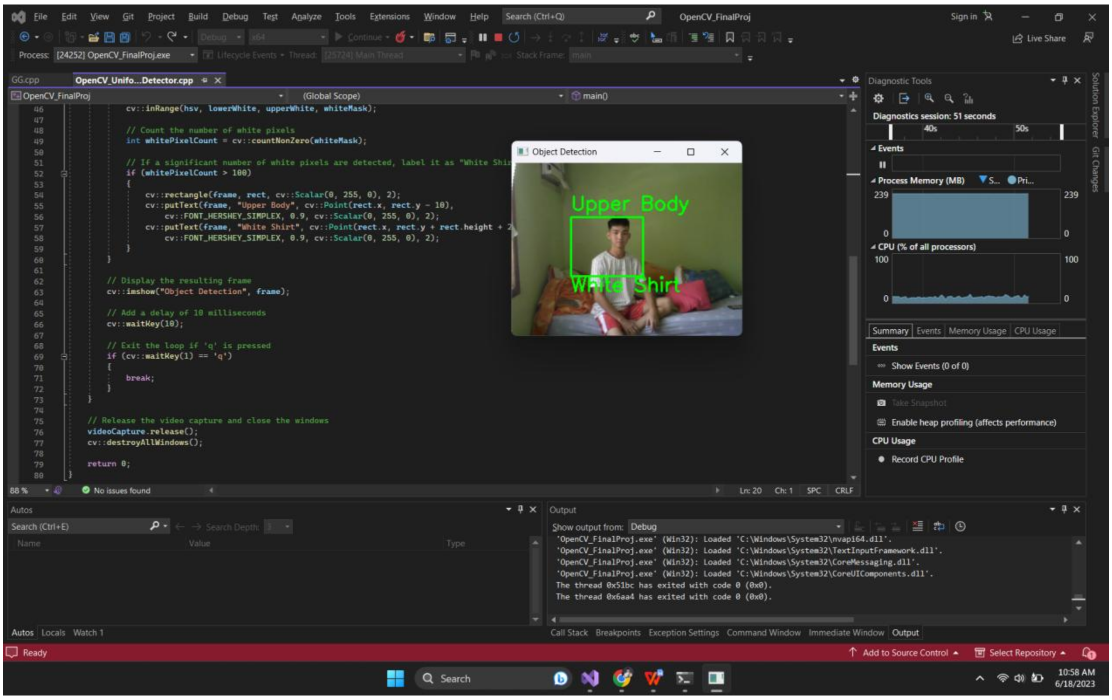

Object Detection
OpenCV_FinalProj


Object Detection
Upper Body
White Shirt