

Building an Adaptive Vietnamese License Plate Recognition and Retrieval System using Multi-Task Deep Learning

Phuoc Minh Hieu Pham*, Sy Sieu Cao

**Corresponding author: hieu.2201700085@st.umd.edu.vn*

Abstract

Automatic License Plate Recognition (ALPR) is an essential component of intelligent transportation, yet its performance is often significantly degraded by real-world image distortions and regional plate format complexities. This research addresses these challenges by proposing a highly adaptive, multi-task deep learning framework specifically designed for the Vietnamese license plate context. The system targets the unique diversity of Vietnamese plates while robustly handling low-quality image inputs.

The proposed framework operates as a multi-stage, conditional pipeline. First, a real-time object detection model is employed to localize all license plate instances. The core component of the system is a lightweight Quality Assessment Module (QAM), which acts as an intelligent router, analyzing and classifying each detected plate into one of three distinct categories: "clear", "restorable", or "unrestorable". The system's adaptive nature is demonstrated in the subsequent multi-branch routing: "restorable" images are selectively forwarded to a specialized restoration neural network. Conversely, "clear" images bypass this resource-intensive step. Finally, "unrestorable" images are rejected entirely, preventing erroneous processing and optimizing overall system throughput. A robust Optical Character Recognition (OCR) model is then used to transcribe the character string from both "clear" and successfully "restored" plates. Finally, the recognized string is used as a query key for retrieving vehicle information from an associated database. This multi-task approach—integrating detection, quality assessment, conditional restoration, and recognition—demonstrates significant accuracy improvements under challenging real-world conditions compared to traditional, non-adaptive pipelines. The system provides a robust and efficient solution for practical ALPR and information retrieval applications within the specific context of Vietnam.

Keywords— Vietnamese License plate recognition, multi-task learning, deep learning, computer vision, image retrieval.