Contactless Apprehension of Traffic Violators on 24-hours Basis
All-Vehicle Detection System (CATCH-ALL)

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Department of Science and Technology – Philippine Council for Industry, Energy, and Emerging Technologies for Research and Development (DOST-PCIEERD)

Project PropONENTS
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Intelligent Transport Systems Laboratory, De La Salle University – Manila
<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>DESIGN: SOFTWARE/HARDWARE</th>
<th>IMPLEMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To implement a machine vision system that will capture vehicle images on the street intersection in real time.</td>
<td>100% Complete</td>
<td>75% Complete</td>
</tr>
<tr>
<td>2. To design and develop an Artificial Intelligence (AI) software that can do the following:</td>
<td>100% Complete</td>
<td>75% Complete</td>
</tr>
<tr>
<td>a) identify the vehicle plate using a camera vision,</td>
<td>100% Complete</td>
<td>75% Complete</td>
</tr>
<tr>
<td>b) identify number coding and reckless driving (swerving) traffic violations and provide immediate notification to the violators, and</td>
<td>100% Complete</td>
<td>75% Complete</td>
</tr>
<tr>
<td>c) provides unquestionable evidence on the traffic violations committed.</td>
<td>100% Complete</td>
<td>75% Complete</td>
</tr>
<tr>
<td>3. To integrate the results of objectives 1 to 2 and implement the Automated Traffic Violation Detection and No-contact Apprehension System (CATCH-ALL) on the traffic intersection of Taft-Estrada street, Malate, Manila in real time</td>
<td>80% Complete</td>
<td>50% Complete</td>
</tr>
</tbody>
</table>
### Objective Attainments

<table>
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<tr>
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<th>DESIGN: SOFTWARE/HARDWARE</th>
<th>IMPLEMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. To conduct actual study on the effects of CATCH-ALL in the street traffic.</td>
<td>-</td>
<td>20% Complete</td>
</tr>
<tr>
<td>5. To conduct actual study on the Filipino drivers' behavior towards the implementation of CATCH-ALL.</td>
<td>-</td>
<td>10% Complete</td>
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</tbody>
</table>
6Ps (CATCH-ALL)

1. PUBLICATIONS
2. PRODUCTS OR PROCESS
3. PATENTS
4. PEOPLE SERVICES / CAPABILITY BUILDING
5. PLACES AND PARTNERSHIPS
6. POLICY
PUBLICATIONS

List of papers published in IEEE HNICEM 2015 in Cebu, Philippines:
1. A genetic algorithm and artificial neural network-based approach for the machine vision of plate segmentation and character recognition
2. Machine vision for traffic violation detection system through genetic algorithm

List of papers published in IEEE TENCON 2016 in Singapore:
1. Automated Traffic Violation Apprehension System Using Genetic Algorithm and Neural Network
2. Fuzzy Logic Based Vehicular Plate Character Recognition System Using Image Segmentation and Scale-Invariant Feature Transform
3. Intelligent System Architecture for a Vision-Based Contactless Apprehension of Traffic Violations
5. Passenger Demand Forecast Using Optical Flow Passenger Counting System for Bus Dispatch Scheduling
6. Philippine Vehicle Plate Localization using Image Thresholding and Genetic Algorithm
PUBLICATIONS

List of papers to be published in Science and Information (SAI) Computing Conference 2017 in London, UK:
• Vehicle Detection and Tracking Using Corner Feature Points and Artificial Neural Networks for a Vision-based Contactless Apprehension System

List of papers to be published in JACIII (Journal of Advanced Computational Intelligence and Intelligent Informatics):
• Traffic Estimation and Warning System using Fuzzy Logic and GSM
6Ps (CATCH-ALL)

PRODUCTS OR PROCESS

Software packages: Detecting traffic violations and contactless apprehension notice
  • Vehicle detection and tracking
  • Plate number localization and recognition
  • Vehicle profiling (class and color)
  • Number coding violation detection
  • Beating the red light detection
  • Swerving detection
  • Over-speeding detection
  • Traffic violation information system
PATENTS

No pending patent application

Possible
1. Computer-implemented inventions
2. System architecture patents
**6Ps (CATCH-ALL)**

**PEOPLE SERVICES / CAPABILITY BUILDING**

List of graduate student/researchers:

<table>
<thead>
<tr>
<th>NAMES</th>
<th>COURSE</th>
<th>EXPECTED YEAR OF GRADUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Robert Kerwin Billones</td>
<td>PHD-ECE</td>
<td>3(^{rd}) Term 2017-2018</td>
</tr>
<tr>
<td>2. Edison Roxas</td>
<td>PHD-ECE</td>
<td>3(^{rd}) Term 2018-2019</td>
</tr>
<tr>
<td>3. Rhen Anjerome Bedruz</td>
<td>MS-ECE</td>
<td>2(^{nd}) Term 2016-2017</td>
</tr>
<tr>
<td>4. Ana Riza Quiros</td>
<td>MS-ECE</td>
<td>2(^{nd}) Term 2016-2017</td>
</tr>
<tr>
<td>5. Aaron Christian Uy</td>
<td>MS-ECE</td>
<td>2(^{nd}) Term 2016-2017</td>
</tr>
<tr>
<td>6. Noel Alarcon</td>
<td>MS-ECE</td>
<td>2(^{nd}) Term 2016-2017</td>
</tr>
<tr>
<td>7. Jinmar Valentino</td>
<td>MS-CS</td>
<td>2(^{nd}) Term 2016-2017</td>
</tr>
</tbody>
</table>
6Ps (CATCH-ALL)

PLACES / PARTNERSHIPS

1. MANILA CITY GOVERNMENT AND AFFECTED BARANGAYS
2. MANILA TRAFFIC AND PARKING BUREAU (MTPB)
3. METRO MANILA DEVELOPMENT AUTHORITY (MMDA) - Given access to CCTV database
4. DEPARTMENT OF TRANSPORTATION (DOTr) – possible candidate
5. LAND TRANSPORTATION OFFICE (LTO) – possible candidate
POLICY

• Coordination with Manila Traffic and Parking Bureau for establishing Traffic Discipline Zone in Taft Ave. to Singalong Ave. along Estrada St.

Other possible policies:

1. Implementation in Taft-Estrada, Manila City for driver behavior monitoring (for traffic violations) which can be expanded to other MM roads.
2. Traffic Violations No-Contact Apprehension for LTO
6Ps (CATCH-ALL)

Establishment of Traffic Discipline Zone
6Ps (CATCH-ALL)

POLICY

Starting Point of Traffic Discipline Zone
Traffic Signage in the Traffic Discipline Zone
6Ps (CATCH-ALL)

**POLICY**

No waiting at any time

No stopping any time

Left lane must turn left

Right lane must turn right
6Ps (CATCH-ALL)

POLICY

Meeting with MTPB
OVERVIEW OF THE PROJECT

CATCH-ALL SYSTEM ARCHITECTURE

VIDEO CAPTURE
- SMART CAMERA
- LOW-COST IP CAMERA

VIDEO ANALYSIS SYSTEM
- VEHICLE DETECTION AND TRACKING
- VEHICLE PROFILING
- VEHICLE PLATE LOCALIZATION AND PLATE CHARACTER RECOGNITION
- TRAFFIC VIOLATION IDENTIFICATION

OUTPUT SYSTEM
- OUTDOOR LED SCREEN (REAL-TIME VIDEO FEEDBACK)
- TRAFFIC VIOLATION INFORMATION SYSTEM
  - CAR PROFILE
  - PLATE NUMBER
  - VIOLATION
  - DATE AND TIME OF VIOLATION
Vision-Based Contactless Apprehension System

VIDEO CAPTURE SYSTEM

- SMART CAMERA SYSTEM
- LOW-COST IP CAMERA SYSTEM

OUTPUT SYSTEM

- OUTDOOR LED SCREEN (REAL-TIME VIDEO FEEDBACK)
- TRAFFIC VIOLATION DATABASE
  - CAR PROFILE
  - PLATE NUMBER
  - DATE AND TIME OF VIOLATION

INTELLIGENT OPERATING ARCHITECTURE (IOA)

PERCEPTION MODULE

- EXTERNAL SENSING
- INTERNAL SENSING

EXECUTION MODULE

- EXTERNAL SYSTEM FEEDBACK
- INTERNAL SYSTEM FEEDBACK

INTELLIGENCE MODULE

- VEHICLE IDENTIFICATION AND PROFILING
- VEHICLE PLATE LOCALIZATION
- PLATE CHARACTER RECOGNITION AND TRACKING
- TRAFFIC VIOLATION IDENTIFICATION

MEMORY MODULE

- SHORT-TERM MEMORY (ACTIVE MEMORY)
- LONG-TERM MEMORY
Video Capture Sub-System

Camera Locations and Views
Computing Server

- Tesla computing processor, 256 Cores
- 40 Terabytes of storage data
- Running on Linux (CentOS 7)
- Programming environment ready for use
  - Additional libraries can be installed as needed
  - Automatic connection to the NAS (drives)
- Configured as shared storage (hard drives) for the server and all network-connected computers
- Also configured as credential server for Windows and Linux
- Information and any recorded videos from the IP cameras will be stored here
Computing Server

- Two units:
  - Main UPS
  - Extra battery

- To be used in case of power failure
Terminal Systems (Desktops)

- Computers fully assembled and operational
  - One motherboard is defective and awaiting replacement

- Basic software configuration complete
  - 3 Linux computers
  - 4 Windows computers

- Work-in-progress:
  - Licensing (c/o ITS)
  - LabVIEW (c/o ITS)
  - Microsoft Office (c/o ITS)
  - Create accounts for all users (via NAS)
Vehicle Detection and Tracking Experiment 1
(Using Optical Flow in Labview)
Vehicle Detection and Tracking Experiment 2
(Using Blob Analysis and Kalman Filter in MATLAB)
Vehicle Detection and Tracking Experiment 3 (Taft-Estrada Intersection)
Vehicle Detection and Tracking Experiment 4
(Using OpenCV)
Vehicle Detection and Tracking Experiment 5
(Using Optical Flow in OpenCV)
Vehicle Detection and Tracking Experiment 6
(Violation Detection in OpenCV)
Plate Localization System

ORIGINAL IMAGE

DIGITAL IMAGE AT DIFFERENT THRESHOLDING VALUES

FINAL OBTAINED PLATE LOCATION

OBTAINED PLATE AREA
VIDEO ANALYSIS SYSTEM

Sample Optical Character Recognition

Text Read
AAJ3800
VIDEO ANALYSIS SYSTEM
OUTPUT SYSTEM

OUTDOOR LED SCREEN
(REAL-TIME VIDEO FEEDBACK)

TRAFFIC VIOLATION DATABASE
- CAR PROFILE
- PLATE NUMBER
- DATE AND TIME OF VIOLATION

- TRAFFIC VIOLATIONS
  * NUMBER CODING
  * BEATING THE RED LIGHT
  * SWERVING
  * OVERSPEEDING

Versatile Digital Signage Player
SMP-2000
Outdoor LED Screen: Hardware and Software Testing
<table>
<thead>
<tr>
<th>Objectives</th>
<th>Expected Output</th>
<th>Milestone Indicators</th>
<th>Measure</th>
<th>Work Component and/or Tasks</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To conduct a study on the current traffic situation in EDSA and LRT Line 2 (Taft Avenue) for CATCH-ALL implementation. 2. To secure a permit from Manila City LSSU for the physical improvements needed to implement the CATCH-ALL project. 3. To train and acquire all the parameters and inputs needed to implement the CATCH-ALL project. This includes both the hardware and software.</td>
<td>Complete study report containing the volume of the traffic before the project is implemented. 2. Acquisition of needed equipment and materials for CATCH-ALL project. 3. Permit from Manila City LSSU for installing and maintaining equipment and materials needed to implement the CATCH-ALL project.</td>
<td>1. Abstract and statistical analysis of the traffic situation in the area where the CATCH-ALL project is to be implemented. 2. Acquire the CATCH-ALL project equipment and materials. 3. Acquire all CATCH-ALL project equipment from both local and international vendors. 4. Assemble traffic management and CCTV camera installations.</td>
<td>1. Actual experiment and observation on vehicle movement on the target streets. 2. Purchase of equipment which includes cameras and other materials needed to implement CATCH-ALL projects. 3. Contact and follow up the officials of Manila City LSSU regarding the permit. 4. Implement physical improvements in EDSA (Taft Avenue). 5. Hire and supervise private contractors to work on traffic signs, camera installations, and other civil works needed to implement CATCH-ALL project.</td>
<td>Delayed Procurement, Building, Implementation, Delayed due to hardware installation.</td>
<td></td>
</tr>
<tr>
<td>To design and develop a Artificial Intelligence (AI) software that can do the following: a) identify the vehicle plate using a camera vision, b) identify number coding and reckless driving (exceeding traffic violations and provide immediate notification to the violations, and c) provides无情可断 evidence on the traffic violations encountered.</td>
<td>The CATCH-ALL software has been installed on the field and tested. The LSSU board that will display information of traffic violations is installed.</td>
<td>Display accurate, reliable, and robust result in real-time.</td>
<td>Display accurate, reliable, and robust result in real-time.</td>
<td>Delayed due to hardware installation.</td>
<td></td>
</tr>
<tr>
<td>To conduct a study on the Filipino drivers' behavior towards the implementation of CATCH-ALL.</td>
<td>Complete study report containing the statistical analysis of the attitudes of the drivers before and after the CATCH-ALL is installed.</td>
<td>Produce technical papers.</td>
<td>Produce technical papers.</td>
<td>Delayed due to hardware installation.</td>
<td></td>
</tr>
</tbody>
</table>

**Projected Duration**:
- 1st Quarter: Study and Development of the CATCH-ALL software.
- 2nd Quarter: Implementation and Testing of the CATCH-ALL project.
- 3rd Quarter: Finalization of the project and report submission.
- 4th Quarter: Presentation of findings at international conference.
• Ongoing Construction of Fiber Optics Cable
• Placement of LED Screen
• Pavement Markings
PUBFIX AND CATCH-ALL INTEGRATION PROPOSAL PROJECT
1. **WIRELESS MESH COMMUNICATIONS NETWORK FOR VIDEO STREAMING**

**NOTE:**
Video-based networks can be efficiently scaled using a wireless communications network setup. Traditional wired networks are more difficult to scale because of cost and time-delays in construction.
Radio Link Only (Wireless)
Video data are sent wirelessly from remote locations (Henry Sy Sr. Hall, Velasco Hall, St. Miguel) to a computer in M106 Lab.
2. **IN-VEHICLE TRAFFIC VIOLATIONS DETECTION FOR PUBLIC UTILITY VEHICLES (BUSES OR TAXIS OR JEEPNEYS)**

Computer Vision-Based In-Vehicle Traffic Violations Detection
- Not wearing seatbelt
- Texting while driving

Sensor-Based In-Vehicle Traffic Violations Detection
- Drunk Driving

**NOTE:**
Traffic violations will be transmitted to the server whenever the vehicle passes through the road-side unit (RSU)

This is an automatic traffic violations detection system and also an accident prevention system.
Vehicle Equipment Setup
Gabriela Hills: short distances, narrow roads, more obstructions
Vista Verde: long distances, narrow roads, less obstructions
Test Setup (Typical, 3-Hop Connection)
• Traffic violations information system that runs on web platform will be available to online users. Traffic violations data from no-contact apprehension systems (CATCH-ALL) will be used.

• Traffic violations data analytics from no-contact apprehension systems (CATCH-ALL) are used to analyze traffic patterns in specific routes. These data analytics can be used as guide in decision making by policy makers, traffic law enforcement agencies, and other stakeholders.
List of violators on the specified traffic violation

Shows the distribution of violations in daily, weekly, and monthly basis.
TRAVIS Version 1.0 Development (Traffic Violation Information System)
List of traffic violations and corresponding penalties

<table>
<thead>
<tr>
<th>Violations</th>
<th>First Offense</th>
<th>Second Offense</th>
<th>Third Offense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorum Operation (Cargo Vehicle)</td>
<td>(C) 1,000.00</td>
<td>(C) 2,000.00</td>
<td>(C) 3,000.00</td>
</tr>
<tr>
<td>Colorum Operation (Cargo Vehicle)</td>
<td>(C) 3 Mos Conf. Plt</td>
<td>(C) 6 Mos Imp. Mv</td>
<td>(C) Crdl of Frtn</td>
</tr>
<tr>
<td>Colorum Operation (Cargo Vehicle)</td>
<td>(D) 1,000.00</td>
<td>(D) 2,000.00</td>
<td>(D) 3,000.00</td>
</tr>
<tr>
<td>Colorum Operation (Cargo Vehicle)</td>
<td>(D) 3 Mos Sus. DL</td>
<td>(D) 6 Mos Sus. DL</td>
<td>(D) Rev. Of DL</td>
</tr>
<tr>
<td>Colorum Operation (Passenger) - MMDOA Req. No. 97 - 004</td>
<td>(D) 1,000.00</td>
<td>(D) 2,000.00</td>
<td>(D) 3,000.00</td>
</tr>
<tr>
<td>Colorum Operation (Passenger) - MMDOA Req. No. 97 - 004</td>
<td>(D) 3 Mos Conf. Plt</td>
<td>(D) 6 Mos Imp. Mv</td>
<td>(D) Crdl of Frtn</td>
</tr>
<tr>
<td>Colorum Operation (Passenger) - MMDOA Req. No. 97 - 004</td>
<td>(D) 1,000.00</td>
<td>(D) 2,000.00</td>
<td>(D) 3,000.00</td>
</tr>
<tr>
<td>Colorum Operation (Passenger) - MMDOA Req. No. 97 - 004</td>
<td>(D) 3 Mos Sus. DL</td>
<td>(D) 6 Mos Sus. DL</td>
<td>(D) Rev. Of DL</td>
</tr>
<tr>
<td>CR / OR NOT CARRIED</td>
<td>(D) 150.00</td>
<td>(D) 150.00</td>
<td>(D) 150.00</td>
</tr>
</tbody>
</table>
List of violators on the specified traffic violation

<table>
<thead>
<tr>
<th>VIOLATION</th>
<th>PLATE NUMBER</th>
<th>VEHICLE CLASS</th>
<th>VEHICLE COLOR</th>
<th>DATE VIOLATED</th>
<th>TIME VIOLATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEEDING</td>
<td>def456</td>
<td>sedan</td>
<td>red</td>
<td>July 3, 2016</td>
<td>300</td>
</tr>
<tr>
<td>SPEEDING</td>
<td>xyz</td>
<td>truck</td>
<td>black</td>
<td>July 2, 2016</td>
<td>200</td>
</tr>
<tr>
<td>SWERVING</td>
<td>xyz</td>
<td>truck</td>
<td>black</td>
<td>November 3, 2016</td>
<td>700</td>
</tr>
<tr>
<td>SWERVING</td>
<td>def456</td>
<td>sedan</td>
<td>red</td>
<td>July 2, 2016</td>
<td>400</td>
</tr>
<tr>
<td>DRUNK DRIVING</td>
<td>def456</td>
<td>sedan</td>
<td>red</td>
<td>January 10, 2016</td>
<td>1100</td>
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<tr>
<td>COUNTERFLOWING</td>
<td>xyz</td>
<td>truck</td>
<td>black</td>
<td>September 3, 2016</td>
<td>200</td>
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</tbody>
</table>
4. **IN-VEHICLE DRIVER BEHAVIOR ANALYSIS AND DRIVER ASSISTIVE TECHNOLOGIES**

Computer Vision-Based Driver Assistive Technologies

- Drowsiness detection and speech-based feedback system (driver will be notified/alerted by the computer if he is sleepy)
- Road signs notification and speech-based feedback system (the system will detect road signs and advise the driver to follow traffic rules), i.e.
  - Red light notification
  - No loading/unloading notification
  - One-way notification
  - No U-turn notification, etc.

**NOTE:**
The system can help the drivers in avoiding traffic violations and accidents.

Traffic violations can be recorded if the driver violated the road signs notification. Traffic violations will be transmitted to the server whenever the vehicle passes through the road-side unit (RSU)
5. PUBLIC UTILITY VEHICLES (BUS, TRAINS, ETC.) ON-BOARD SECURITY SYSTEM USING AUDIO-VISUAL MULTIMEDIA SYSTEM

Computer Vision- and Audio-Based Security System for Detecting People’s Behavior and Activity in Public Utility Buses
• Detection of deadly weapons (guns, knives, etc.)
• Audio-visual commotion detection during robbery/hold-up, hostage taking, and bomb threats
• Monitoring road conditions (illegal parking, accidents, etc.)

NOTE:
Activity will be transmitted to the server whenever the vehicle passes through the road-side unit (RSU)
6. AUTOMATED PARKING SPACE DETECTION SYSTEM USING COMPUTER VISION AND SMARTPHONE APPS

• Computer vision are used to detect vehicles entering and leaving a parking area. Smartphone app users are notified in real-time of possible parking space in nearby locations.

NOTE:
The system aims to minimize traffic congestions due to vehicle owners unable to find a parking space. It can also minimize illegal parking violations.