Needs and Requirements for License Plate Reader Systems used by United States Law Enforcement Agencies

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Report prepared for the National Institute of Justice by Casandra Robinson, Savannah River National Laboratory, Document # SRNL-L1300-2011-00118.

Executive Summary

The focus of this report is license plate reader systems used by United States law enforcement practitioners. A Special Technical Committee of local, state, and federal practitioners having relevant experience was brought together to describe their operational environments, missions, and needs and requirements related to such systems. This report captures the information and will serve as the basis for development of a National Institute of Justice standard for license plate reader systems.

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1. Introduction

A Special Technical Committee (STC) of practitioners and technical experts was convened for the purpose of developing a voluntary standard for license plate reader (LPR) systems used by United States (US) law enforcement agencies. The first step in the effort is defining law enforcement's operational, functional, and performance needs and requirements for this equipment.

The purpose of this report is to document those needs and requirements, providing a basis from which the committee can begin to develop the standard. Participants in this effort are identified in Appendix A.

2. Categories of LPR Systems

The STC members identified three categories of LPR systems are used by law enforcement agencies:

- Mobile systems installed in vehicles. Figure 1 of Appendix B provides a diagram of the mobile LPR system. Components of such systems include a plate imaging camera, a contextual image camera, the processor (i.e., software, read/capture algorithm, optical character recognition (OCR), metadata input, and comparison to database), user interface, system storage, the power system, and the housing and mounting hardware. Any other components, including the alert list, the global positioning system (GPS), the time source, and the power source, are considered to be external to the mobile LPR system.

- Fixed systems installed in semi-permanent or permanent locations. Figure 2 of Appendix B provides a diagram of a fixed LPR system. The components for a fixed system are the same as those of the mobile system, except that the software comparison of the plate information to the alert list occurs external to the LPR system.

- Portable systems that may be temporarily installed in a location and moved as the need arises.

3. Methodology

The needs and requirements were defined over the course of several STC meetings. The participants were first convened together to discuss needs and requirements in general. In subsequent meetings, the participants were divided into 2 groups with one group focusing on mobile systems and the second group focusing on fixed systems. The input of each group was then reviewed to determine commonalities between their needs and requirements.

4. Results

The STC members identified the following types of requirements, and these are further described in subsequent, and separate, sections for mobile and fixed systems:

- System requirements.
- User/Administrator requirements.
- Image acquisition requirements.
- System software and processing requirements.
- Data management and output requirements.
- Environmental requirements.
- Other requirements.

5. *Mobile LPR Requirements*

5.1. System Requirements

5.1.1. The system must have the ability to synchronize with an external GPS/Automatic Vehicle Locator (AVL).

5.1.2. The system GPS must meet a specified standard, and the most appropriate standard should be researched and specified.

5.1.3. The system must have the ability to synchronize with a known external time source, provide an accurate time/date stamp, and maintain time within the system.

5.1.4. The system must be able to interface with other vehicle systems, including vehicle power and the mobile data computer (MDC) (if applicable).

5.1.5. The system must be able to operate on available power. Because the available power depends on the application (i.e., the vehicle's power system), it is suggested that the LPR be able to operate on manufacturer recommended power + 10%.

5.1.6. The system must have the capability to be directly interfaced via hard-wired connection to the vehicle power.

5.1.7. The system must have the capability for a user to power down the system from within the vehicle passenger compartment.

5.1.8. The system must inform the user of the time between vehicle recognition to output of DME[1], and setting a maximum time limit is recommended.

5.1.9. The system must have the capability to receive alert lists.

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[1] Digital multimedia evidence (DME): evidence stored or transmitted in a binary form and includes data representing documents, audio, video, metadata, and any other information attached to a digital file.

5.2. User/Administrator Interface Requirements

5.2.1. The system must have capability to assign and manage permissions for levels of authorized access and control (e.g., system administrator level, alert list administrator level, authorized user level).

5.2.1.1 System Administrator Access: The system must have the capability for a system administrator to perform the following:

- Activate/deactivate individual cameras or combinations of cameras.
- Change system information and audit log information.
- Assign access privileges for alert list administrators and authorized users.
- Manage alert lists and notifications.

5.2.1.2 Alert List Administrator Access: The system must have the capability for an alert list administrator to perform the following:

- Manage alert lists and notifications.
- Enter plates for amber or silver type alerts.
- Push/pull a list of plates in a non-typical situation.

5.2.1.3 Authorized User Access: The system must have the capability for an authorized user to perform the following:

- Input user information.
- Log into the system.
- Input plate information to be added to a local alert list in the vehicle that is separate from the downloaded alert list.
- Correct a plate read, edit a read, and/or add a state.

All above inputs must be included in the DME Audit Log.

5.2.1.4 Authorized User Controls: The system must have the capability for the following authorized user controls:

- Copy function to select the OCR interpretation for potentially pasting into computer aided dispatch (CAD) or other user interfaces.
- Copy function to select the photo(s) for potentially pasting into other applications.

- Quick function checks to verify that the system is working at shift start.

- Flag/identify captures at time of read so that the user can tag images with details. For example, the user should be able to mark individual captures with information about an event related to the image or mark images that include a vehicle of interest.

5.2.2. The system should send a signal indicating to the user that the system is on.

5.2.3. The system must continuously provide the contextual image, the plate image, the OCR interpretation, alert list (and additional information about the list), and required metadata of the license plate through a basic viewer.

5.2.4. If the system incorporates a viewer, the system must provide the user the ability to turn off the viewer or minimize the display window.

5.2.5. The system must have the capability to show the diagnostic display showing system level events (i.e., system audit log).

5.2.6. The system must provide the capability to display usage statistics (e.g., reads, alerts, log ins, etc.).

5.2.7. The system must provide the ability for the user to select a day or night mode to accommodate viewing in sunlight or darkness and to produce an audible alert.

5.2.8. The system must have capability to output audible and/or visible notifications (display) to the user:

- GPS signal is diminished in strength or lost.

- GPS is disconnected or has failed.

- Any camera is disconnected or has failed.

5.3. Image Acquisition Requirements

5.3.1. The system must be able to acquire and interpret images during the following types of motion:

- System moving and target stationary (e.g., parked vehicle) at various relative angles.

- System moving and target moving at various relative speeds: Typical scenarios include (1) the system and targets moving in opposite directions, (2) the system and targets moving in same direction, and (3) the system and target moving in same direction with the target at an angle with respect to the system (e.g., turning). The basic system must be able to capture images in its lane and one lane width to the side of the patrol vehicle.

- System stationary and target moving: An example scenario is a patrol vehicle stopped alongside the road reading plates of passing vehicles.

- System stationary and target stationary: If system reads the same plate contiguously within a specified time frame, the system should either not continue to capture, have a manual override, or flag images. This requirement would prevent, for example, a patrol vehicle parked overnight from continuously capturing images and resulting in thousands of records.

5.3.1.1 Specialized cameras for the above applications may be designated for a specific application and not required to meet requirements for all four types of motion.

5.3.2. The system must be capable of capturing images while compensating for variables related to motion including relative speed, relative position between the system and target, and angle of view (e.g., multiple viewing angles, complex angles, looking horizontally).

5.3.3. The system must be able to see and obtain an image in various conditions:

- Range of lighting conditions, including sun glare, full daylight, and night time.

- Inclement weather conditions, including snow, ice, rain, fog, and blowing sand. Reflections due to inclement weather conditions impact the system's ability to see and obtain an image.

5.3.4. The system must provide a contextual image in an industry standard file format to allow export to an external editing program.

5.3.5. The system must provide a contextual image with a user-definable minimum viewing range around the plate, and the image resolution must be maintained. This requirement is necessary because some agencies are restricted to viewing the plate only while others prefer a wider range so that scene details are provided.

5.3.6. The system should be able to capture the contextual image of a vehicle even if the vehicle's license plate cannot be read by the system. This feature should be configurable (e.g., turned on/off and triggered by reflectivity or other means) by the system administrator.

5.3.7. The system should provide a live view from all types of cameras (e.g., plate read, contextual read), not necessarily simultaneously, upon request of the user. This is needed for alignment and troubleshooting purposes.

5.3.8. The system must be able to read non-stacked characters of a minimum height; specific requirements need to be defined. Note: The American Association of Motor Vehicle Administrators (AAMVA) is working on guidelines for states in creating license plates.

5.3.9. The system must have the ability to read stacked characters or, at least, recognize stacked characters as a stack and treat appropriately. How stacked characters are represented

must be defined. Note: The AAMVA is working on guidelines for states in creating license plates.

5.4. System Software and Processing Requirements

5.4.1. The system software must effectively provide:

- Identification and recognition (i.e., accurate representation) of license plate numbers (digits and letters).
- Contextual image must be in color and accurately represent color when tested under preset lighting conditions.
- Metadata that is locked and synchronized with plate images.

5.4.2. Desired, but not required, features of a system include the following:

- Identification and recognition of state, province, and country.
- Color recognition by the system for query purposes.

5.4.3. The system must perform a diagnostic to detect any malfunction (i.e., dropped frames; loss of time stamp, video, audio, or any external references, if any, normally recorded by the system) or loss of functionality of the recorder, camera, displays and microphones.

5.4.3.1 The diagnostic shall be performed on system startup and at administrator-configurable intervals.

5.4.3.2 Any malfunction or loss of functionality shall be documented in the System Audit Log.

5.4.4. The system must automatically produce metadata including the following information, and this information must not be embedded so that there is the ability to move its location on the screen:

- Time/date stamp for acquisition and time for OCR.
- GPS location of capture.
- Patrol vehicle identifier.
- Camera designation (placement on vehicle); this applies to mobile and fixed systems.
- Alarm indications, such as power interruptions, low storage space, etc.
- User input of information.
- DME Audit Log.

- System Audit Log.

5.4.5. The DME Audit Log must include the following:

- User identification and logging in/out.
- Hash or other verification shall be computed for the duplicate using an industry-standard method and shall be defined and provided with the duplicate.
- The calculated hash of the duplicate should be recorded as part of the audit log, as well as the hash of the original file.
- Identification of the source of the DME, including the patrol vehicle installation/site identification, central processing unit (CPU), hardware identification, etc.

5.4.6. The System Audit Log must include all system-level events, software updates, hardware changes, and a copy of the metadata. The system shall poll all system-level components and automatically record into the System Audit Log all system-level details and events, including the following, at least each time status changes:

- Date and time of event.
- GPS location of event.
- Hardware identification, including manufacturer and model number.
- Software version.
- System status change (e.g., boot up, power on).
- System-level component status change indicators (e.g., camera failure; changes to input/output ports, components, or application programming interfaces (APIs); loss of GPS signal).

5.4.7. The System Audit Log shall provide the ability to manually record at least the following:

- Vehicle installation/site identification.
- User identification.

5.5. Data Management and Output Requirements

5.5.1. The system must comply with at least the specified minimum resolution for the contextual photo, and this minimum resolution must also be defined. It is a desirable feature to also have user-configurable resolution.

5.5.2. The system must provide data that is exportable in an interoperable (i.e., National Information Exchange Model (NIEM)-conforming) format.

5.5.3. The system must have capability to import interoperable (i.e., NIEM-conforming) records from external sources.

5.5.4. The system must provide storage of DME at the camera location to allow saving of DME at least until export.

5.5.5. The system must provide the capability to export a duplicate[2] in the original file format.

5.5.6. The system must have capability to compare captures/reads with an alert list(s).

5.5.7. The system must have the capability to perform a standard query of statistics (e.g., vehicle counts, reads, hits, etc.).

5.5.8. The system must have the capability to securely transmit and receive data.

5.5.9. The system must provide the capability to perform a cryptographic verification (e.g., hash) for exported data.

5.6. Environmental Requirements

5.6.1. The system must be able to withstand and operate in moisture, humidity, and temperature extremes.

5.6.2. The system must be housed or protected to prevent ingress of water and dust.

5.6.3. The system cables and connections must be resistant to mechanical stress, crush, and ingress of dust or moisture.

5.6.4. The system must be able to withstand and operate during mechanical shock, vibration, and impact consistent with the intended operational environment. Test parameters must be defined. Cameras must maintain alignment, and the mounts must be durable.

5.6.5. The system must operate during electromagnetic/radio frequency (RF) interference from other systems.

5.6.6. The system must not produce electromagnetic interference that will impact other vehicle systems.

5.7. Other Requirements

5.7.1. Documentation must be provided by the manufacturer, including the following:

- Specification sheets

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[2] Duplicate: An exact reproduction of the original data validated through a hash process.

- User's manual (including programming procedures, installation instructions for each type of vehicle, precautions, care and maintenance guidance) and quick start guide. This documentation must also be available via a website.

- Parts list.

6. Fixed LPR Requirements

6.1. System Requirements

6.1.1. The system must have the ability to synchronize with an external GPS.

6.1.2. The system GPS must meet a specified standard, and the most appropriate standard should be researched and specified.

6.1.3. The system must have the ability to synchronize with a known external time source, provide an accurate time/date stamp, and maintain time within the system.

6.1.4. The system must be able to operate on available power. Because the available power depends on the application, it is suggested that the LPR be able to operate on manufacturer recommended power ±10%.

6.1.5. The system must inform the user of the time between vehicle recognition to output of DME, and setting a maximum time requirement is recommended. This is very important for stationary cameras to ensure information is provided before a vehicle is too far from the system location.

6.1.6. The system must have the capability to receive alert lists.

6.2. User/Administrator Interface Requirements

6.2.1. The system must have capability to assign and manage permissions for levels of authorized access and control (e.g., system administrator level, alert list administrator level, authorized user level).

6.2.1.1 System Administrator Access: The system must have the capability for a system administrator to perform the following:

- Activate/deactivate individual cameras or combinations of cameras.

- Change system information and audit log information.

- Assign access privileges for alert list administrators and authorized users.

- Manage alert lists and notifications.

6.2.1.2 Alert List Administrator Access: The system must have the capability for an alert list administrator to perform the following:

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- Input user information.
- Log into the system.
- Input plate information to be added to a local alert list in the vehicle that is separate from the downloaded alert list.
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All above inputs must be included in the DME Audit Log.

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6.2.5. The system must have the capability to show the diagnostic display showing system level events (i.e., system audit log).

6.2.6. The system must provide the capability to display usage statistics (e.g., reads, alerts, log ins, etc.).

6.2.7. The system must provide the ability to produce an audible alert.

6.2.8. The system must have capability to output audible and/or visible notifications (display) to the user:

- GPS signal is diminished in strength or lost.
- GPS is disconnected or has failed.
- Any camera is disconnected or has failed.

6.3. Image Acquisition Requirements

6.3.1. The system must be able to acquire and interpret images during the following types of motion:

- System stationary and target moving: An example scenario is a fixed system installed alongside the road reading plates of passing vehicles.
- System stationary and target stationary: If system reads the same plate contiguously within a specified time frame, the system should either not continue to capture, have a manual override, or flag images.

6.3.1.1 Specialized cameras for the above applications may be designated for a specific application and not required to meet requirements for all types of motion.

6.3.2. The system must be capable of capturing images while compensating for variables related to motion including relative speed, relative position between the system and target, and angle of view (e.g., multiple viewing angles, complex angles, looking horizontally).

6.3.3. The system must be able to see and obtain an image in various conditions:

- Range of lighting conditions, including sun glare, full daylight, and night time.
- Inclement weather conditions, including snow, ice, rain, fog, and blowing sand. Reflections due to inclement weather conditions impact the system's ability to see and obtain an image.

6.3.4. The system must provide a contextual image in an industry standard file format to allow export to an external editing program.

6.3.5. The system must provide a contextual image with a user-definable minimum viewing range around the plate, and the image resolution must be maintained. This requirement is important because some agencies are restricted to viewing the plate only while others prefer a wider range so that scene details are provided.

6.3.6. The system should be able to capture the contextual image of a vehicle even if the vehicle's license plate cannot be read by the system. This feature should be configurable (e.g., turned on/off and triggered by reflectivity or other means) by the system administrator.

6.3.7. The system should provide a live view from all types of cameras (e.g., plate read, contextual read), not necessarily simultaneously, upon request of the user. This is needed for alignment and troubleshooting purposes.

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- Color recognition by the system for query purposes.

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6.4.4. The system must automatically produce metadata including the following information, and this information must not be embedded so that there is the ability to move its location on the screen:

- Time/date stamp for acquisition and time for OCR.
- GPS location of capture.
- Installation/site identifier.
- Camera designation; this applies to mobile and fixed systems.
- Alarm indications, such as power interruptions, low storage space, etc.
- User input of information.
- DME Audit Log.
- System Audit Log.

6.4.5. The DME Audit Log must include the following:

- User identification and logging in/out.
- Hash or other verification shall be computed for the duplicate using an industry-standard method and shall be defined and provided with the duplicate.
- The calculated hash of the duplicate should be recorded as part of the audit log, as well as the hash of the original file.
- Identification of the source of the DME, including the installation/site identification, CPU, hardware identification, etc.

6.4.6. The System Audit Log must include all system-level events, software updates, hardware changes, and a copy of the metadata. The system shall poll all system-level components and automatically record into the System Audit Log all system-level details and events, including the following, at least each time status changes:

- Date and time of event.
- GPS location of event.
- Hardware identification, including manufacturer and model number.
- Software version.
- System status change (e.g., boot up, power on).
- System-level component status change indicators (e.g., camera failure; changes to input/output ports, components, or APIs; loss of GPS signal).

6.4.7. The System Audit Log shall provide the ability to manually record at least the following:

- Installation/site identification.
- User identification.

6.5. Data Management and Output Requirements

6.5.1. The system must comply with at least the specified minimum resolution for the contextual photo, and this minimum resolution must also be defined. It is a desirable feature to also have user-configurable resolution.

6.5.2. The system must provide data that is exportable in an interoperable (i.e., NIEM-conforming) format.

6.5.3. The system must have capability to import interoperable (i.e., NIEM-conforming) records from external sources.

6.5.4. The system must provide storage of DME at the camera location to allow saving of DME at least until export.

6.5.5. The system must provide the capability to export a duplicate in the original file format.

6.5.6. The system must have capability to compare captures/reads with an alert list(s).

6.5.7. The system must have the capability to perform a standard query of statistics (e.g., vehicle counts, reads, hits, etc.).

6.5.8. The system must have the capability to securely transmit and receive data.

6.5.9. The system must provide the capability to perform a cryptographic verification (e.g., hash) for exported data.

6.6. Environmental Requirements

6.6.1. The system must be able to withstand and operate in moisture, humidity, and temperature extremes.

6.6.2. The system must be housed or protected to prevent ingress of water and dust.

6.6.3. The system cables and connections must be resistant to mechanical stress, crush, and ingress of dust or moisture.

6.6.4. The system must be able to withstand and operate during mechanical shock, vibration, and impact consistent with the intended operational environment. Test parameters must be defined. Cameras must maintain alignment, and the mounts must be durable.

6.6.5. The system must operate during electromagnetic/RF interference from other systems.

6.6.6. The system must not produce electromagnetic interference that will impact other systems.

6.7. Other Requirements

6.7.1. Documentation must be provided by the manufacturer, including the following:

- Specification sheets.
- User's manual (including programming procedures, installation instructions, precautions, and care and maintenance guidance) and quick start guide. This documentation must also be available via a website.
- Parts list.

7. Portable LPR Requirements

The committee recognizes that there is a category of portable LPR systems that incorporates characteristics of both mobile and fixed systems. The requirements for portable systems will be defined during development of the standard.

8. Recommendations

It is recommended that surveys and data collections be done to determine the operational conditions under which LPR systems are being used so that appropriate test methods for the standard may be developed. Careful consideration must also be given to definition of terms for the standard, such as contextual read, plate read, contextual image, plate image, and capture.

Appendix A Participants

Participant	Title	Organization
Hassan Aden	Deputy Chief	Alexandria (VA) Police Department, Patrol Operations Bureau
John Bergman	Software Architect, Chief Technical Officer	Xpedient Services, LLC
Rodney Brimlow	Sergeant	Broward County (FL) Sheriff's Office
Miles Brissette	Prosecutor	Tarrant County (TX) Criminal District Attorney's Office
M.T. Brown	Detective	Lawrence (KS) Police Department
Robert Burek	Senior Staff Engineer	SGS Consumer Testing Services
[redacted]	Computer Scientist	National Institute of Standards and Technology, Standards Coordination Office
Paul Coghill	Project Engineer	Intertek
Fernand Corriveau	Electronic Technologist, Forensic Video/Audio Technician	Canada Border Services Agency
Mike Fergus	Program Manager	International Association of Chiefs of Police
Grant Fredericks	Forensic Video Analyst	Forensic Video Solutions
[redacted]	Chief, Technical Support Division	Drug Enforcement Administration Intelligence Division
Ian Hamilton	Project Manager	International Association of Chiefs of Police
Scot Haug	Chief	Post Falls (ID) Police Department
Emile Larson	Captain, Deputy Commander – Narcotics Division	Jefferson Parish (LA) Sheriff's Office
Carl Maupin	Lieutenant	Leesburg (VA) Police Department, Field Operations Division
[redacted]	Project Manager, Land Border Integration	Department of Homeland Security, Customs and Border Protection
[redacted]	Electronic Engineer	Federal Bureau of Investigation
Joey Pomperada	Electronic Engineer	Space and Naval Warfare Systems Center, Joint Information Sharing Branch

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Participant	Title	Organization
Casandra Robinson	Program Manager	Savannah River National Laboratory
Frances Scott	Program Manager	National Institute of Justice
Mark Seifert	Deputy Superintendent, Lt. Colonel (ret.)	Delaware State Police
Dale Stockton	Project Manager	Automated Regional Justice Information System (ARJIS)
Brian Ursino	Director of Law Enforcement	American Association of Motor Vehicle Administration
Heather Whitton	Regional License Plate Reader Project Manager	Cincinnati (OH) Police Department

Appendix B Figures

Figure 1. Mobile LPR System Diagram

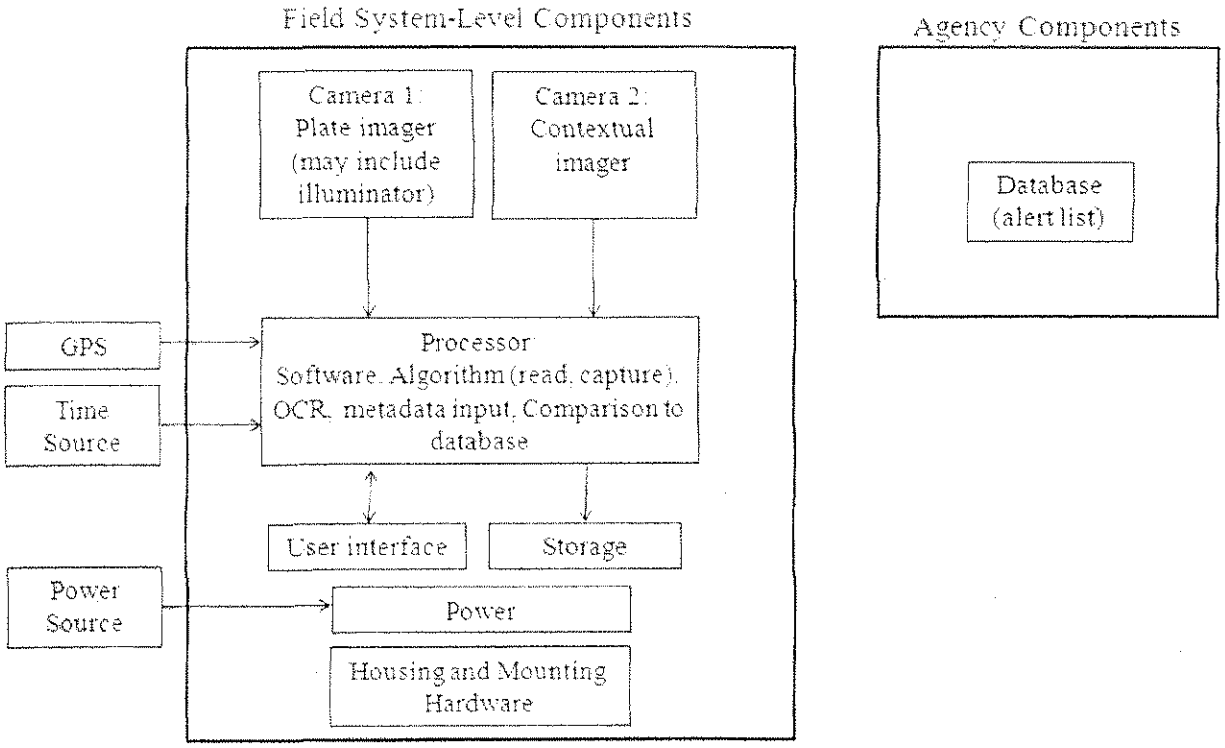

Figure 2. Fixed LPR System Diagram