WELCOME TO INSPECTIMARK - THE ROAD MARKINGS INSPECTION HUB

Thank you for choosing InspectiMark as your go-to resource for comprehensive information on the health status of road markings. Our mission is to provide you with a user-friendly platform where you can access detailed information regarding the health state of road markings. In this guide, we will walk you through the process of data collection, data analysis, results presentation, and how to harness the full potential of our product.

1. **DATA PROCESSING**

In this section the procedures of data collection, data analysis and results presentation are discussed.

Step 1: Data Collection

InspectiMark thrives on the collective efforts of users/citizens. By contributing to our data collection process, users make a crucial impact on improving road safety. The process of data collection is as follows:

1. **Downloading InspectiMark application:** First, users download our application from Play store (https://play.google.com/store/apps/details?id=com.inspectimark.app). InspectiMark App leverages crowdsourcing to collect real-time data about road markings. It is a user-friendly mobile app that make connection between road users and road authorities. This app allows road users, particularly drivers, to report road marking defects directly from the app. This data contribution from users is a valuable source of information for road authorities.

2. **Providing videos from the roads**: Provide visual evidence of road markings issues by uploading clear and well-documented videos recorded from the roads by the users. By

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encouraging users to contribute videos through InspectiMark, the potential for improving road marking inspection and enhancing road safety is tremendous. Users who utilize InspectiMark as a dashcam for their personal purposes can now extend their impact to benefit the broader community. Sharing their videos provides a valuable source of data for road authorities, allowing them to gain a real-time, on-the-ground perspective of road marking conditions. This collaborative effort not only aids in identifying and addressing road marking defects promptly but also fosters a sense of collective responsibility for road safety. It's a powerful example of how technology can bridge individual actions with a shared goal of making our roadways safer for all. The user-generated videos through InspectiMark play a pivotal role in creating a safer and more efficient road infrastructure, showcasing the impact of community involvement in shaping a safer transportation environment.

3. **Data features**: The recorded videos collected through InspectiMark come with several notable features that make them exceptionally valuable for road marking inspection and maintenance:

- **High Quality:** The videos are recorded in high quality, ensuring clear and detailed footage. This level of clarity is essential for accurately assessing road marking conditions and defects, as even minor imperfections can be easily identified.
- **GPS Coordinates:** Each video is tagged with GPS coordinates, providing precise location data. This feature enables road authorities to pinpoint the exact locations of road marking issues, facilitating quick and targeted responses for maintenance and repairs.

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- **Real-Time Data:** Since the videos are captured in real-time, they offer an up-to-the-date snapshot of road conditions. This real-time aspect allows for immediate action on critical road marking defects, enhancing road safety.

- **User Perspective:** The videos are recorded from the user's perspective, typically while driving. This user-generated viewpoint provides a unique vantage point that reflects the actual experience of road users, which is invaluable for road authorities to understand the challenges faced by drivers and pedestrians.

- **Comprehensive Coverage:** Users, by virtue of their daily travels, inadvertently provide a comprehensive view of road marking conditions across various routes. This wide coverage ensures that road authorities can assess and prioritize maintenance on an extensive network of roadways.

The combination of high-quality videos with GPS coordinates and real-time data gives road authorities a powerful tool for not only identifying road marking issues but also for making data-driven decisions to enhance road safety and the overall quality of road markings. These features collectively contribute to more effective and efficient road maintenance practices and improved road safety for all.

Step 2: Data Verification

Once users' data is submitted, the data undergoes under a careful verification process to make sure of the accuracy and relevance of the information. This verification process is vital to maintain the integrity of our database.

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Step 3: Data Analysis

Appropriate videos are analysis using state-of-the-art computer vision and artificial intelligence (AI) methods. Advanced Deep Learning models are developed and employed to carefully examine the videos, to detect and evaluate road markings, and to identify healthy and defective road marking. This includes recognizing various types of markings and different levels of defects such as faulty markings, defective markings and missing markings.

 The AI system identifies markings and categorizes them into Healthy and Defective groups. This categorization is vital for road authorities to prioritize maintenance and allocate resources effectively. For instance, a severely faded lane marking might require more immediate attention than a less critical issue.

Step 4: Results Combination and Presentation

Results aggregation and presentation in the context of InspectiMark are critical aspects of the solution, as they transform the data collected and analyzed into actionable information for road authorities. Here's how results are aggregated and presented:

- **Aggregation of Data:** The first step in results presentation involves aggregating the data obtained from the videos and their analysis. This data includes information about the location, type, and severity of road marking defects, as well as other relevant details such as visibility issues, risk factors, and historical data.

- **Geographic Information System (GIS) Mapping:** The processed data is integrated into a comprehensive Geographic Information System (GIS) map. This map displays the geographical locations of road marking defects using the GPS coordinates from the

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videos. It provides a clear and visual representation of where the issues are located, allowing you to quickly identify problem areas.

- **Comprehensive Reports:** InspectiMark generates a range of comprehensive reports based on the data analysis. These reports are essential for making informed decisions and prioritizing actions. The type of the generated reports depends on the customer's contract. The reports include:

  o **Defect Report:** Pinpoints the location, type, and severity of defective markings, facilitating targeted maintenance planning.

  o **Visibility Report:** Identifies visibility issues under various conditions, particularly beneficial for elderly road users.

  o **Risk Report:** Evaluates risk factors based on marking type, speed limits, defect severity, and more, enabling focused safety measures.

  o **Maintenance Report:** Supports optimized maintenance planning based on location, severity, risk, traffic, weather, and available resources.

  o **Prediction Report:** Forecasts future defects by analyzing historical degradation patterns, aiding in proactive maintenance.

  o **Performance Report:** Tracks material and contractor performance over time, fostering accountability and efficient contract management.

- **Results Visualization:** The presented results are often visualized through charts, graphs, and tables. This visual representation makes it easier for you to understand and act upon the data effectively.

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- **User-Friendly Interface:** InspectiMark typically provides you with a user-friendly interface for accessing and interacting with the aggregated results and reports. This interface allows you to navigate the data, view maps, and access detailed information with ease.

- **Actionable Insights:** The aggregated results and reports offer actionable insights that empower you to make informed decisions. Based on the demand, this can include prioritizing maintenance efforts, implementing targeted safety measures, optimizing resource allocation, and planning for long-term road marking improvements.

- **Continuous Monitoring and Updating:** The results presented are not static. InspectiMark allows for continuous monitoring and updating of the data as new videos are collected and analyzed. This ensures that you have access to the most up-to-date information about road marking conditions.

In summary, results aggregation and presentation in InspectiMark provide you with the necessary tools to understand the state of road markings, prioritize maintenance, enhance safety, and allocate resources efficiently. The combination of GIS mapping, comprehensive reports, and user-friendly interfaces ensures that the data is not only collected but also translated into actionable insights for improving road infrastructure and safety.

2. INSPECTIMARK'S WEB GIS

InspectiMark Website (https://inspectimark.com/) offers an interactive Web GIS platform that allows you to access and visualize geographic data related to road markings. Here are some of the potential features that our website can provide to enhance the user experience:

- **User-Friendly Interface:** The website has an intuitive and user-friendly interface that makes it easy for you to navigate and access the information they need.

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- **Map Visualization:** The core feature of our web GIS is the map visualization. Users can view road marking data on an interactive map, which allows for easy identification of areas with defects or maintenance needs. The map supports zooming, panning, and various layers for displaying different types of data.

- **Data Filtering and Search:** You would be able to filter and search for specific information, such as types of defects, locations, or time periods. This feature makes it convenient for RWS to focus on the areas and data that are most relevant to their needs.

- **Real-Time Data:** Our web GIS can provide real-time updates on road marking conditions. This ensures that road authorities can respond quickly to emerging issues reported by users through the InspectiMark app.

- **Crowdsourced Data Integration:** The web GIS seamlessly integrates the data collected through the InspectiMark app. This integration allows increasing reliability of the results by increasing the number of measurements for a specific area.

- **Report Access:** Users are able to access the comprehensive reports generated by InspectiMark directly from the web GIS. These reports, such as defect reports, visibility reports, and risk reports, are valuable for making informed decisions.

- **Data Export:** This allows users to export data from the web GIS for further analysis or reporting purposes. This is in the form of downloadable spreadsheets or reports.

- **User Permissions and Collaboration:** User permission settings controls who can access and edit data. Collaboration features can enable multiple stakeholders to work together on maintenance planning and decision-making.

- **Mobile Accessibility:** Our web GIS is responsive and mobile-friendly so that you can access it on various devices, including smartphones and tablets.

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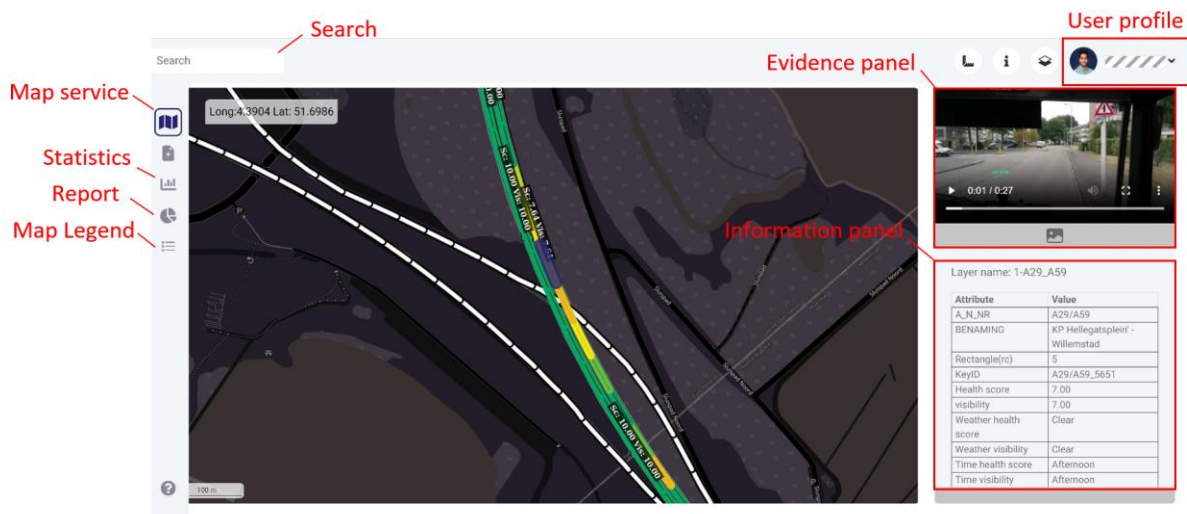|	
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- **Educational Resources:** Our web GIS provides resources and documentations for users to better understand how to use the web GIS effectively. These training materials and guides can be valuable for new users.

- **Support and Feedback:** InspectiMark offers a support system for users to provide feedback or report issues related to the web GIS. This helps ensure a smooth user experience and allows for continuous improvement.

- **Customization:** Depending on the specific needs of the users, customization options are provided to allow them to tailor the interface and data display to their preferences.

InspectiMark web GIS creates a powerful and user-friendly platform that empowers you to make data-driven decisions, prioritize maintenance efforts, and improve road safety based on the insights provided by InspectiMark.

2.1. Different parts of our Web GIS panel

Below, you'll find an image displaying our Web GIS panel's homepage, with various sections highlighted for in-depth discussion to follow.
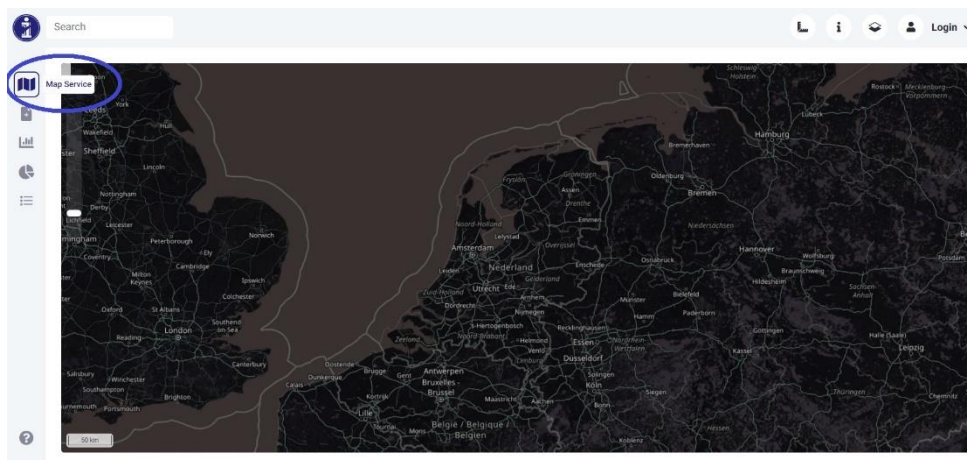
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2.1.1. Map Service:

This section offers both spatial and nonspatial data concerning the map of markings. It showcases tools associated with the map and the information accessible through it. To enrich user engagement with the map service and simplify data and information exploration, we've seamlessly integrated an array of tools and functionalities into the map interface. Detailed information on these map features and instructions on their utilization can be found within this section.


- **User Profile**

Realizing the complete potential of map features and gaining access to both spatial and non-spatial information requires the imperative step of completing the system registration process. Once your user account receives approval and access levels are set by the system administrator,

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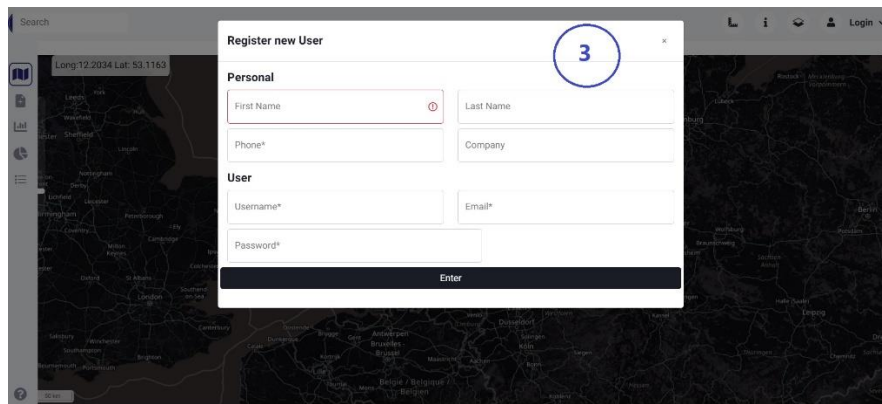|	
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you will have the ability to access map data and employ crucial data analysis tools in accordance with your access permissions.

To initiate the user account creation process, please adhere to the steps below:
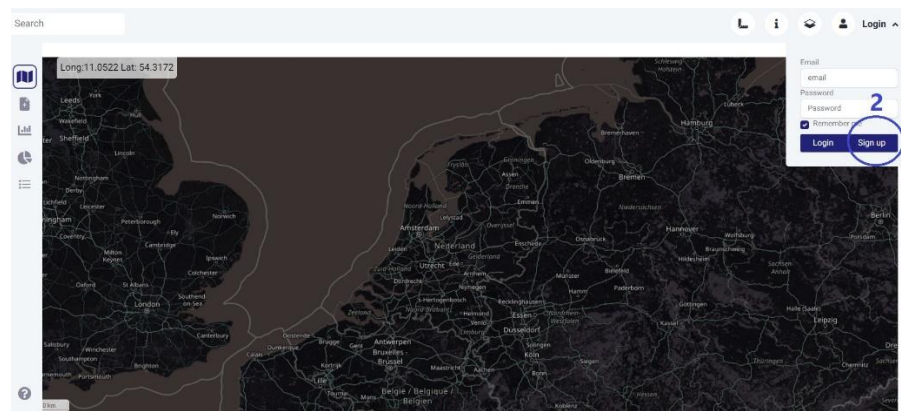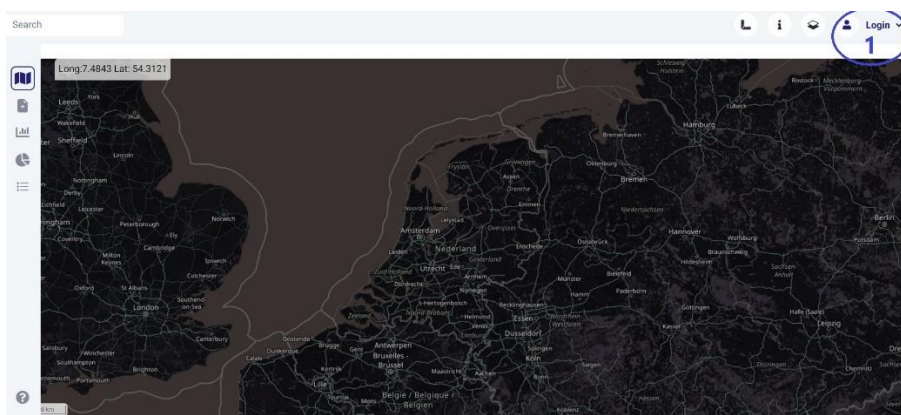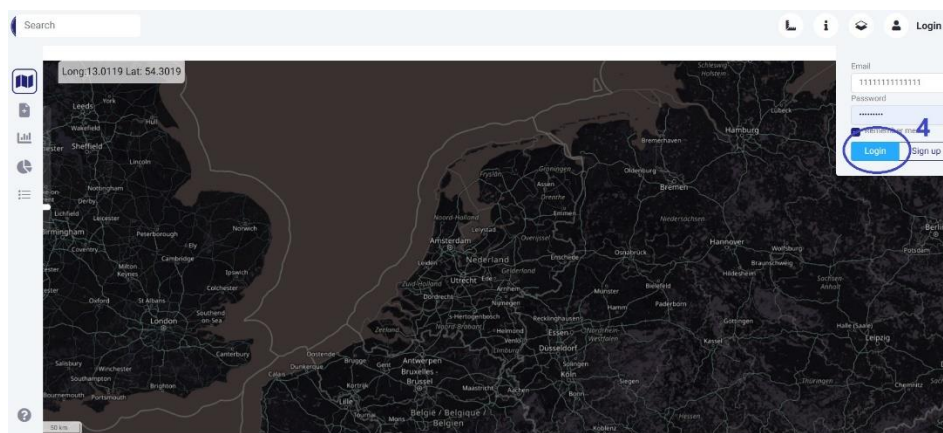
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Note: Once you've successfully created your user account, the system administrator will conduct a review of your account information. Following approval, you will receive a confirmation email containing your user account details. Subsequently, you can log into the system by using the username and password provided to you.

You are now able to utilize map tools and features in accordance with your access level to the information.

- ***Evidence Panel***

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The images and videos corresponding to each defective section are viewable here. When you choose a specific section on the map, this panel opens automatically, displaying images or videos that illustrate the presence of defective markings in that section. It's important to note that this evidence is exclusively provided for sections with a health score below 10. If a section has a health score of 10, the evidence panel remains empty, showing no content.

- **Information panel**

This panel provides comprehensive details about the chosen section, encompassing a range of information, including, but not restricted to:

  o **Road Information:** This section includes data such as the highway name, segment name, and section number.

  o **Markings Information:** It specifies the count of various types of markings present in the selected section.

  o **Measurements Information:** This part furnishes data on the measurements conducted, including the number of measurements taken, the time of day for each measurement, the prevailing weather conditions during each measurement, and the health score associated with each measurement.

  o **Health Score and Visibility:** Here, you can find the overall health score and visibility of the chosen section, derived from the collective results of all the measurements.

- **Search**

This tool allows you to look up a particular highway or segment.

- **Filter**

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With the filter tool, you have the capability to refine the results according to various criteria, including health score, visibility, weather conditions, daily time, and more.

2.1.2. Statistics

Within this section, you'll discover data pertaining to the project's advancement, the percentage of completion for each highway, the quantities of collected, analyzed, and deployed data, and a comparison of different highways based on the quantity of defective markings.
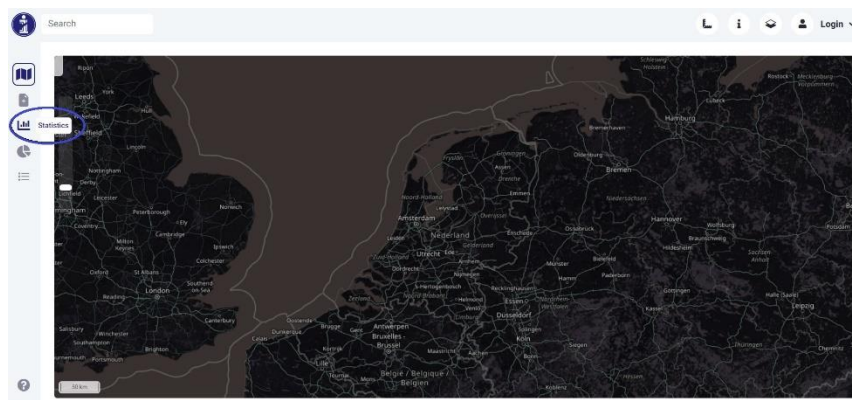
2.1.3. Report

You have the capability to create personalized reports for the entire project or for a specific portion of the project, be it a particular highway, segment, or section. The types of reports you can generate, including defect reports, visibility reports, risk reports, prediction reports, maintenance reports, and performance reports, are contingent upon your access level.
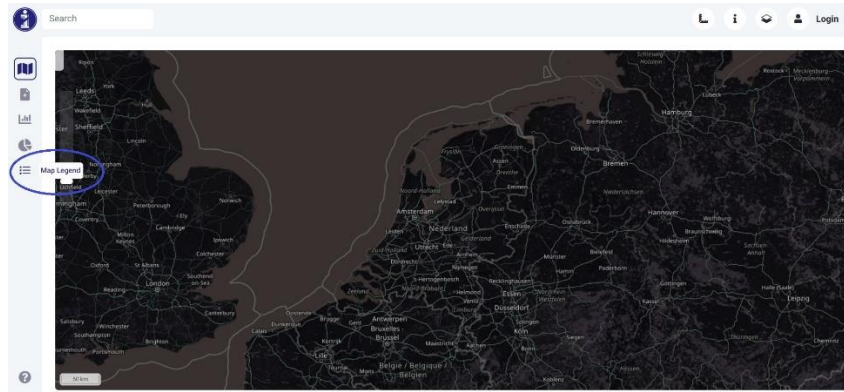
2.1.4. Map Legend

This section empowers you to customize the map style to align with your specific requirements.

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FAQ

1. **What categories of road markings are identified by InspectiMark?**

Our AI model can distinguish between 16 types of markings, each classified into two categories: 'Correct' and 'Defective,' resulting in a total of 32 distinct categories. These 16 types of markings are shown below. Correct markings are specified with a "c" letter after the name of the marking, e.g., a correct rectangle is shown by "rcc" or a correct yield is denoted by "yc". On the contrary, defective markings are specified with a "f" letter after the name of the marking, e.g., a defective rectangle is shown by "rcf" or a defective yield is denoted by "yf".
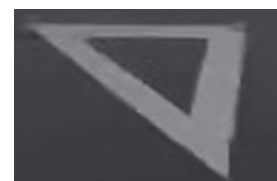
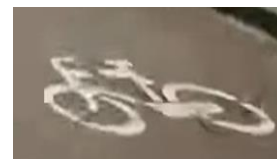|			
Rectangle (rc)	Square (sq)	Double-Rectangle (drc)	Big Yield (by)
Yield (y)	Right Turn (rt)	Left Turn (lt)	Bicycle (b)
Straight-Right Turn (srt)	Straight-Left Turn (slt)	Keep Left (kl)	Keep Right (kr)

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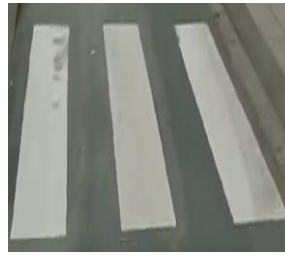|	
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| Roundabout (ra) | Straight (s) | Zebra (z) | Speed Ramp (sr) |

2. **When is a marking identified as a defective marking?**

Our AI technology has undergone extensive training using a substantial dataset comprising thousands of labeled road images. These images were captured from various locations on Dutch roads and meticulously labeled by our team. This dataset encompasses both correct and defective markings. Accordingly, when the AI model analyses videos provided by the users, if a marking is faded or partially-removed, the AI model labels it as a defective marking. Some examples of defective and correct markings are illustrated below.

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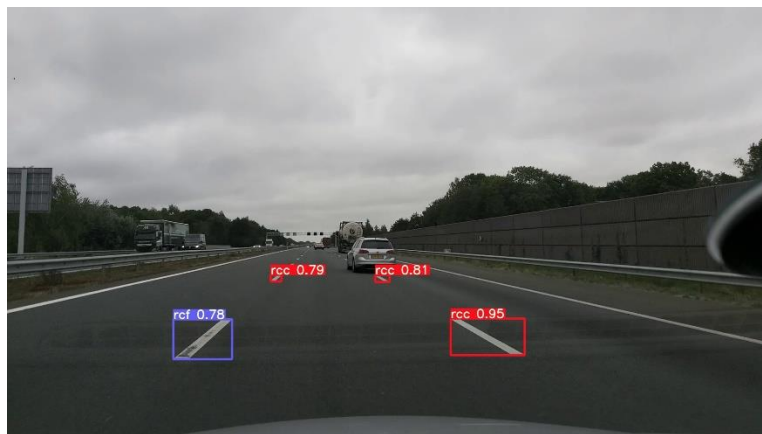
3. **How have the roads of RWS been divided into discrete segments within our Web GIS panel?**

RWS has designated distinct names for their highways, such as A29, A10, and so on. Each of these highways is subsequently divided into shorter segments, ranging from less than 1 kilometer to more than 104 kilometers, as determined by RWS. These segments are further subdivided into sections, each with a length of 40 meters, and detailed information regarding the markings within each specific 40-meter section is provided. In essence, each section contains comprehensive

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information about all the markings present within that particular 40-meter segment. It's important to note that the section lengths have been carefully chosen to strike a balance between providing a satisfactory level of detail and ensuring practical ease of maintenance. If RWS has any particular preferences or requirements regarding section length, we are open to making adjustments accordingly.

4. **What is visibility?**

In the context of road markings, visibility refers to how well these markings can be seen and recognized by drivers and other road users. It encompasses various factors that affect the ease with which road markings can be observed, understood, and followed, ensuring safe and efficient traffic flow. Some key factors influencing visibility in road markings include:

- *Contrast:* The difference in color or luminance between the marking and the road surface plays a crucial role in visibility. High-contrast markings are more visible, especially under varying lighting conditions.
- *Retroreflectivity:* Road markings are often designed to be retroreflective, meaning they bounce light from vehicle headlights back toward the drivers. This enhances visibility at night or in low-light conditions.
- *Maintenance:* Proper maintenance, such as regular repainting, is essential to ensure that road markings remain visible over time. Faded or worn markings can reduce visibility and safety.
- *Weather conditions:* Visibility can be significantly affected by adverse weather conditions such as rain, snow, or fog. High-quality road markings are designed to remain visible in various weather conditions.

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- ***Daily time:*** During certain times of the day, like early morning or evening, the visibility of road markings may decrease due to the angle of sunlight.

To ensure accurate data on road marking visibility, it is necessary to capture and analyze multiple videos under various daily timeframes and weather conditions using the AI model. These weather conditions encompass a range from sunny, rainy, snowy, cloudy, partially cloudy, to overcast. Daily timeframes include early morning, morning, afternoon, evening, and night. The mobile app automatically assigns time and weather condition tags to each recorded video. These tags are subsequently employed to generate and interpret the visibility report.

5. **How does our AI model calculate the health score and visibility of markings?**

Our AI model analyzes every frame of a recorded video, and for each frame, it calculates the health score by taking into account the quantity of both defective and intact markings present in that frame. This calculation also considers the probability of detection associated with the AI model's analysis of those markings.

However, the question arises: ***how are these frame-based results displayed on our Web GIS map?***

To elucidate how the AI model computes health scores and visibility across roads, it is essential to delve into the hierarchical structure of highways within our Web GIS platform. Each frame of a video is linked to a specific GPS coordinate. Therefore, based on the frame rate of recorded videos by the InspectiMark app (25, 30, 48, 50, and 60), we will have 25, 30, 48, 50, or 60 GPS points on the Web GIS map, each point containing information extracted from its associated frame. These individual points, situated within each 40-meter section, collectively contribute to the creation of section-specific information. All the sections within a segment, each spanning 40

meters, consolidate their data to generate segment-specific information. Ultimately, all segments within a given highway culminate in the generation of comprehensive highway-level results.

The health score and visibility of highways, segments, and sections are determined based on the individual points' health score and visibility.

For a specific point on the map, its health score is derived as the maximum score from various measurements. For example, if point A has scores of 10, 7.5, and 8.1 in three different measurements, its final health score is considered as 10. Conversely, the visibility score for a specific point is determined as the minimum score among those measurements. In the case of point A, its visibility score would be 7.5.

When it comes to sections, their health score and visibility are computed as the average value of the health and visibility scores of points within that section. Similarly, for segments, the health score and visibility are calculated as the mean values of the health and visibility scores of points within that segment. For highways, the health score and visibility are determined by averaging the health and visibility scores of points located within that highway.

6. **How is user privacy addressed by InspectiMark?**

In our Web GIS platform, user privacy is of utmost importance. To safeguard individuals' personal information, we have implemented a privacy-conscious approach that includes blurring both vehicle license plates and human faces in our geospatial data. This intentional blurring not only complies with privacy regulations and ethical standards but also ensures that sensitive information remains protected. Furthermore, as a standard practice, our App records all videos without audio to ensure the privacy of our users.

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