

# Chapter 1

## Introduction

### 1.1 Overview

According to the National Road Length by Classification, Surface Type, and Condition of the Department of Public Works and Highways (DPWH), as of October 2022 approximately 98.97

In an interview with the Road Board of DPWH Region 6 it was stated that road condition assessments are mostly done manually with heavy reliance on engineering judgment. In addition, manual assessment of roads is also time consuming which leaves maintenance operations to wait for lengthy assessments (J. Chua, Personal Interview. 16 September 2024). In a study conducted by Ramos, Dacanay, and Bronuela-Ambrocio (2022), it was found that the Philippines' current method of manual pavement surveying is considered as a gap since it takes an average of 2-3 months to cover a 250 km road as opposed to a 1 day duration in the Australian Road Research Board for the same road length. Ramos et al. (2022) recommended that to significantly improve efficiency of surveying methods and data gathering processes, automated survey tools are to be employed. It was also added that use of such automated surveying tools can also guarantee the safety of road surveyors (Ramos et al., 2022).

If the process of assessment on the severity of road defects can be automated then the whole process of assessing the quality of roads can be hastened up which can also enable maintenance operations to commence as soon as possible if necessary. If not automated, the delay of assessments will continue and roads that are supposedly needing maintenance may not be properly maintained which can affect the general public that is utilizing public roads daily.

## 88 1.2 Problem Statement

89 Roads support almost every aspect of daily life, from providing a way to transport  
90 goods and services to allowing people to stay connected with their communities.  
91 However, road defects such as cracks and potholes damage roads over time, and  
92 they can increase accident risks and affect the overall transportation. The current  
93 way of inspecting the roads for maintenance is often slow as it is done manually,  
94 which makes it harder to detect and fix defects early. The delay in addressing  
95 these problems can lead to even worse road conditions (J. Chua, Personal Inter-  
96 view. 16 September 2024). There are several research studies into automated  
97 road defect classification that have advanced in recent years but most of them  
98 focus on identifying the types of defects rather than assessing their severity or  
99 characteristics like depth. Without reliable data on the depth of the defect, road  
100 maintenance authorities may underestimate the severity of certain defects. To ad-  
101 dress these challenges, advancements are needed across various areas. An effective  
102 solution should not only detect and classify road defects but also measure their  
103 severity to better prioritize repairs. Failing to address this problem will require  
104 more extensive repairs for damaged roads, which raises the cost and strains the  
105 budget. Additionally, road maintenance would still be slow and cause disruptions  
106 in daily activities. Using an automated system that accurately detects, classifies,  
107 and assess the severity of road defects by incorporating depth are necessary to  
108 efficiently monitor road quality.

## 109 1.3 Research Objectives

### 110 1.3.1 General Objective

111 This special problem aims to develop an automated system that will accurately  
112 detect, classify, and assess the severity of the different types of road defects by us-  
113 ing image analysis, depth measurement technologies, and combination of machine  
114 learning and computer vision techniques.

### 115 1.3.2 Specific Objectives

116 Specifically, this special problem aims:

- 117 1. To collect high-quality images of road surfaces that capture different types of

- 118 road defects including their depth in various lighting and weather conditions.
- 119 2. To develop and train a machine learning model to detect, classify, and assess  
120 the severity of road defects from images.
- 121 3. To measure the accuracy of the system by comparing the depth measure-  
122 ments against ground truth data collected from actual road inspections
- 123 4. To develop a prototype system that can detect and measure road defects  
124 from image input, analyze their depth, and assess their severity.

## 125 1.4 Scope and Limitations of the Research

126 This system will include a collection of images of different road defects, such as  
127 potholes and cracks, using cameras and depth-sensing tools. The images will be  
128 captured under various lighting and weather conditions to ensure that the data  
129 has variations. The scope is limited to visual and depth data. High-quality and  
130 diverse image data sets are essential for training an efficient model, and by focusing  
131 on capturing the depth, it will allow a more accurate assessment of severity of the  
132 road defects.

133 Depth measurement tools, such as LiDAR drones or stereo cameras will be used  
134 to record the depth of the road defect. Only accessible defects will be measured,  
135 any cracks and potholes filled with water may not be accurately assessed.

136 A machine learning model will be used to identify, classify, and assess the  
137 severity of road defects. It will use the image dataset to classify and assess the  
138 road defect types accurately, however, the effectiveness will depend on the quality  
139 and quantity of the training dataset. There can be a limited variety of images  
140 or inaccuracies due to environmental factors. The model will allow consistent  
141 and automated assessment of road defects which is more efficient than manual  
142 inspection.

143 The accuracy of the system will be evaluated by comparing the depth measure-  
144 ment it produces against data collected from the field through manual inspections.  
145 However, the comparisons could be limited to selected sample sites because col-  
146 lecting field data across a wide area can be time-consuming. Comparing the data  
147 is important to validate the reliability of the system. It ensures that the data  
148 that the system produces is accurate so it increases confidence in using it for road  
149 maintenance.

## 150 1.5 Significance of the Research

151 This special problem aims to be significant to the following:

152 *Computer Science Community.* This system can contribute to advancements  
153 in computer vision and machine learning by using both visual and depth data to  
154 assess the severity of road defects. It introduces a more comprehensive approach  
155 compared to the usual image-only or manual inspection methods. This combina-  
156 tion can be applied to other fields that need both visual and depth analysis like  
157 medical imaging.

158 *Concerned Government Agencies.* This system offers a valuable tool for road  
159 safety and maintenance. Not only can this detect and classify anomalies, it can  
160 also assess the defect's severity which allows them to prioritize repairs, optimal  
161 project expenditures, and better overall road safety and quality.

162 *Field Engineers.* In the scorching heat, field engineers are no longer required  
163 to be on foot unless it requires its engineering judgement when surveying a road  
164 segment. It can hasten the overall assessment process.

165 *Future Researchers.* The special problem can serve as a baseline and guide of  
166 researchers with the aim to pursue special problems similar or related to this.