



The Discrimination of Less Frequently Encountered Colored Pen Inks Based on their Optical Properties

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ABSTRACT

Minimal information is available to questioned documents examiners when confronted with less frequently encountered colored inks. Therefore, this study explored the properties of less common ink colors from typically encountered writing instruments such as ballpoint, rollerball, porous-tips, and gel pens. The goal of this project was to determine the most discriminating conditions for each ink type and color. This was achieved by spanning different illumination techniques that are commonly used during questioned document examinations, such as sample exposure to filtered colored light, infrared reflectance, infrared luminescence, and fluorescence by ultraviolet excitation. For comparison purposes, the gray value of ink strokes was measured using the plot profile tool in ImageJ software.

INTRODUCTION

An extensive body of research has been dedicated to investigating multiple methods of ink analyses and differentiations primarily of the more popular black and blue inks.

Less data are available to questioned documents examiners when confronted with less frequently encountered colored inks, such as red, purple, green, turquoise, pink, orange, and maroon.

This study explored the properties of these less common ink colors of frequently encountered writing instruments such as ballpoint, rollerball, porous-tips, and gel pens.

The optical properties of the ink samples were first considered because these are the first features that questioned document examiners inspect, especially in the context of comparative examinations between unknown specimens and inks from known sources.

The goal of this study was to determine the most discriminating conditions for a given set of ink type and color. However, only preliminary data for green gel and ballpoint ink pens are provided.

MATERIALS AND METHODS

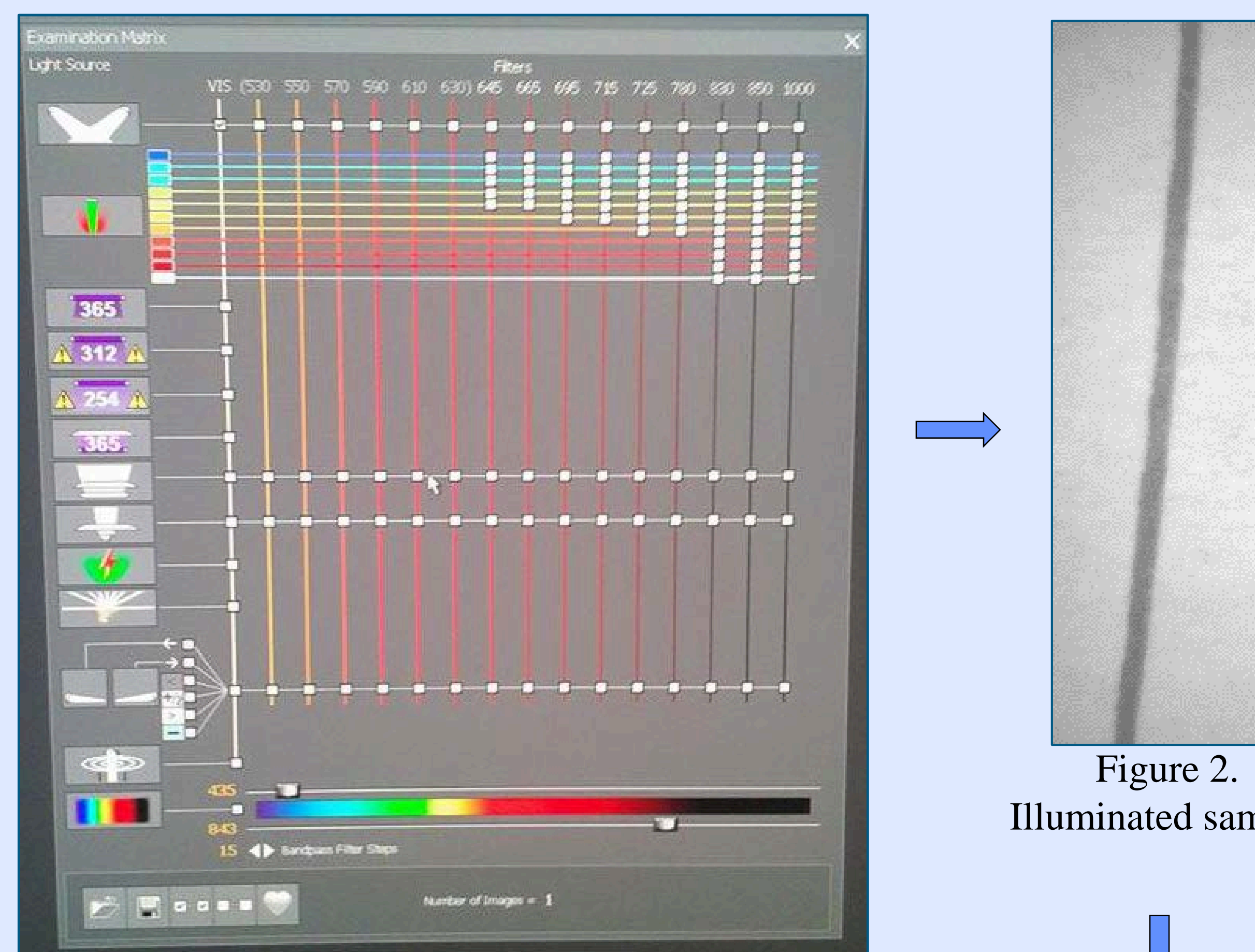


Figure 1. Auto-Examination Matrix of the VSC 6000.

Figure 2. Illuminated sample.

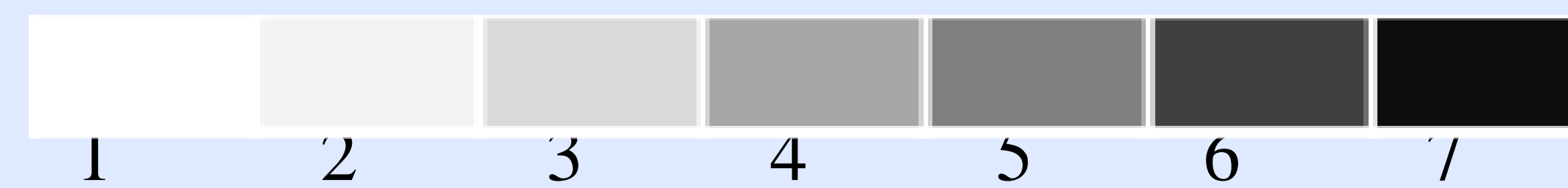


Figure 3. Grayscale to assess variability.

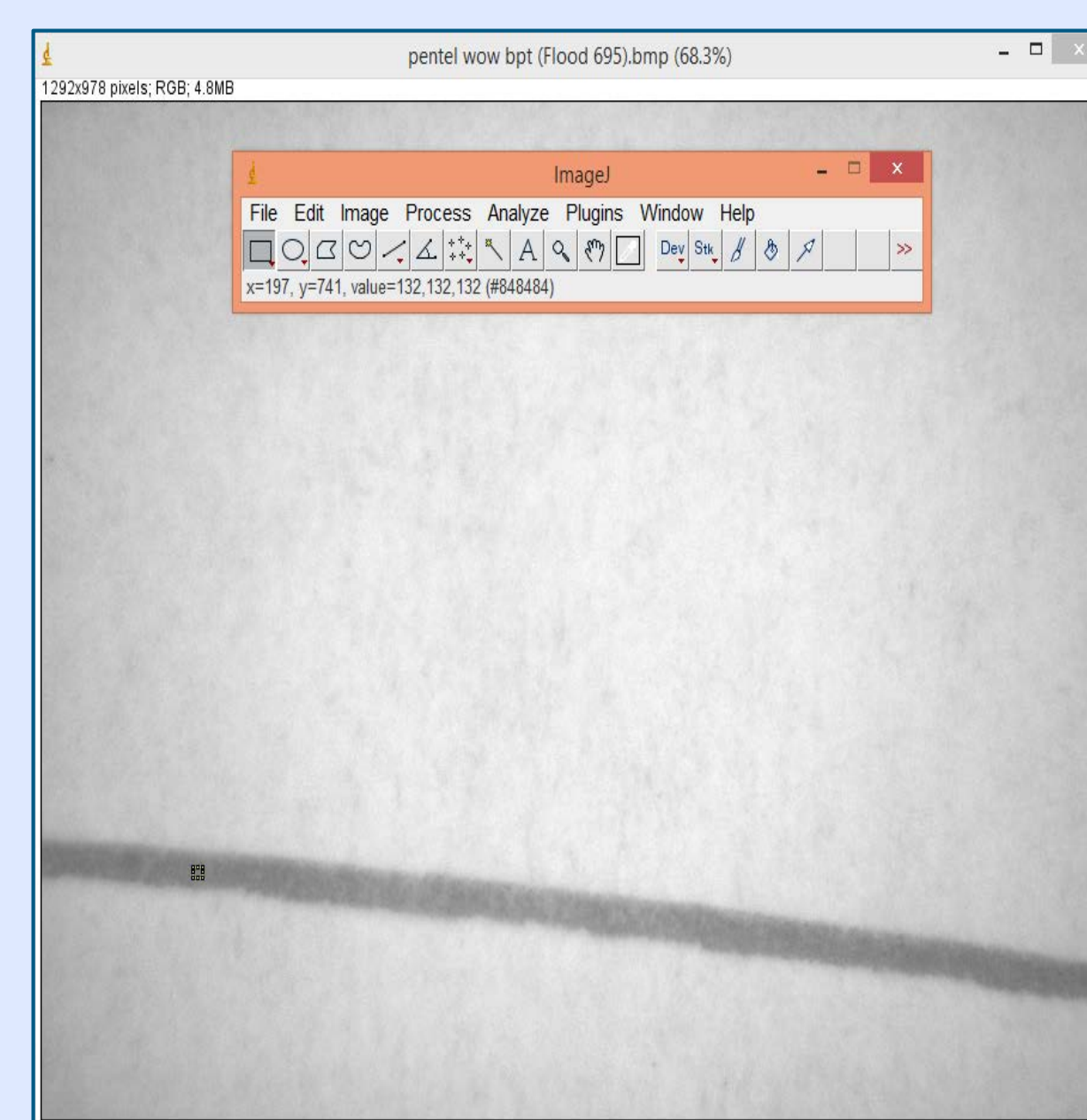


Figure 4. Image J Analysis.

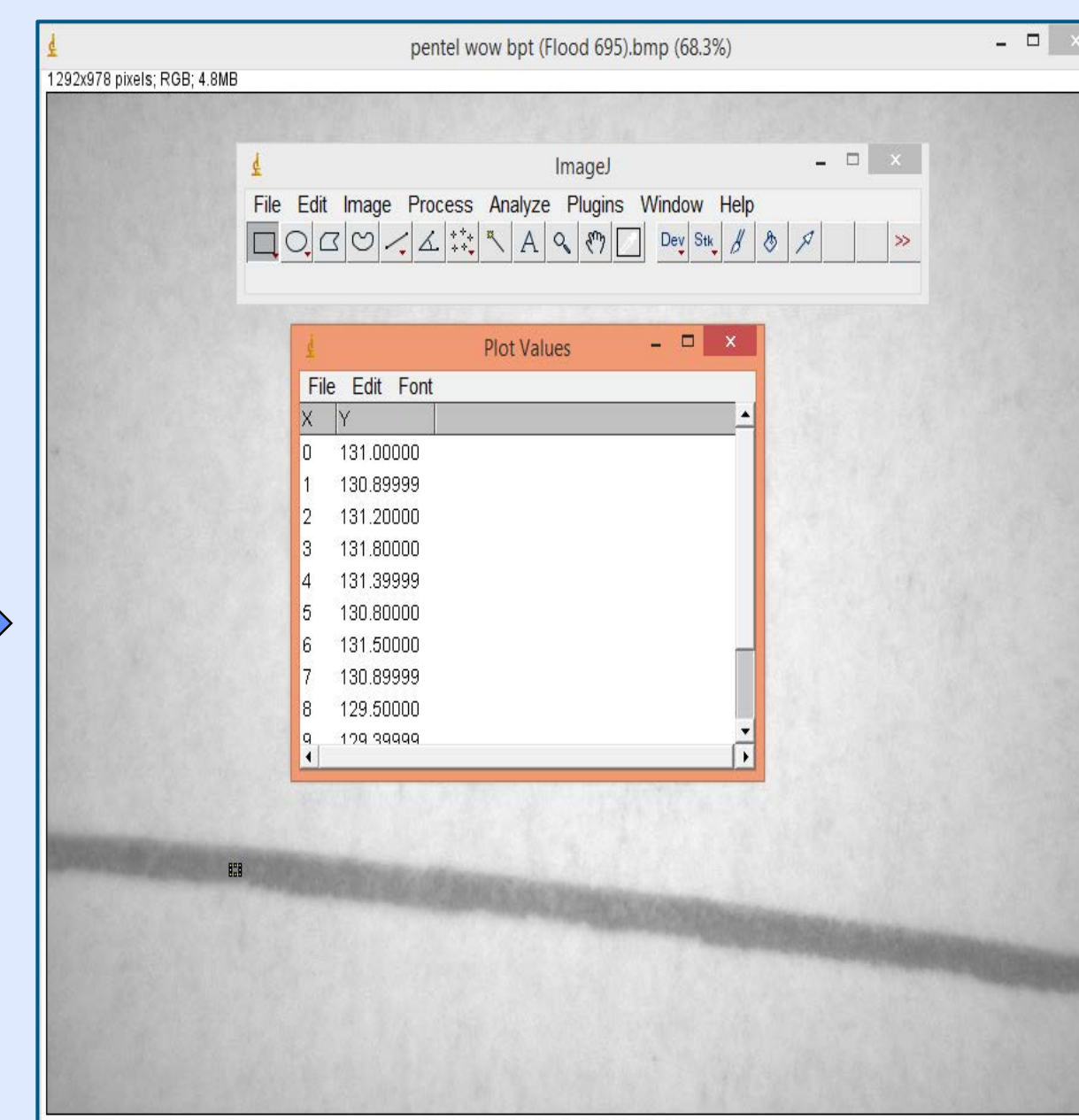


Figure 5. Image J intensity values.

RESULTS

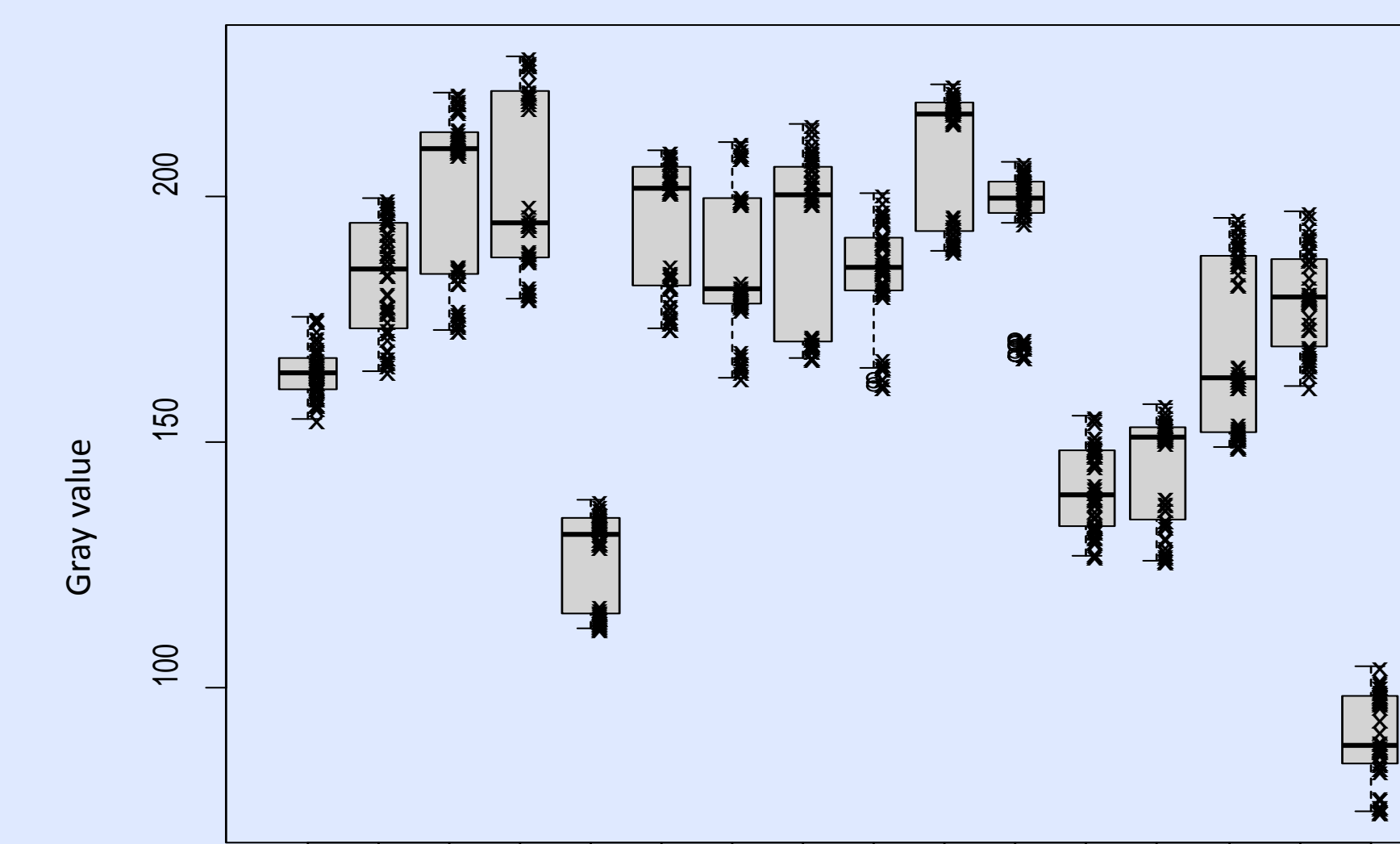


Figure 6. Box plot for green gel pens using the 695 nm visible light filter.

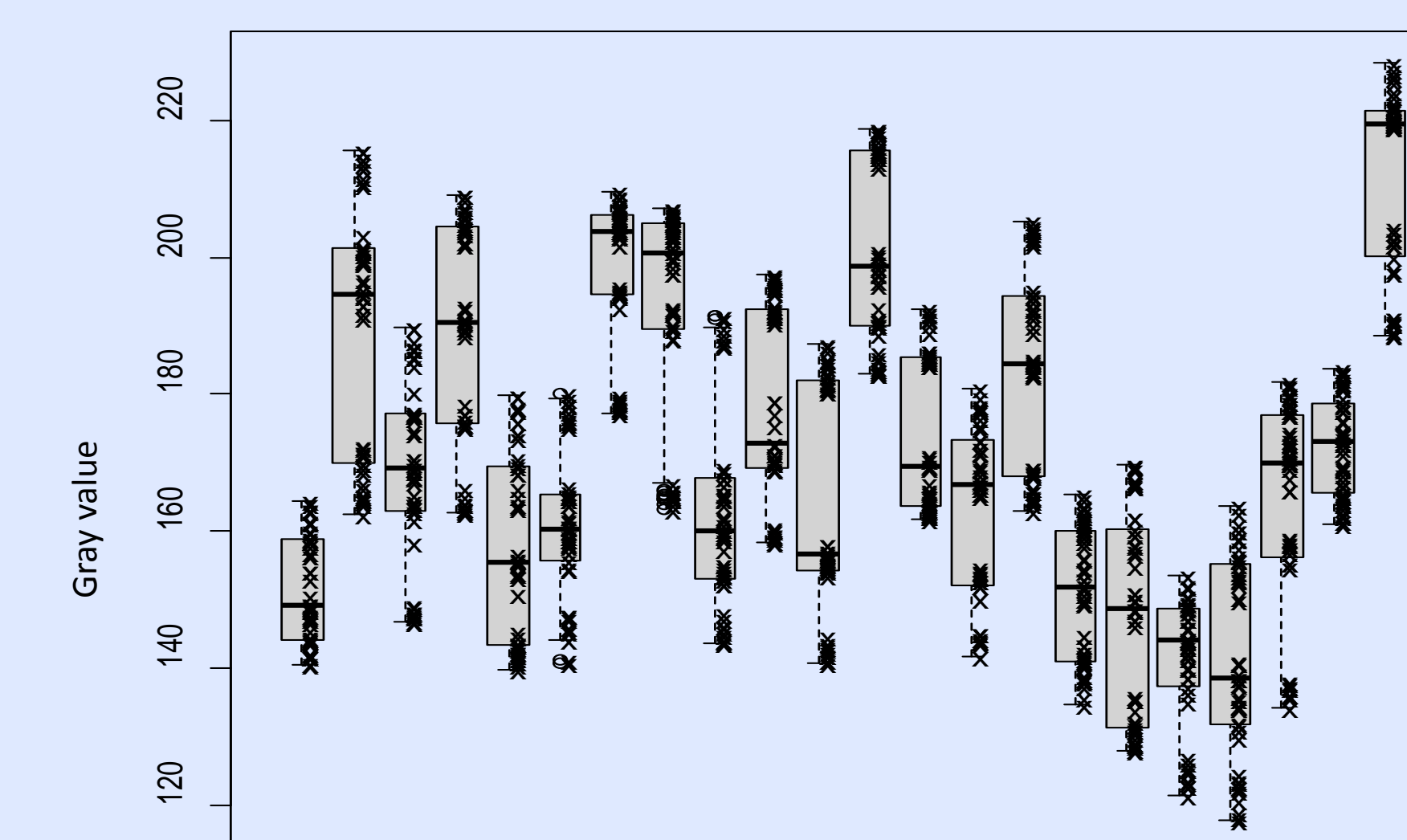


Figure 7. Box plot for green ball point pens using the 695 nm visible light filter.

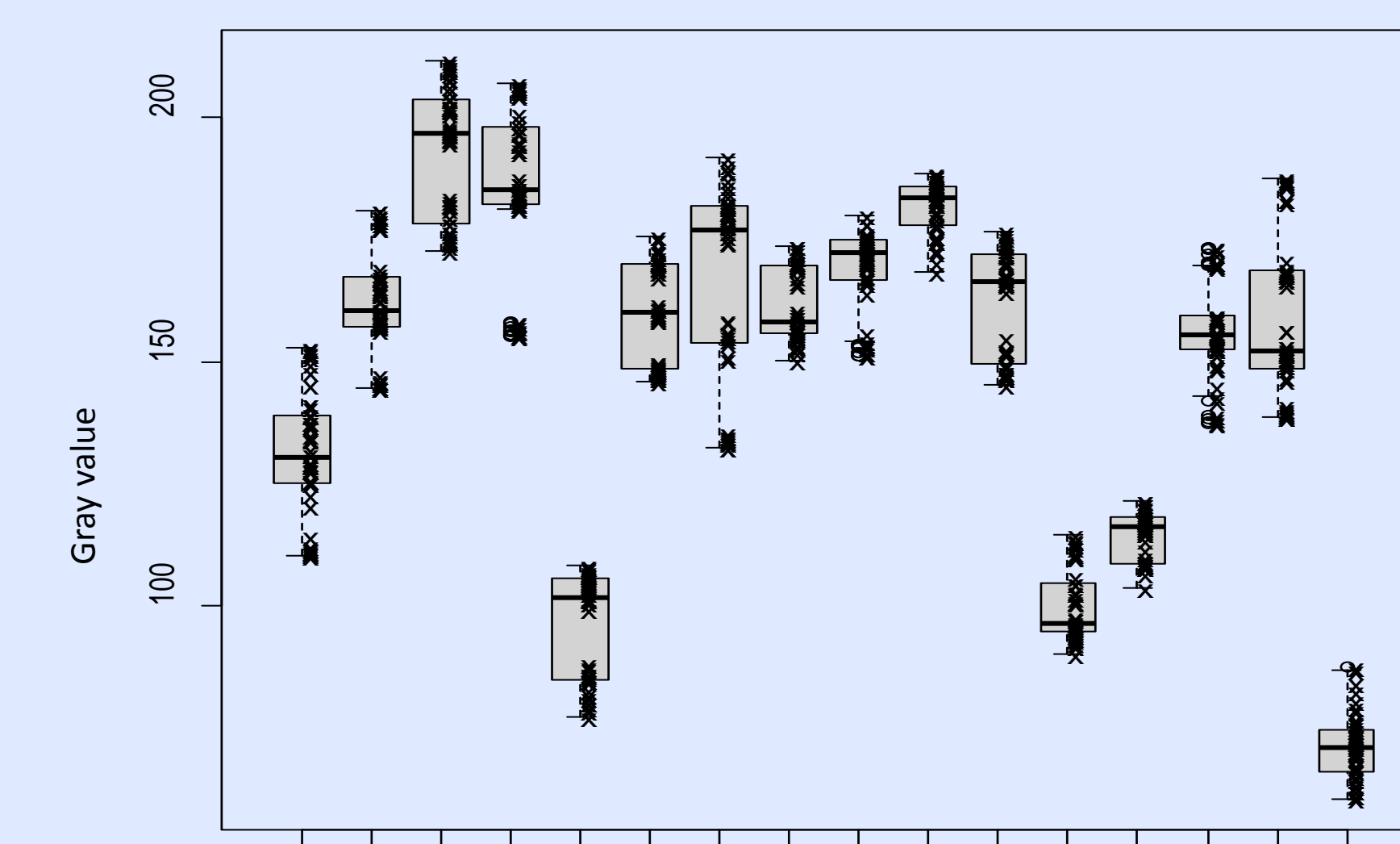


Figure 8. Box plot for green gel pens using the 665 nm visible light filter.

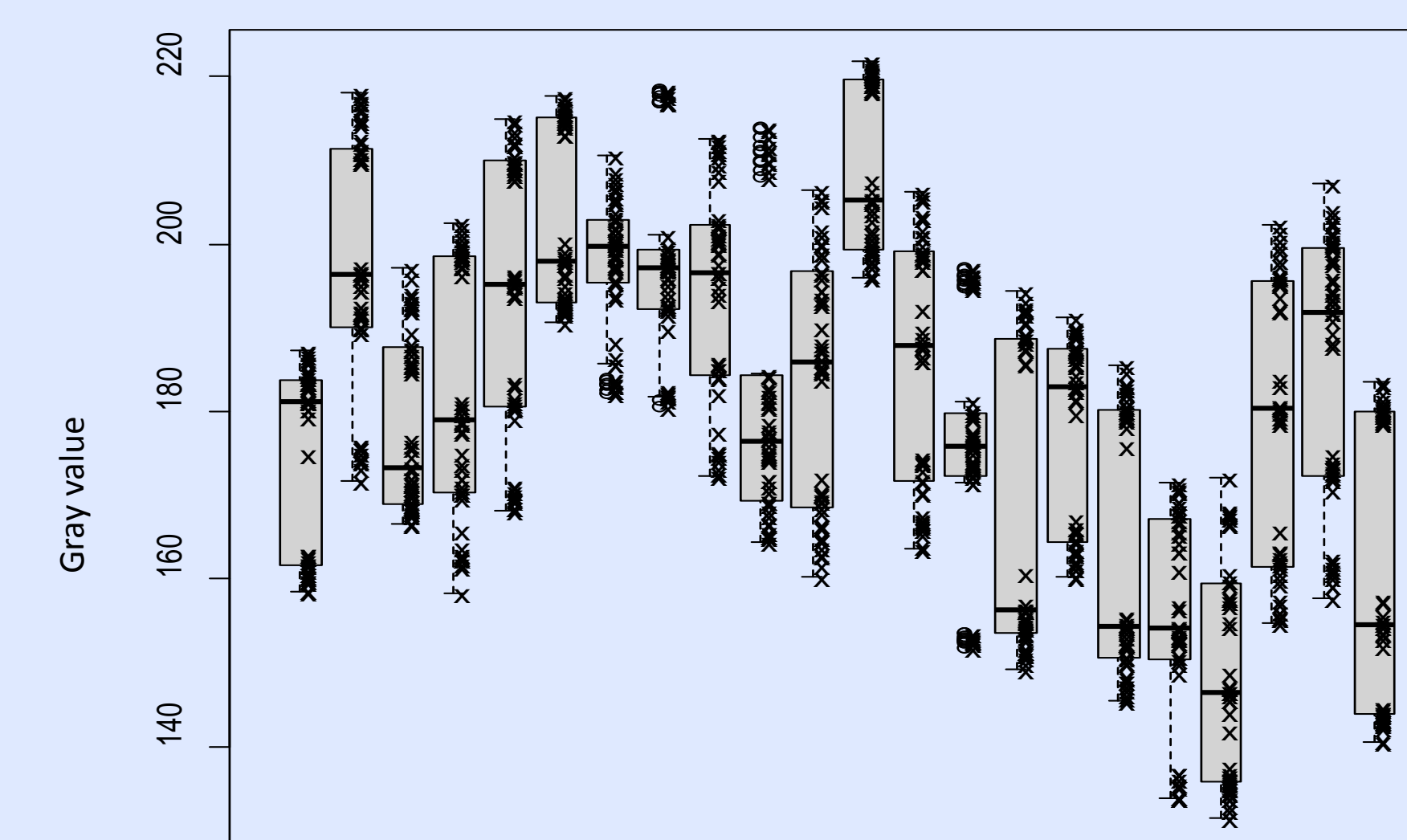


Figure 9. Box plot for green ball point pens using the 715 nm visible light filter.

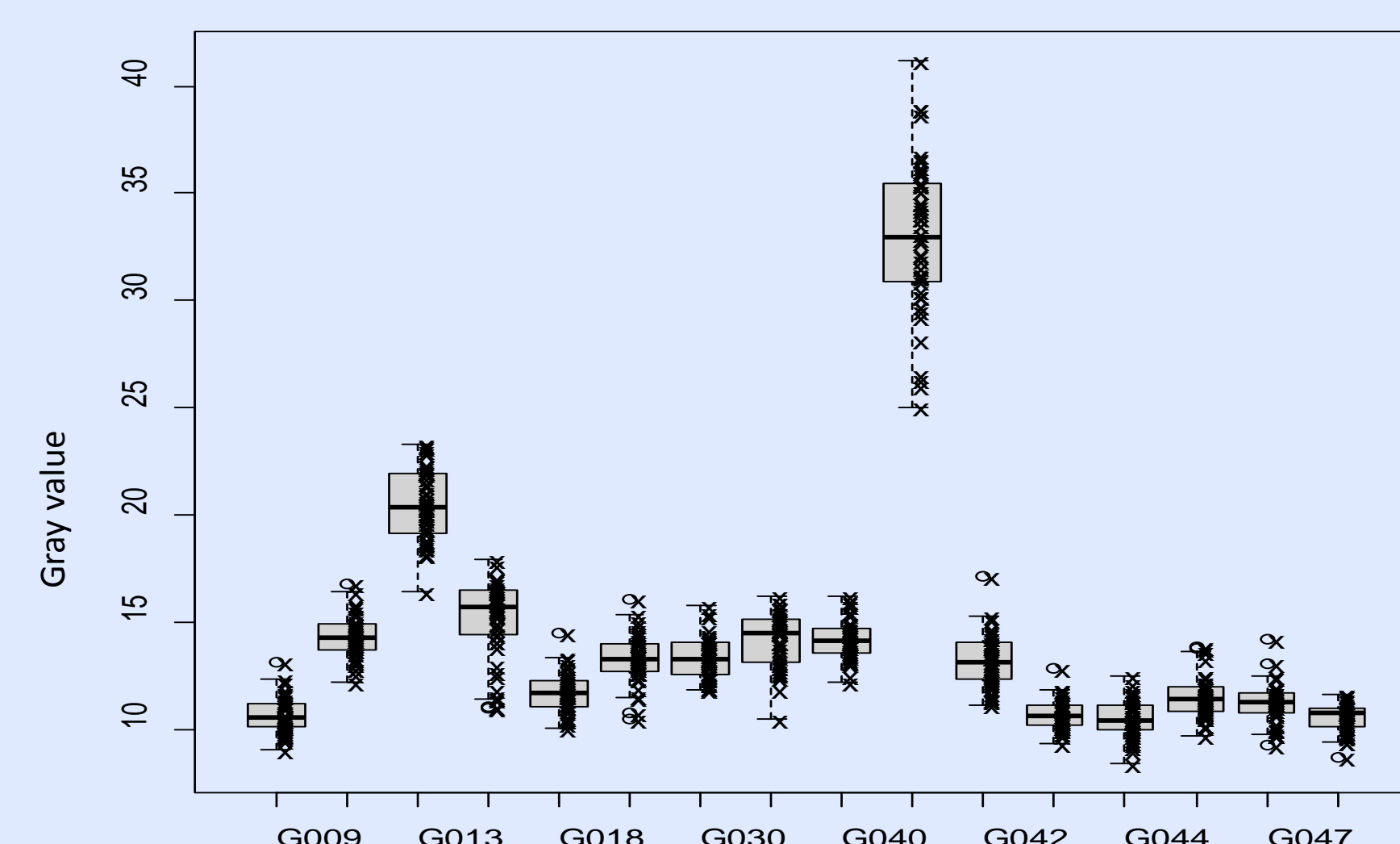


Figure 10. Box plot for green gel pens using the 445-570 nm IR filter.

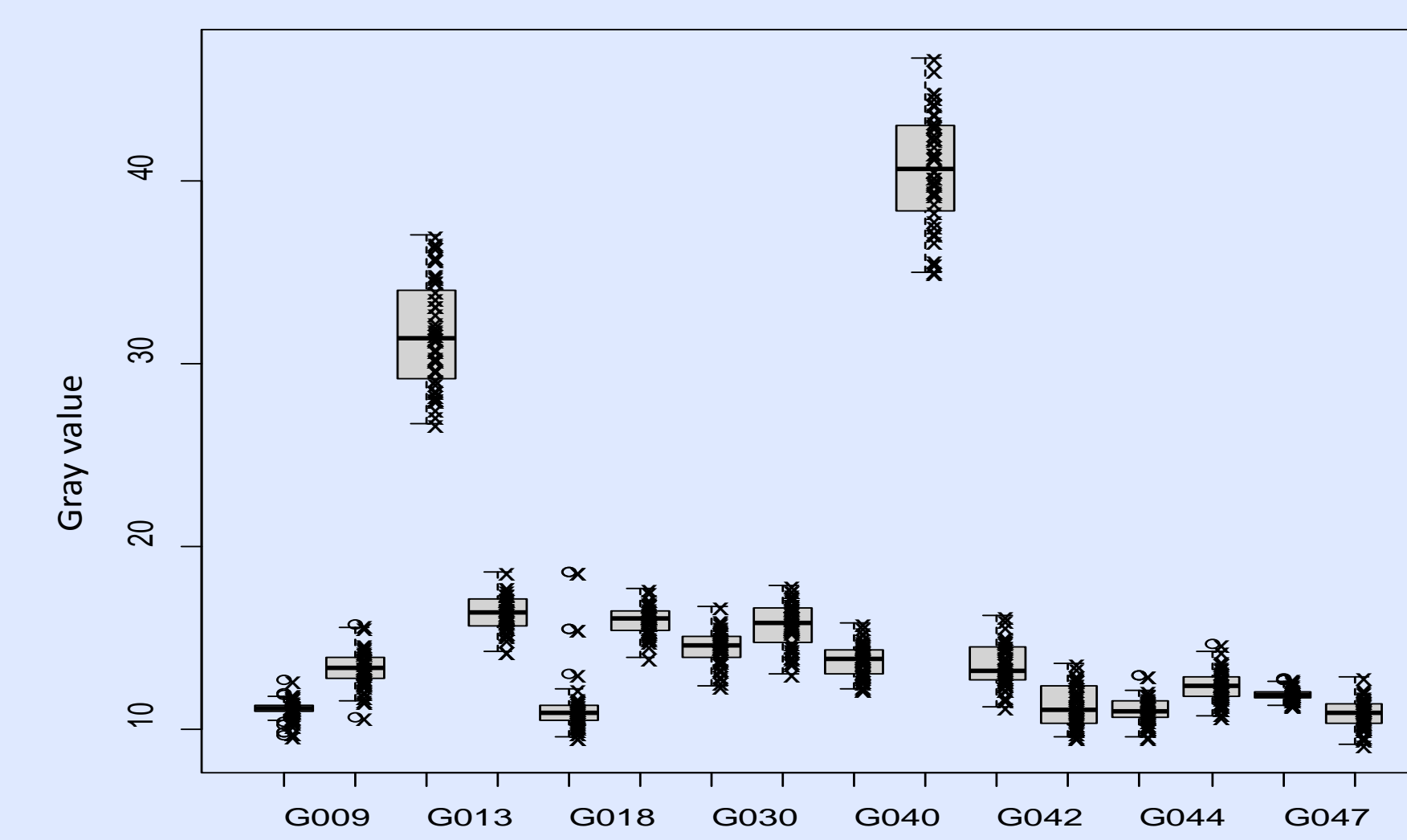


Figure 11. Box plot for green gel pens using the 485-610 nm IR filter.

DISCUSSION AND CONCLUSIONS

- The most discriminatory illuminating conditions for green gel pens was visible light at 665 nm and 695 nm, and IR absorption and reflectance for 445-570 nm and 485-610 nm [Fig. 7, 9, 11, and 12]. For green ball point pens, the most discriminatory illuminating conditions were visible light at 695 nm and 715 nm [Fig. 8 and 10].
- Since minimal data are available regarding rare ink types, this methodology can be applied to forensic casework allowing questioned documents examiners to distinguish between green gels and ballpoints ink pen types for comparative examinations, but also assess intra and inter source variation for a plethora of other colored ink types.