Cardboard Packaging Waste Minimization: Autonomous Box Selection by Stereoscopic RGB-Depth Vision System and Complementary Deep Learning Classification

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Amidst the dramatic expansion of online shopping and deliveries, wasted cardboard packaging has become a major challenge in modern-day society. In this research, an innovative approach to the issue of box packaging waste is proposed by selecting the ideal cardboard box for a set of items efficiently. Employing stereoscopic depth vision technologies and deep learning classification techniques, the system uses real-time analysis of depth images to compute an optimal cuboid for unpackaged items while also accounting for characteristics such as fragility and toxicity. The system, facilitated by two Intel® RealSense™ RGB-D cameras, first captures the overhead and sideview images to determine the dimensions of an unknown object. The obtained dimensions of the minimum cuboid from the overhead and sideview images are translated with calibration to estimate the length, width, and height of the object. Afterward, a two-step deep learning implementation is used to determine the general category and characteristics of the object by training a learning model with images collected for training and validation. The implementation aids the selection process, considering factors such as fragility or toxicity that may necessitate wrapping or separate packaging. Lastly, a modified Largest Area First Fit (LAFF) algorithm uses the output dimensions for irregular-shaped objects and dimensions scanned from the barcode of packaged objects to determine the best box from a list of standard Amazon boxes. Overall, the computer simulation shows that the proposed method can be implemented in a cardboard packaging warehouse for optimal box selection, effectively minimizing cardboard waste.