

Image-Based Robotic Framework for Automated Bottle Handling in Beverage Production Lines

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Abstract

Beverage production is one of the major food processing industries in the world. In Sri Lanka, some of the production processes in the beverage industry are automated and some are not. It is identified that in production lines, the fallen bottles are handled manually, which increases production downtime. Bottle repositioning is a labor-intensive task. I suggest specifying the human errors and safety risks that are unavoidable. It is a major concern to develop an automated production line for repositioning fallen bottles. Manual handling will increase the manufacturing lead time and decrease production profits. Therefore, a framework is designed from an automated approach implementing artificial intelligence (AI) and robotic technologies to detect and reposition fallen bottles, minimizing production inefficiencies and I suggest specifying the ergonomic hazards. The proposed strategy utilizes computer vision techniques to identify fallen and upright bottles by their orientation from the camera live feed. Pose estimation techniques calculate the spatial coordinates, distance from the base of the robotic arm, and angles of fallen bottles. This pose data is transferred to arm controller software running inverse kinematics algorithms, which generate accurate G-code instructions for the robotic arm. The two microcontrollers in the system execute these instructions which enable the robotic arm to reposition fallen bottles correctly. The developed prototype accurately classifies the “Fallen” and “Upright” bottles, by detecting the fallen bottles by determining their poses using computer vision techniques and making robotic arm manipulation using the generated G-code through inverse kinematics to put down the falling bottles. These procedures ensure accurate bottle handling in production lines. In addition, this system provides a lower cost of manual labor and an improved product. Furthermore, it eliminates ergonomic hazards associated with manual interventions thereby improving workplace safety. The combination of artificial intelligence and robotics can optimize industrial processes, improving operational efficiency and establishing safer workplaces.

Keywords: *Artificial Intelligence, Computer Vision Techniques, Pose Estimation, Inverse Kinematics, Robotic Arm*