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VIRTUAL DROP TEST ANALYSIS ON HIGH VALUE PRODUCT

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Abstract - ***Virtual drop test analysis*** *is a powerful simulation technique used to predict the behavior of high-value products under impact conditions. By creating digital models of products and their environments, engineers can simulate various drop scenarios, assess potential damage, and optimize designs for durability and safety. This approach is particularly valuable for products where physical testing can be costly, time-consuming, and even destructive. Through virtual drop tests, companies can identify design flaws early in the development process, improve product safety and reliability, and optimize product design. The virtual drop test analysis is a crucial process in validating the durability and reliability of high-value products, particularly in industries such as automotive and electronics. This analysis simulates the conditions a product would face during a drop, allowing engineers to assess potential damage without physically dropping the item. Utilizing the myRIO microcontroller enhances this testing by providing robust data acquisition and control capabilities.*

Key Words**:** *Virtual drop test analysis, myRIO controller, high-value products.*

1. INTRODUCTION

The myRIO controller, developed by National Instruments, is a compact and versatile platform that integrates with various sensors and actuators. It is particularly well-suited for educational purposes and prototyping applications. When applied to virtual drop test analysis, the myRIO controller can facilitate real-time data acquisition and control during simulations. The myRIO controller can process data from multiple sensors in real-time, allowing for immediate feedback during simulations. It can interface with simulation software (like LabVIEW) to create a cohesive testing environment where physical prototypes can be tested alongside virtual models. The platform supports various programming languages and environments, making it adaptable for different testing requirements. Utilize FEA tools to simulate the drop test scenario. This involves defining material properties, boundary conditions, and mesh generation. Run the drop test simulation using software like ANSYS for complex calculations regarding stress distribution, deformation, and potential failure points. During the simulation, use the myRIO controller to collect data from sensors that measure impact forces, accelerations, and other critical parameters.

1.1 Background of the Work

The virtual drop test analysis using a myRIO controller involves simulating and analyzing the behavior of high-value products under drop impact conditions. The myRIO (Rugged I/O) controller is a real-time embedded system designed by National Instruments, commonly used in applications where real-time data acquisition, control, and processing is essential. This system is used to gather data from sensors, process the data, and provide feedback or control signals. In engineering and product design, drop tests are commonly conducted to assess how a product, especially high-value or sensitive items like electronics, fragile materials, or consumer products, will perform when subjected to accidental drops or impacts. These tests are important for determining the durability and reliability of the product, as well as for designing protective measures (e.g., packaging, casings). Traditionally, drop tests have been physical, involving dropping a sample from a known height and measuring the forces or deformations it experiences. However, physical drop tests can be expensive, time-consuming, and potentially damaging to the product itself, particularly when the product is of high value or is not easily replaceable.

1.2 Motivation and Scope of the Proposed Work

The motivation behind using a **myRIO controller** for virtual drop test analysis of high-value products arises from several challenges faced by industries involved in the design and manufacturing of sensitive and expensive products. These challenges include the high cost of physical testing, the need for faster product development cycles, and the increasing demand for more reliable and efficient testing methods that reduce the risk of product damage. Traditional drop testing involves physically dropping prototypes or final products to simulate real-world scenarios. However, physical testing is costly, especially for high-value products such as advanced electronics, medical devices, or aerospace components. These tests can lead to damaged products, necessitating additional manufacturing and testing cycles. For high-end products where each unit can be worth thousands of dollars, the cost of performing numerous drop tests can be prohibitive. Traditional drop tests can be time-consuming, involving the setup of physical drop rigs, multiple rounds of testing, and analysis. In industries like consumer electronics, where design cycles are fast-paced, this slow process can delay product release and increase time-to-market. Engineers require faster ways to test and validate the durability of their products without waiting for physical tests to be completed. While computational simulations, such as Finite Element Analysis (FEA), can model the behavior of a product under impact conditions, they rely heavily on accurate real-world data to be effective. Virtual simulations without real-world validation are often limited by assumptions and simplifications. This is where integrating **myRIO controllers** with real-time data acquisition can bridge the gap, providing live, accurate data during testing and validating the simulation models for higher accuracy.

2. METHODOLOGY

The first step is to create a detailed finite element model (FEM) of the high-value product to be tested. The model should accurately represent the product's geometry, material properties (e.g., elasticity, plasticity, and fracture behavior), and boundary conditions. For example, a smartphone model will include the casing, internal components (e.g., screen, battery, motherboard), and other relevant parts. Advanced FEA software (such as ANSYS, ABAQUS, or COMSOL Multiphysics) can be used to generate the model. The model will simulate the dynamic impact response, stress distribution, and potential failure points when subjected to a drop event. Define the drop conditions, including the height, velocity, drop angle, and surface properties. For example, the product could be dropped onto a hard surface or a soft foam mat to study how the material behaves under different shock absorbers. The simulation will calculate the forces generated during impact and estimate the product's deformation, stress, and potential failure modes. Different drop scenarios can be simulated (e.g., face-down, corner-down) to test all possible orientations.

2.1 System Architecture

A CAD model of the product (e.g., a smartphone, medical device) is developed using CAD software. The model is imported into simulation software (e.g., ANSYS, ABAQUS) to create a detailed finite element mesh that represents the product's components and materials. The simulation accounts for drop conditions (height, velocity, angle) and simulates how the product deforms, absorbs energy, and potentially fails under impact. The drop simulation is run on the product model to calculate the distribution of forces, stress, and acceleration during the drop. The output of the simulation includes key parameters such as maximum impact force, deformation levels, stress distribution, and failure points (e.g., crack initiation or breakage). The simulation parameters (drop height, impact velocity, etc.) are mirrored in the physical drop test. The real-time data from the sensors during the physical test is compared with simulation results to validate the FEM model. The myRIO performs signal conditioning (amplifying, filtering, or converting analog signals from sensors into digital data). Real-time data is processed on the myRIO and sent to the computer for logging and analysis.

2.2 Data Acquisition

To acquire accurate data during the drop test, various sensors are used to measure the product's behavior under impact. These sensors provide information on forces, acceleration, strain, and d Real-time data acquisition is critical to ensure that engineers can monitor the drop test as it happens and adjust parameters if necessary. LabVIEW is used as the programming environment to interface with the myRIO controller. Visualize real-time data from the sensors (accelerations, forces, strains). Create Graphical User Interfaces (GUIs) for monitoring drop events and sensor outputs live. Provide feedback and alerts if certain thresholds are exceeded (e.g., maximum impact force, critical strain). Engineers can see real-time plots for acceleration, force, and strain using graphical displays on the LabVIEW interface. Time vs. Force/Acceleration/Strain Graphs are commonly used to track how forces and other parameters evolve during the drop event, especially at the peak of impact. Color-coded indicators (e.g., red for critical force levels) can. Data from the myRIO sensors is continuously logged in a local buffer or transmitted to a PC or server for storage. The data is typically stored in CSV or binary format, making it easy to analyze later. be implemented to highlight areas of concern, ensuring that the team can act quickly. The real-time data from the physical test (e.g., impact forces, strain, acceleration) is continuously compared against the simulation outputs. If discrepancies are found between the simulation and real-world data, feedback loops allow engineers to adjust simulation parameters (e.g., material properties, drop height) for more accurate future predictions.

3. Analyze and significance:

High-value products often have intricate designs and multiple components. Virtual simulations can accurately capture these complexities, providing a comprehensive understanding of the product's behavior under impact. The properties of materials used in high-value products can significantly influence their response to impact. Accurate material modeling is essential for reliable simulation results Virtual drop tests can simulate a wide range of impact conditions, including different heights, angles, and surfaces. This allows engineers to evaluate the product's performance in various real-world scenarios. The primary objective is to evaluate how the myRIO controller performs under drop conditions, ident Given its applications in education, research, and industry, ensuring that the myRIO controller can endure impacts is essential for maintaining functionality and reliability. Utilize simulation software (e.g., ANSYS, LS-DYNA) to create a digital model of the myRIO controller. This model undergoes finite element analysis (FEA) to simulate various drop scenarios. The controller is subjected to multiple drop tests from specified heights onto flat surfaces, with assessments made after each drop to check for physical damage or loss of functionality. Key parameters include drop height, surface type (e.g., concrete, carpet), and orientation during the drop (e.g., display up or down). These factors are critical in determining how the device

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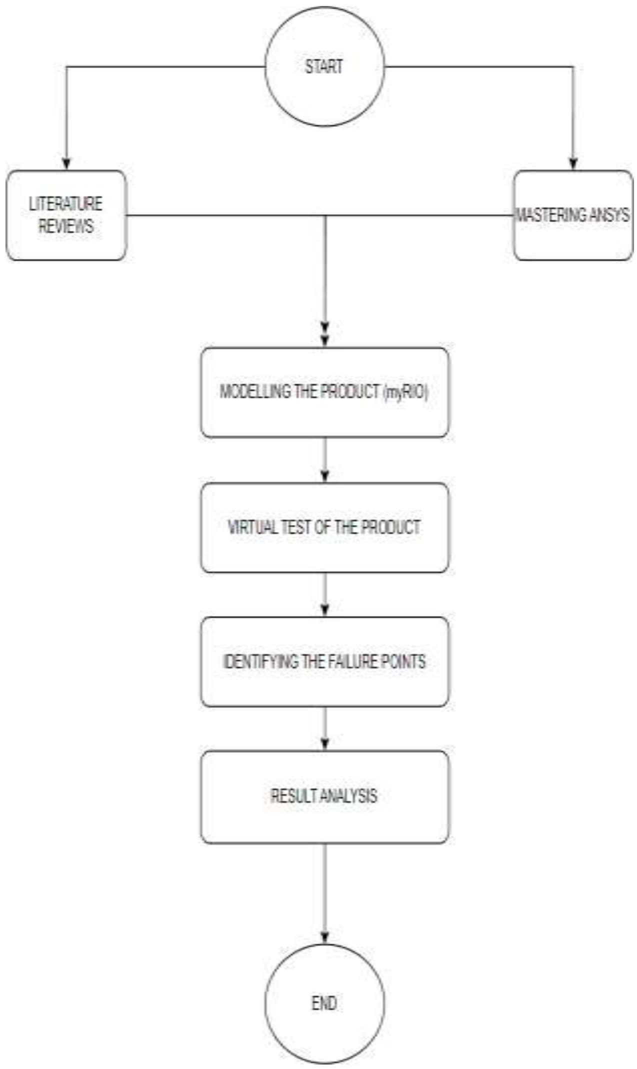
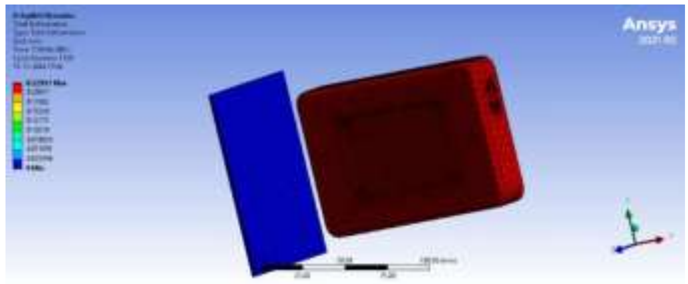
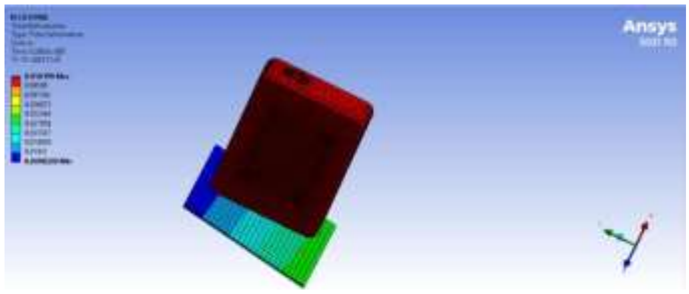
will respond to impacts. Virtual drop testing significantly reduces development costs by minimizing the need for physical prototypes. This is especially beneficial for high-value products like the myRIO controller, where prototyping can be expensive and time-consuming. Identifying weaknesses in design before production allows manufacturers to make necessary adjustments, leading to more reliable products that meet user expectations Drop testing is an invaluable process for evaluating the robustness of the myRIO controller. By leveraging advanced simulation techniques, manufacturers can enhance product durability while optimizing costs and ensuring compliance with safety standards.

4. FLOW CHART



5. DESIGN AND ANALYZING





6. CONCLUSIONS

Deformation behaviour simulation on dropping a myRIO controller has been discussed in detail in this paper. The emphases are on how to obtain reliable results using efficient computer aided engineering (CAE) applications for electronic materials. Real cases are used to simulate deformation behaviour of the product according to drop test data. When comparing the simulation results with physical test results good agreement is observed. A drop test FEA has been generated for myRIO and its behaviour was observed on dropping at height under Earth's gravity. The height was considered to be the critical damaging height for the. Product and the deformation is simulated and analyzed using Ansys software the results are calculated and tested . When the values and deformation behaviour are observed, it is seen that the values of simulation overlap with stress values from compression test data that were used to give the stress–strain curve. Finite element simulation gives a good indication of unknown, complex or difficult-to-estimate behaviour of material.

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