JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ADDITIVE MANUFACTURING ARTIFICIAL INTELLIGENCE

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ABSTRACT:

Artificial intelligence (AI) has undeniable usefulness for the advance of additive manufacturing (AM). The variables affecting a laser powder bed fusion build — laser power, hatch distance, gas flow and more — are simply too numerous to test for every single part that a user may want to print

KEY WORDS:

Addictive manufacturing, Artificial intelligence.

INTRODUCTION:

Artificial intelligence (AI) has undeniable usefulness for the advance of additive manufacturing (AM). The variables affecting a laser powder bed fusion build — laser power, hatch distance, gas flow and more — are simply too numerous to test for every single part that a user may want to print.Industrial automation in the realm of industry 4.0 is on the rise since 21 st century. Industry 4.0 makes a factory smart by incorporating automation and using cyber physical systems, internet of things, high speed computing and automated manufacturing systems. The execution stage of an automated production industry is smart manufacturing which exists in the form of an additive manufacturing system. The importance of additive manufacturing is more pronounced in automotive and aerospace industries due to their high rate of production. This review paper highlights the importance of integrating additive manufacturing systems with industry 4.0. A proposed model of smart manufacturing is also presented in which artificial intelligence is incorporated in additive manufacturing systems for improving the overall efficacy of production industries.

Laser powder bed fusion additive manufacturing (LPBF-AM):

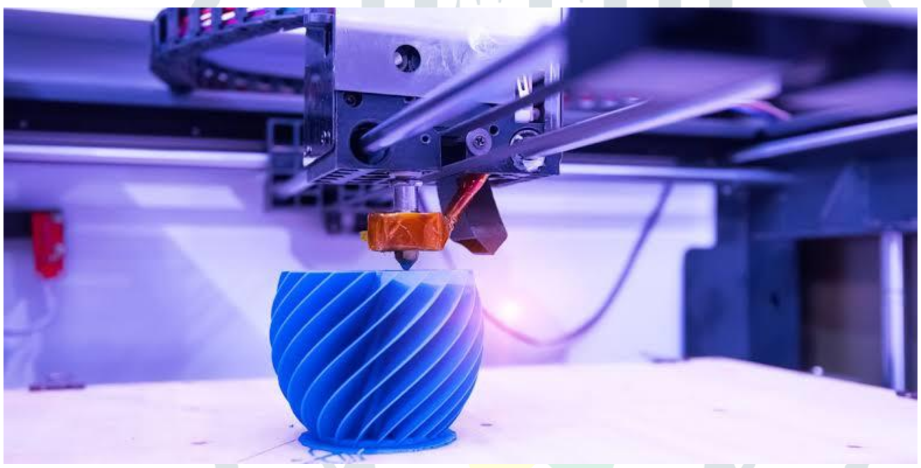
The design freedom offered by additive manufacturing (AM) enables the fabrication of components with internal surfaces that are challenging to access post-manufacture. This is of concern, as the surface condition can markedly deteriorate fatigue performance. Additionally, the adaptation of surface finishing methods for AM components with topologically optimised designs can be a costly practice. It is therefore desirable to consider deploying AM parts with no or minimal surface processing for targeted applications. This requires an in-depth understanding of the formation of various types of AM surfaces, including the variation in surface condition and controlling factors, and their influence on mechanical performance. The last few years have seen significant research advances in these aspects. Ti-6Al-4V is the most extensively studied alloy for AM. The research data available now allows an informative treatment of this topic for both practical applications and future research. Using laser powder bed fusion (LPBF) of Ti-6Al-4V as a model AM−alloy system, this article examines (i) the characteristics of various types of LPBF surfaces including horizontal, vertical, inclined, upward, downward, internal isolated, and slotted surfaces; (ii) the design features and LPBF variables that affect the surface topography; (iii) the capabilities of existing post-AM surface processing methods; and (iv) the influence of AM surface topography on mechanical properties by focusing on the fatigue performance. On this basis, design considerations are recommended for AM of consistent surfaces, and priority surface-related research issues are identified. The purpose is to establish an essential knowledge base for improved commercial designs for LPBF for suitable dynamically loaded applications, with no or minimal surface processing. While centring on LPBF of Ti-6Al-4V, the insights derived are expected to be applicable to other AM processes or metallic materials

Laser in additive manufacturing:

Laser-based additive manufacturing (LBAM) is **a family of advanced production systems, use to fabricate metal parts, complete functional and functionally graded products.**

Smart manufacturing in additive manufacturing

Additive manufacturing (AM) is a smart manufacturing technique that fabricates components directly from 3-D models by selectively joining materials. This technology is revolutionizing the way products are created by reducing turnaround times, increasing viable component complexity, and enabling economic low-volume and mass-customized production. As this technology gains traction as a means of producing end-use components, focus has been placed on improving quality and consistency to ensure components can perform and their traditionally manufactured counterparts. This chapter will focus on selective laser sintering (SLS), an industrial AM technique for producing polymer components. Design guidelines will be presented that, when followed, improve the probability of creating high-quality components that match the design intent. SLS failure modes and process control will also be discussed to provide an understanding of how to properly build components. Incorporating the design guidelines and understanding machine control methodologies allow users to create high-quality components consistently.



The Additive Manufacturing Process:

Additive manufacturing, often referred to as 3D printing, is a computer-controlled process for creating 3D objects.As the name implies, objects are built up by 'adding' material — usually a plastic, ceramic, or metal powder — to a build platform in thin layers, which are hardened using a curing agent, heat, or a laser beam.

But how does additive manufacturing work?

After all, the actual *build* is only one part of a much larger process. In this article, we'll look at the entire additive manufacturing process from start to finish.If you're new to it, it's easy to assume that the additive manufacturing process falls into just two parts: design and printing. But that's just not the case.The additive manufacturing process is really much more complex and can be broken down into four main steps:

Step 1: Using CAD Software to Design a Model

As you'd expect, Computer-Aided Design (CAD) plays a critical role in additive manufacturing. It's used to design and test 3D models that are viable for real-world applications.Some of the top CAD software products for professional use include:AutoCAD — one of the first CAD suites to be released, all the way back in 1982. AutoCAD is widely used across all industries for 3D design, and known to be extremely versatile in expert hands.Creo — a market leader in product design that includes a wide range of design functionality and the ability to complete dimension calculations during the modeling process.SolidWorks — widely used for industrial object design. Solidworks includes an extremely wide range of engineering tools and features.

Step 2: Pre-Processing

Pre-processing covers a range of steps that must be completed between design and manufacturing. It covers two primary activities:

Simulation modeling

Simulation modeling is used to digitally test 3D designs before they are manufactured. These tests are used to determine the real-world structural integrity of an object — i.e., whether it is likely to fail, how it might fail, and what forces it can withstand without failing. Common simulation modeling techniques include Computational Fluid Dynamics (CFD), Finite Element Analysis (FEA), and Non-Linear Stress Analysis.

Preparing Files for 3D printing

Once a 3D design has been tested and signed off, it's ready to be prepared for printing. To do this, a hurdle must be overcome: interoperability.Interoperability is the ability of different computer systems to exchange and make use of information. In the additive manufacturing process, the problem is simple — manufacturing machines like 3D printers don't 'understand' CAD files well enough to enable the manufacturing process.To overcome this, a file must be converted into a set of instructions that can be understood by additive manufacturing hardware. These instructions are created using 'slicer' software such as Spatial's CGM Polyhedra which converts the 3D design into 2D layers or slices which can then be used to calculate the tool path or G-Code needed to manufacture the object

Step 3: Printing

Depending on the additive manufacturing technology being used, the 'printing' phase can look very different.In a typical 3D printing process — like those seen in commercially available 3D printers — print heads alternate a layer of powder material with a layer of binding liquid. These layers are built up on top of each other to form the final product. This process is more accurately called 'binder jetting'.However, other forms of additive manufacturing look quite different.Stereolithography (SLA) uses powerful lasers in place of a liquid binder to cure layers of photopolymer resin. During the build cycle, the building platform is lowered into a pool of resin, into which the laser traces the pattern of the layer being printed. Once each layer is cured, the build platform is fractionally lowered into the resin pool.On the other hand, in Fused Deposition Modeling (FDM), a thermoplastic material is heated and applied to the build platform layer-by-layer. Once a layer is dry, the next layer is applied on top of it.Other commontechniques include Selective Laser Sintering (SLS), Metal Laser Sintering (DMLS), and Electron Beam Melting (EBM).

Step 4: Post-processing

Post-processing is often the most expensive and time-consuming aspect of additive manufacturing.

The steps vary depending on the type of additive manufacturing process being used, but usually fall into three categories:

Build removal — Removing excess material from the object and build platform.

Part separation — Removing the object from the build platform, separating parts, and removing any support structures used to aid the build process.

Debinding — Soaking objects in a solution to remove any excess binding material.

Every Step is Critical

In manufacturing — and additive manufacturing in particular — cutting corners is never an option. If you want real-world ready components, every stage of the process must be completed with care and due diligence.If you can develop and maintain a consistent, effective process, you'll be in a great position to manufacture high-quality components time after time.

Conclusion:

The use of AI allows manufacturers to predict when or if functional equipment will fail so that maintenance and repairs can be scheduled in advance. It's important because machines can operate more efficiently – and cost-efficiently – when AI-powered predictive maintenance is used.

ACKNOWLEGEMENT:

This paper was submitted as an part of assignment for the subject of biology for mechatronics engineering.

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