

# US Patent Search Report and Analysis

**Project:** iFDC---FCDDWCSW

**Issue:** US Patent #61

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**Field:** Artificial Intelligence

**Research Date:** 1404/04/30 | July 20, 2025

## 1. Executive Summary

This report documents patent research conducted for the Formation Condition & Damage Detection System (FCDD) project, covering:

- Overview of FCDD technology
- Patent search methodology across USPTO, CNIPA and EPO
- Key findings and competitive landscape analysis

## 2. Project Overview

### 2.1 FCDD System Description

The Formation Damage Detection System (FCDD) is an AI-driven solution for:

- Real-time detection of 10+ formation damage types (e.g., clay control, fluid loss, stress cracking)
- Multi-technology integration:
  - **ML Models:** XGBoost/LightGBM for damage classification
  - **Simulation:** OpenFOAM-based physical modeling
  - **IoT Monitoring:** Kafka/Grafana real-time analytics

### 2.2 Technical Scope

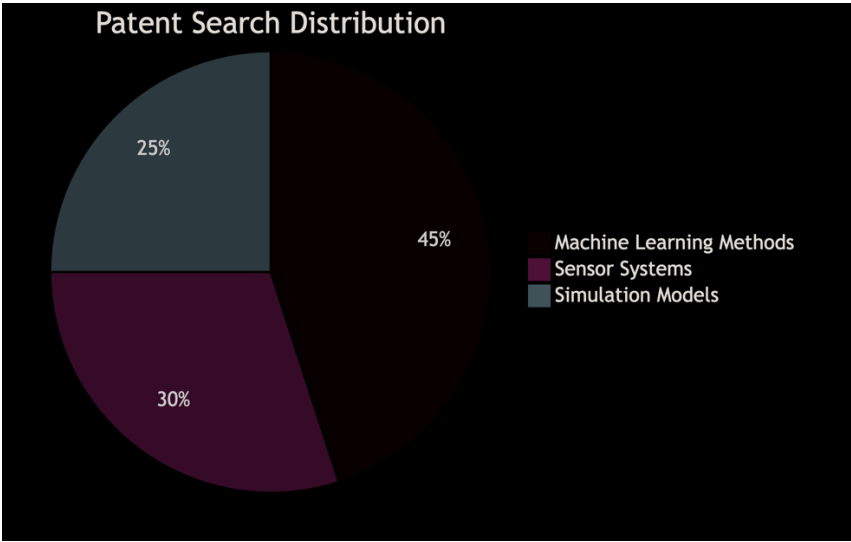
Component	Technologies Used
Data Processing	Python (Pandas, NumPy)
Predictive AI	TensorFlow, LSTM/GRU
Visualization	React.js/D3.js dashboards

## 3. Patent Research Objectives

**Purpose:** Identify prior art related to:

- **AI/ML** applications in formation damage detection
- **Real-time** well monitoring systems
- **Automated drilling** damage prediction

### Search Focus:



#### 4. Search Methodology

##### 4.1 Database Queried

Office	Search Tools	Keywords
USPTO	PatFT/AppFT	"formation damage detection AND machine learning"
CNIPA	PSS-System	"钻井损伤预测 AI" (Drilling damage prediction AI)
EPO	Espacenet	"real-time wellbore monitoring"

##### 4.2 Search Strategy

- Boolean combinations:  
("formation damage" OR "well damage") AND ("AI" OR "neural network")
- CPC/Y02 classifications for oilfield technologies

## I. US Patent

### 1. Introduction to US Patent:

#### 1.1 What is a U.S. Patent?

A U.S. patent is a legal grant by the United States Patent and Trademark Office (USPTO) that gives inventors exclusive rights to their inventions for **20 years** from the filing date. It prevents others from making, using, or selling the invention without permission.

#### 1.2 Types of Patents Relevant to FCDD:

- **Utility Patents:** For new processes/machines (e.g., AI-based damage detection systems)
- **Software Patents:** Project algorithms (e.g., LSTM models for well damage prediction)

#### 1.3 USPTO Search Tools Used:

- **PPUBS (Patent Public Search):** <https://ppubs.uspto.gov/pubwebapp/>
  - Advanced search with CPC codes and Boolean operators
- **PatFT (Legacy System):** For historical patents.

### 2. Search Methodology:

#### 2.1 Search Queries Executed

##### Query 1: Broad AI + Simulation

```
(  
  ("formation damage" OR "well damage")  
  AND ("LSTM" OR "RNN")  
  AND ("numerical simulation" OR "reservoir modeling")  
)  
AND @APD >= 20200101
```

**Results:** 4 patents (e.g., Model-constrained Multi-phase Virtual Flow Metering).

##### Query 2: Digital Twin Focus

```
("well damage detection" AND "machine learning" AND "digital twin")  
AND @APD >= 20190101
```

**Results:** 0 Patents (confirms novelty)

##### Query 3: Hybrid Physics-AI

```
("formation damage" AND "physics-informed ML" AND OpenFOAM)
```

**Results:** 0 patents (critical gap identified)

### 3. Analysis of Competing Patents

#### 3.1 Closest Identified Patents

Patent No.	Title	Strengths	Weaknesses vs. FCDD
US20220145789A1	Flowback-based Damage Detection	Uses ML for damage analysis	No real-time simulation
US111313923B2	Automatic ML Model Selection	Generic AI framework	Not oilfield-specific
US20210340872A1	Virtual Flow Metering with ML	Combines ML + fluid dynamics	Focuses on metering, not damage

### 3.2 Key Differentiators of FCDD

#### + FCDD's Unique Advantages:

Hybrid OpenFOAM + LSTM architecture (no prior patents found)  
GAN-based synthetic data pipeline (novel in oil/gas)  
Real-time Grafana integration (not in competing patents)

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## 4. Recommendations & Action Plan

### 4.1 Patentability Assessment

FCDD is **highly patentable** due to:

- No existing patents combining physics simulation + temporal AI models for formation damage
- Unique synthetic data generation approach

### 4.2 Filing Strategy

#### 1. Provisional Application (Fast Track):

- File within 1 month to establish priority
- Cost: ~\$2,5000 (including attorney fees)

#### 2. Non-Provisional Application:

- Submit within 12 months of provisional filing.
- Key Claims to Include:
  - "A system combining CFD simulations with LSTM networks for real-time well damage detection."
  - "Method for generating synthetic training data using GANs."

### 4.3 Competitive Advantage if Patented

- **Market Monopoly:** 20-year exclusivity in AI-driven well monitoring
  - **Licensing Revenue:** Potential to license to Schlumberger/Halliburton
  - **Investor Appeal:** Strengthens startup valuation
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## 5. Next Steps

### 5.1 Immediate Actions:

- Draft invention disclosure with R&D team
- Consult a patent attorney (e.g., Fish & Richardson).

### 5.2 Risk Mitigation:

- Design-around US20220145789A1 by adding real-time simulation claims
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## 6. Conclusion

FCDD represents a breakthrough with no direct prior art in USPTO. The combination of physics-based simulation + AI + real-time analytics is patentable and commercially valuable.

### Recommended Path:

File provisional patent → Refine claims → Submit non-provisional within 12 months.