REAL TIME DASHBOARD FOR CONSTRUCTION MONITORING SYSTEM (CONSTRUCT SIGHT)

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Abstract:

ConstructSight revolutionizes construction with an AI-powered digital twin. This cloud platform integrates BIM software for real-time data insights on materials, equipment, workers, and site conditions. A comprehensive dashboard offers progress monitoring, budget tracking, and safety analytics. Interactive visualizations and customizable alerts empower proactive decision-making and risk management. ConstructSight incorporates a 3D model for visual progress tracking and clash detection. Biometric access control linked to safety training enhances worker safety. By harnessing AI, ConstructSight empowers construction companies to optimize efficiency, ensure cost control , and prioritize worker safety throughout the project lifecycle.

1.0 Introduction :

Construction, a vital industry, grapples with delays, budget woes, and worker safety concerns. Traditional methods, reliant on fragmented data and reactive decisions, hinder progress.ConstructSight offers a revolutionary solution: AI-powered software creating a digital twin of the construction site, seamlessly integrated with BIM software.

This paper explores ConstructSight's design and implementation, showcasing its potential to revolutionize construction by promoting:

- *Enhanced Efficiency:* Real-time insights enable proactive decisions for smoother workflows and reduced delays.
- *Improved Cost Control*: AI-powered risk management identifies and mitigates potential budget overruns.
- *Prioritized Worker Safety*: Biometric access control linked to safety training fosters a safer environment.

Empowering all players, ConstructSight caters to companies of all sizes and projects. Join us as we delve into ConstructSight's potential to transform construction into a more efficient, cost-effective, and worker-centric industry.

2.0 Problem Statement:

The construction industry lacks a comprehensive and data-driven approach to project management, leading to persistent issues with project delays, budget overruns, and worker safety concerns. Traditional methods rely on fragmented data, hindering proactive decision-making and risk management. This results in inefficiencies, financial losses, and potential safety hazards for workers. ConstructSight proposes an AI-powered solution to address these challenges by creating a digital twin of the construction site and offering real-time insights, predictive risk management, and enhanced worker safety protocols.

3.0 Market / Customer/ Business Need Assessment:

The construction industry yearns for real-time data and insights to move beyond reactive decision-making and costly delays. Traditional methods struggle with efficiency, budgets, and worker safety.

ConstructSight fills this gap, catering to diverse customer needs:

- *Construction Companies:* Improve efficiency, reduce costs, and prioritize worker safety.
- *Architects & Engineers:* Enhance collaboration and communication with construction teams.
- *Subcontractors & Material Suppliers:* Gain project transparency and better communication with general contractors.

4.0 Target Specification:

ConstructSight focuses on enhancing construction safety, project management, and worker engagement through the following target specifications:

1. Worker Safety and Access Control:

- **Software:**
    - Computer vision algorithms for safety gear detection (helmet, life jackets, gloves) using security camera feeds.
    - User access management system with role-based permissions (full access for company head, limited access for managers, site-specific access for engineers).
    - Secure storage of worker biometric data within the ConstructSight dashboard.

2. Worker Engagement and Safety:

- **Software:**
    - Gamification system with reward mechanisms based on reinforcement learning principles to incentivize safe work practices (specific reward structures can be further defined).
    - Integration with worker training records to ensure proper safety training completion before granting access to specific areas.

3. Project Management and Risk Mitigation:

- Sensors to collect real-time data on:
    - Materials (usage, inventory levels)
    - Equipment (operation status, location)
    - Workers (activity levels, location)
    - Environmental conditions (temperature, humidity)
- **Software:**
    - Real-time data analytics platform for:
        - Identifying potential risks related to schedule delays and budget overruns.
        - Generating customizable reports and dashboards with key performance indicators (KPIs) like schedule adherence, budget variance, and incident rates.
    - Digital twin integration with BIM software to create a virtual representation of the construction site for:
        - Improved planning and communication.
        - Early detection and mitigation of potential design issues.

- AI-powered risk management algorithms for predicting and mitigating risks associated with:
  - Budget control
  - Resource allocation

4.Digital Twin Integration:

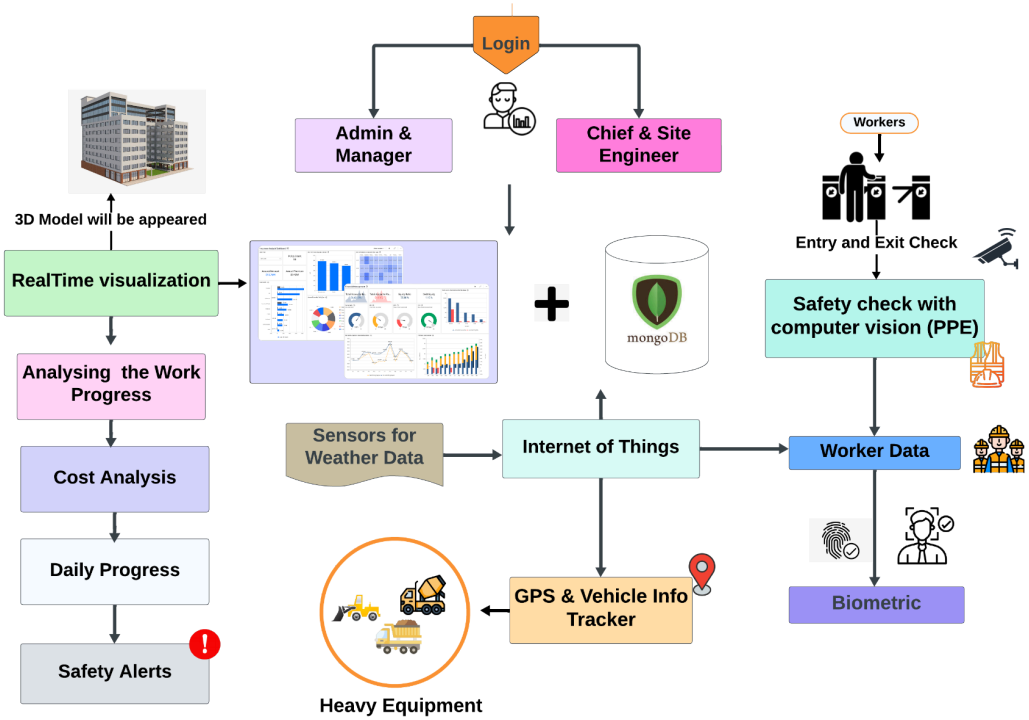
Establish a digital twin of the construction site using BIM data for improved planning, communication, and early detection of design errors.

5.AI-Powered Risk Management:

Implement AI algorithms to analyze real-time data and predict potential risks related to:

Schedule delays due to material shortages or equipment malfunctions.Budget overruns due to cost fluctuations or inefficient resource allocation.

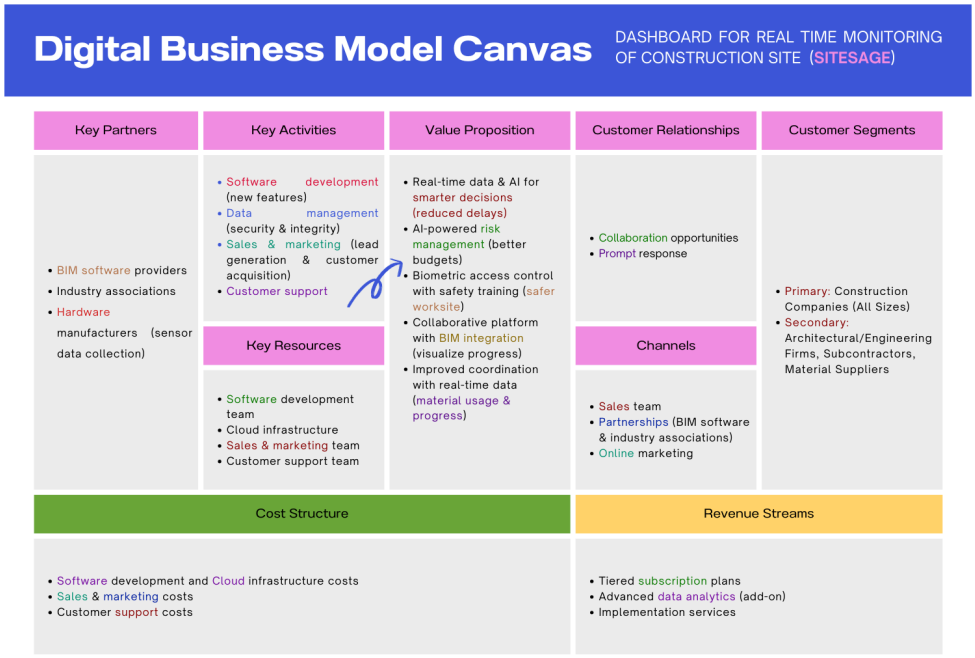
This set of target specifications provides a clear roadmap for the development of ConstructSight. By focusing on worker safety, project management efficiency, and worker engagement, ConstructSight aims to revolutionize the construction industry.



5.0 External Search:

The sources I have used as references for analyzing the need for such a system include research papers and industry reports on construction site monitoring dashboards. These references explore the challenges of real-time construction data management and how various projects have addressed them. I have shared the specific references below.

- researchpaper_1
- researchpaper_2
- Researchpaper_3



6.0 AI & ML in Future Construction site:

The construction industry is poised for a quantum leap forward. We envision a future where AI and Machine Learning (ML) are not just buzzwords, but powerful tools that transform every aspect of construction, from planning to execution.

Here's a glimpse into what our cutting-edge AI & ML solutions will bring:

- *Predictive Powerhouse:* Imagine AI that analyzes historical data to anticipate potential delays, budget overruns, and resource shortages. Proactive intervention becomes the norm, ensuring projects stay on track and within budget.
- *The Efficiency Edge:* ML algorithms will become construction's secret weapon, optimizing resource allocation for labor, equipment, and materials. Every resource will be used to its maximum potential, streamlining processes and minimizing waste.
- *Safety First, Always*: Worker safety is paramount. AI-powered video analytics will keep a watchful eye, identifying potential hazards in real-time and preventing accidents before they happen. Predictive maintenance using ML will ensure equipment functions flawlessly, eliminating downtime and keeping workers safe.
- *Building a Better Tomorrow:* AI will not only optimize construction processes, but also design. Generative design powered by AI will create innovative and sustainable structures, pushing the boundaries of what's possible.
- *Collaboration thrives in a digital twin:* A virtual replica of your construction site, integrated with BIM software, allows all stakeholders (architects, engineers, construction teams) to visualize progress, identify design issues early, and collaborate seamlessly.
- *A Site Transformed*: Drones and advanced sensors will capture real-time data, and AI will analyze it to optimize construction site layout and traffic flow.

Our commitment to AI & ML in construction is unwavering. We believe these technologies have the power to revolutionize the industry, making it safer, more efficient, and more sustainable.

7.0 Business Model

ConstructSight's business model can leverage several revenue streams to capture the value it delivers to construction companies and other stakeholders in the industry. Here are some key monetization ideas:

1. Tiered Subscription Plans:

- Offer different subscription tiers based on project size, complexity, and features required.
- Basic tiers could provide core functionalities like real-time data visualization, basic risk identification, and worker safety monitoring.
- Higher tiers could offer advanced features like:
    - Predictive analytics with more granular risk insights.
    - AI-powered resource optimization and scheduling tools.
    - Integration with BIM software for a comprehensive digital twin experience.
    - Advanced worker safety analytics and personalized training recommendations.

2. Implementation and Training Services:

- Offer consulting services to help companies integrate ConstructSight with existing systems and workflows.
- Provide training programs for users to ensure they can effectively utilize the platform's functionalities.

3. Data Insights and Analytics :

Explore the possibility of offering anonymized and aggregated data insights derived from ConstructSight usage. This data could be valuable to construction industry research firms, material suppliers, and other stakeholders for market analysis and trend identification.

By carefully selecting and implementing these monetization strategies, ConstructSight can ensure its financial sustainability while delivering significant value to the construction industry.

8.0Concept Generation:

Ensuring Worker safety using Face Biometric:

ConstructSight utilizes a secure facial recognition system to enhance worker safety and streamline access control. Enrolled worker data is stored securely, and upon entering the construction site, a camera captures the worker's face. A sophisticated facial recognition algorithm then compares the live image to the worker database. If there's a match, the system grants access by communicating with the integrated access control system. This not only improves security but also automates attendance tracking. Worker attendance data is automatically populated in the ConstructSight dashboard, providing valuable insights for workforce management.

```
#importing libraries
import cv2
import os
from datetime import datetime
import numpy as np
from sklearn.neighbors import KNeighborsClassifier
import pandas as pd
from joblib import load, dump

# VARIABLES
datetoday = date.today().strftime("%m_%d_%y")

# Initializing VideoCapture object to access WebCam
face_detector = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')

# If these directories don't exist, create them
if not os.path.isdir('Attendance'):
  os.makedirs('Attendance')
if not os.path.isdir('static/faces'):
  os.makedirs('static/faces')

# Function to get a number of total registered users
def totalreg():
  return len(os.listdir('static/faces'))

# Function to extract the face from an image
def extract_faces(img):
  if img != []:
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    face_points = face_detector.detectMultiScale(gray, 1.3, 5)
    return face_points
  else:
    return [ ]

# Function to identify face using ML model
def identify_face(facearray):
  model = load('static/face_recognition_model.pkl')
  return model.predict(facearray)
```

```
# Function to train the model on all the faces available in faces folder
def train_model():
  faces = []
  labels = []
  userlist = os.listdir('static/faces')
  for user in userlist:
    for imgname in os.listdir(f'static/faces/{user}'):
      img = cv2.imread(f'static/faces/{user}/{imgname}')
      resized_face = cv2.resize(img, (50, 50))
      faces.append(resized_face.ravel())
      labels.append(user)
  faces = np.array(faces)
  knn = KNeighborsClassifier(n_neighbors=5)
  knn.fit(faces, labels)
  dump(knn, 'static/face_recognition_model.pkl')

# Main loop for face recognition and attendance marking
while True:
  # Capture video from webcam
  cap = cv2.VideoCapture(0)
  ret = True
  while ret:
    ret, frame = cap.read()

 # Convert frame to grayscale for face detection
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

 # Detect faces in the grayscale frame
    faces = face_detector.detectMultiScale(gray, scaleFactor=1.1,
minNeighbors=5)

 # Process each detected face
    for (x, y, w, h) in faces:
      # Extract face region
      face = frame[y:y+h, x:x+w]
```

```
# Identify the face
    identified_person = identify_face(face.reshape(1, -1))[0]
# Draw rectangle and display name
    cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
    cv2.putText(frame, f'{identified_person}', (x + 6, y - 6),
cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 0, 20), 2)

    # Add functionality to mark attendance (e.g., press 'a' key)
    if cv2.waitKey(1) == ord('a'):
      add_attendance(identified_person) # Assuming you have an add_attendance
function

  # Display the resulting frame
  cv2.imshow('Attendance Check, press "q" to exit', frame)

  # Exit on 'q' key press
  if cv2.waitKey(1) == ord('q'):
    break

# Release resources
cap.release()
cv2.destroyAllWindows()
```

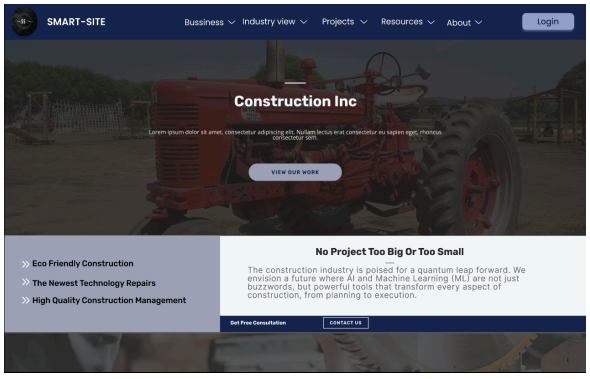
Checking worker Safety with Computer Vision:

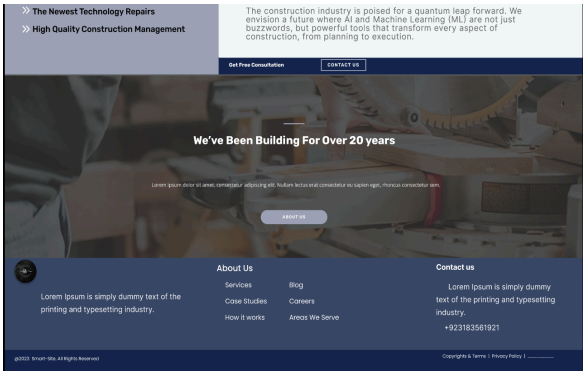
The You Only Look Once (YOLO) algorithm is used to detect objects in real-time within the construction site camera feed. This allows the system to identify whether workers are wearing essential safety gear, such as hard hats, vests, and safety glasses.

Github Repo Link : Internship Task Level 0

9.0 Final Product Prototype:

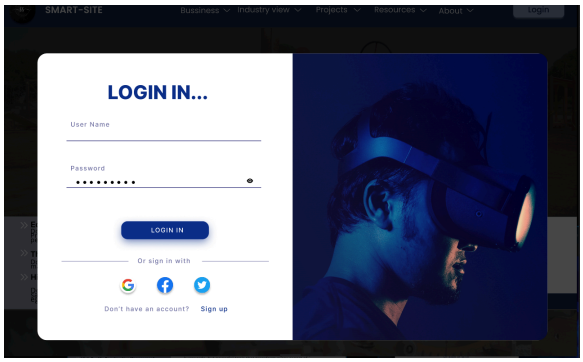
Landing Page :





Login Page :

Login Page ensures only authorized users access the platform, protecting sensitive project information.Role-based access control ensures only authorized personnel can view sensitive project data.

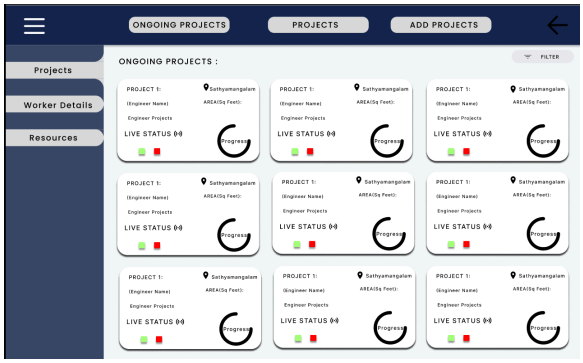


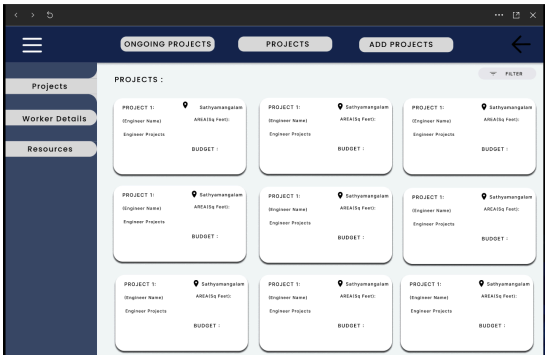
Admin can have all rights to access resources like material allocation, project data , Number of Projects, workers and materials data.

Admin Page:

List of Ongoing Projects and Project Page :

Admin is the only user who can access this page.Here, the quantity of projects that the construction businesses are working on is displayed.They are able to assign engineers, funds, and resources to any project.

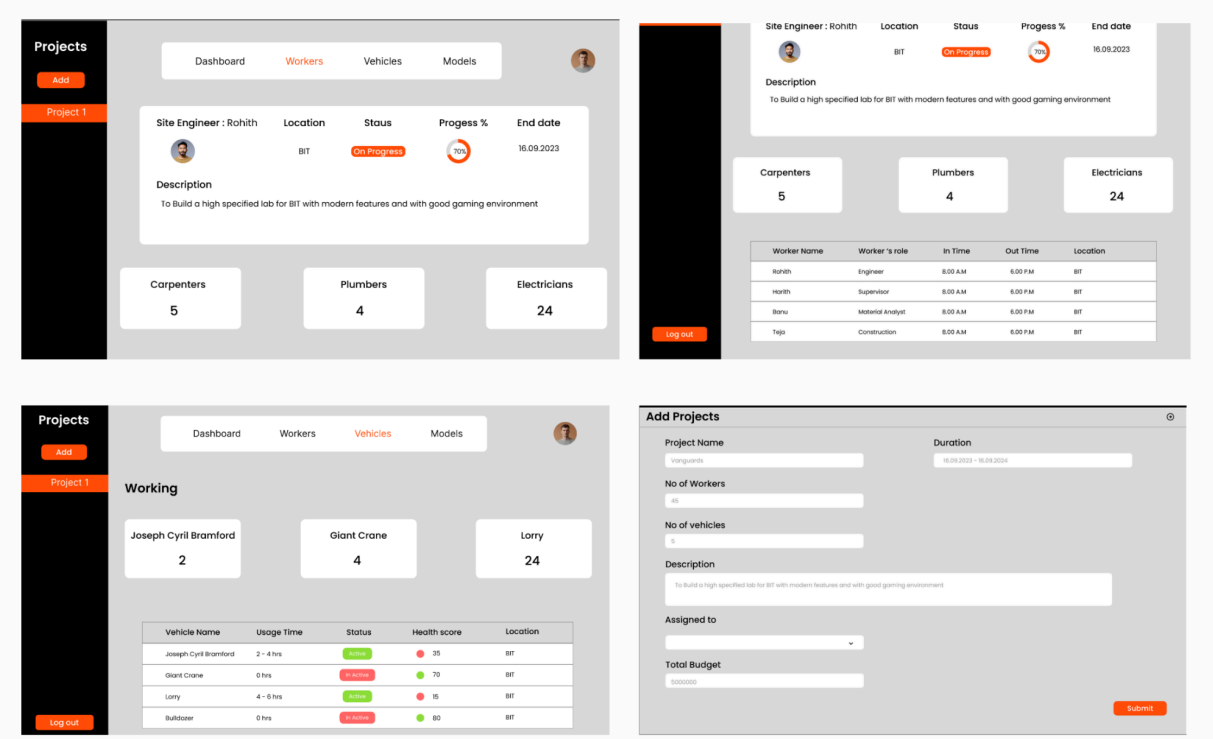




Engineer /Manager :

The project assigned to the particular Manager /Engineer :

Engineers /Managers can view and manage the assigned projects and manage resources like vehicles and workers (potentially identified through computer vision technology). The dashboard provides real-time biometric data for safety monitoring. Engineers can also track the utilization of safety materials on their projects. Users(Admin) can also have access to create new projects.



10.0 Conclusion:

ConstructSight is more than just a construction site monitoring platform; it's a revolutionary AI and ML-powered solution that empowers a safer, more efficient, and collaborative future for the construction industry. We understand the challenges you face, like keeping projects on budget and schedule while ensuring worker safety. Our platform addresses these needs by transforming how projects are planned, executed, and monitored. Imagine real-time insights, proactive risk mitigation, and seamless collaboration – that's the power of ConstructSight.