WI-ESP32 Snakebot: Real-Time Surveillance and Remote Operation

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ABSTRACT

- Innovative approach to expediting and enhancing the efficiency of urban search and rescue operations
- Utilizes advanced snake-like robotics, wireless communication, and sophisticated sensors to navigate through confined spaces
- Flexible and modular design allows maneuvering through tight spaces and adapting to unpredictable terrain
- Equipped with sensors such as cameras, accelerometers, and wifi imaging for identifying and locating survivors.

MOTIVATION

Saving Lives: The primary motivation is to expedite search and rescue operations, especially in the critical hours post-disaster, with the overarching goal of saving lives trapped under rubble.

Risk Mitigation: The snake robot's deployment minimizes risks to human rescuers, especially in situations where structural integrity is compromised, and traditional methods may pose dangers

Resource Optimization: Working in tandem with human rescue teams, the snake robot optimizes resource utilization, providing a comprehensive and effective approach to search and rescue efforts.

LITERATURE REVIEW

1.Wi-fi signal-based through-wall sensing for human presence and fall detection using esp32 moduleSahoo Ajit Kumar, K Akhil, Siba K UdgataIntelligent Systems: Proceedings of ICMIB 2021, 459-470, 2022

Device-free Wi-Fi sensing has gained much attention due to its simplicity, low cost, and it requires no additional hardware. The main advantages of Wi-Fi sensing are, it is unobtrusive, can operate through walls, work without lighting, is ubiquitous, and does not require users to carry any additional wearable devices

2.Wifi csi-based long-range through-wall human activity recognition with the esp32Julian Strohmayer, Martin KampelnInternational Conference on Computer Vision Systems, 41-50, 2023

WiFi Channel State Information (CSI)-based human activity recognition (HAR) is an unobtrusive method for contactless, long-range sensing in spatially constrained environments while preserving visual privacy. Despite the presence of numerous WiFi-enabled devices around us, few expose CSI to users, resulting in a lack of sensing hardware options

3.**ShikWi-ESP—A tool for CSI-based Device-Free Wi-Fi Sensing (DFWS) Muhammad Atif, Shapna Muralidharan, Heedong Ko, Byounghyun YooJournal of ComputationalDesignandEngineering,Volume7,Issue5,October2020,Pages644=656,https://doi.org/10.1093/jcde/qwaa048 Published: 15 May 2020**

Recent progress in Device-Free Wi-Fi Sensing (DFWS) has established the use of wireless signals like Wi-Fi not only to communicate but also as a tool to enable device-free sensing. As an emerging technique, DFWS has many capable applications such as sensing activity and gesture and fall detection, monitoring elderly, surveillance

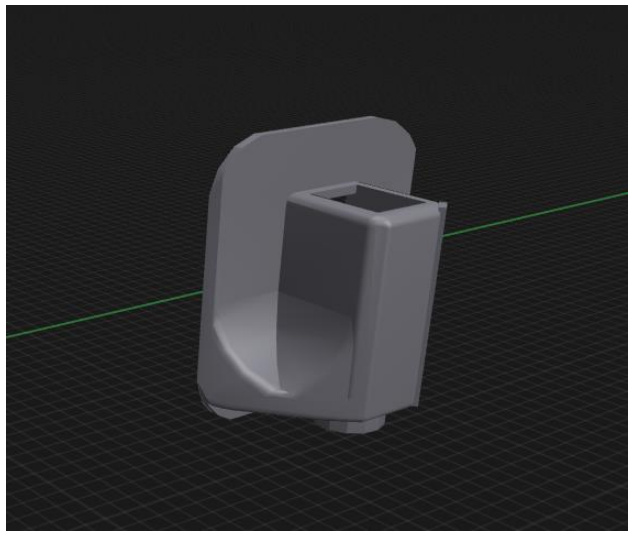
OBJECTIVE

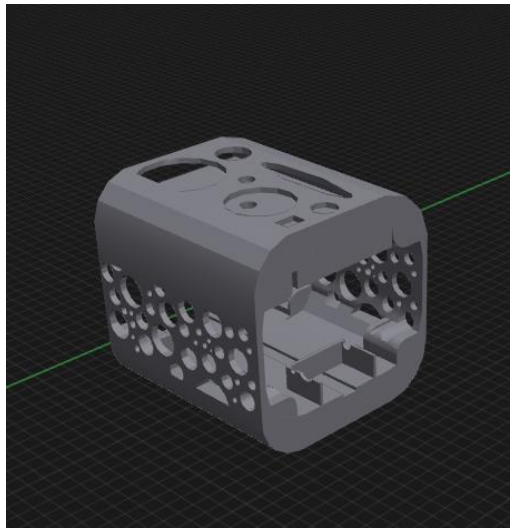
- **Remote Exploration**
- Deploy the snake robot to navigate through the rubble remotely using its Wi-Fi connectivity to transmit live video and sensor data.
- **Victim Identification**
- Equip the robot with sensors, such as cameras and thermal imaging, to identify and locate trapped individuals within the debris.
- **Obstacle Negotiation**
- Enhance the robot's capabilities to navigate through complex rubble by improving its agility and ability to negotiate obstacles.
- **Situational Awareness**
- Integrate advanced sensors to provide the rescue team with a comprehensive understanding of the disaster site, aiding in decision-making.

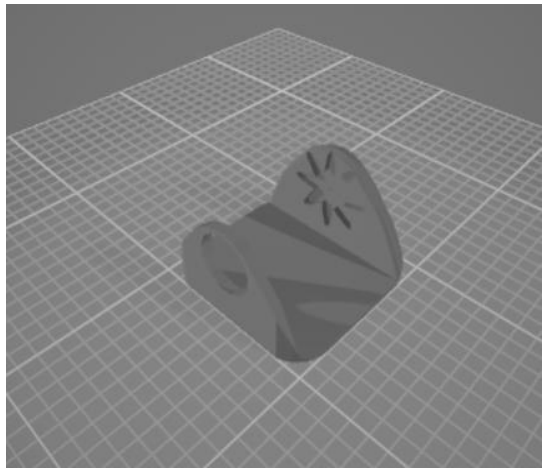
DESIGN METHODOLOGY

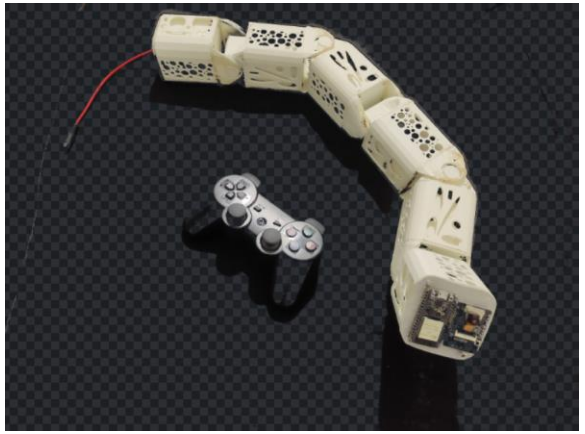
- **Hardware Setup:**
  - Choose a good biobiblical snake robot design
  - Choose good servo motor
  - Using wi-peek technology
  - Using sensor ,camera ,hand
- **Design:**
  - Select and implement robust Wi-Fi communication protocols for real-time data transmission.
  - Ensure secure and reliable communication between the snake robot and the control station.
  - Design an intuitive and user-friendly interface for the rescue team to control the snake robot.

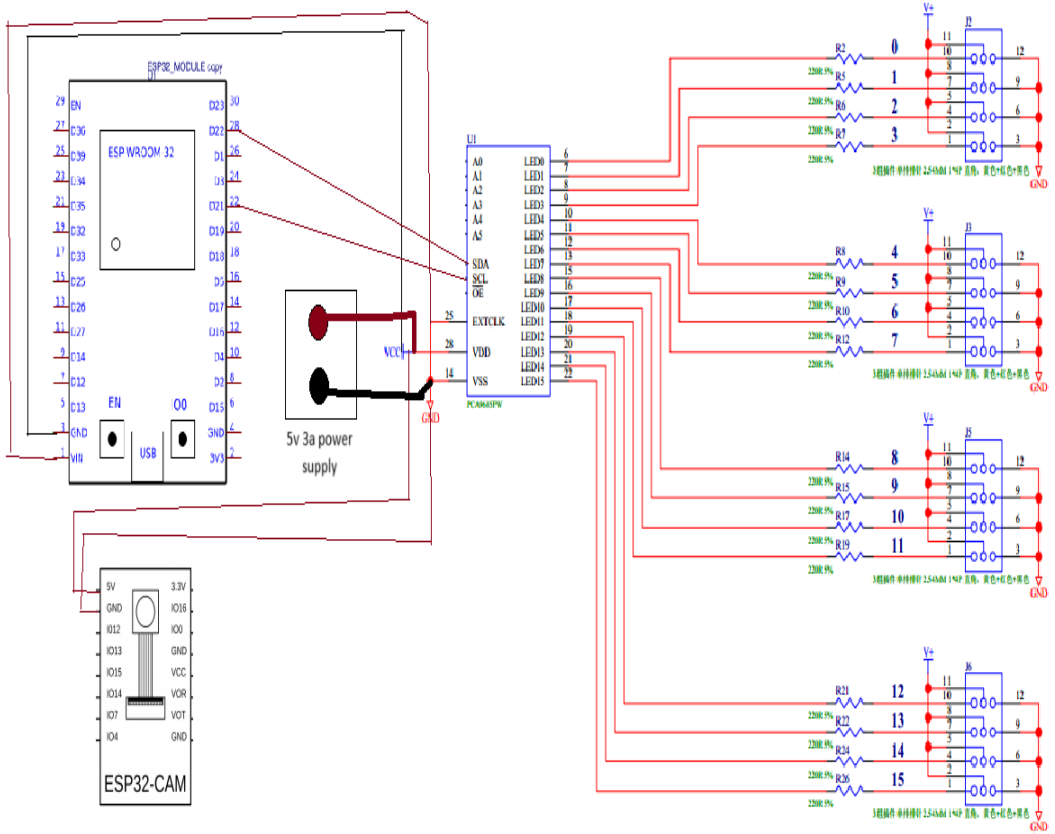
ROBOT SIDE



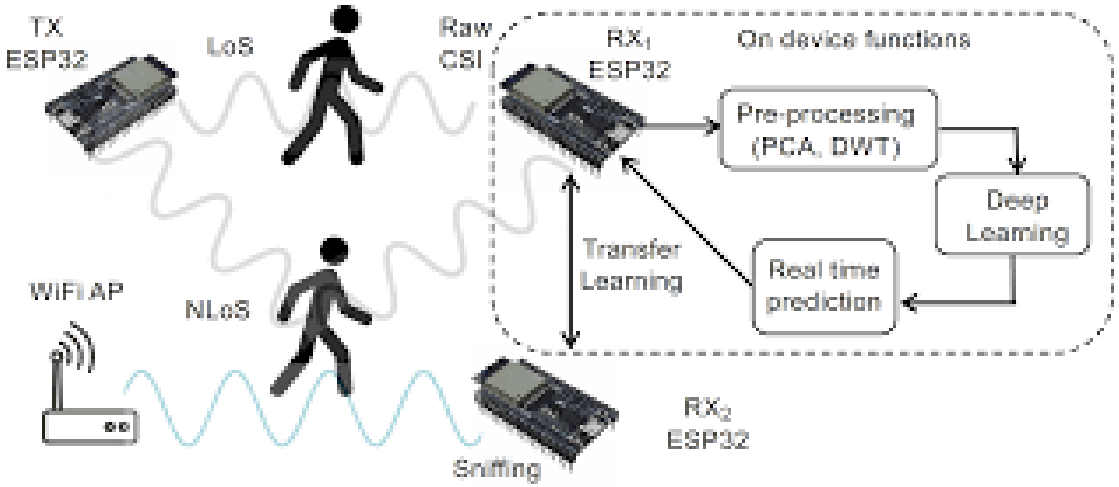






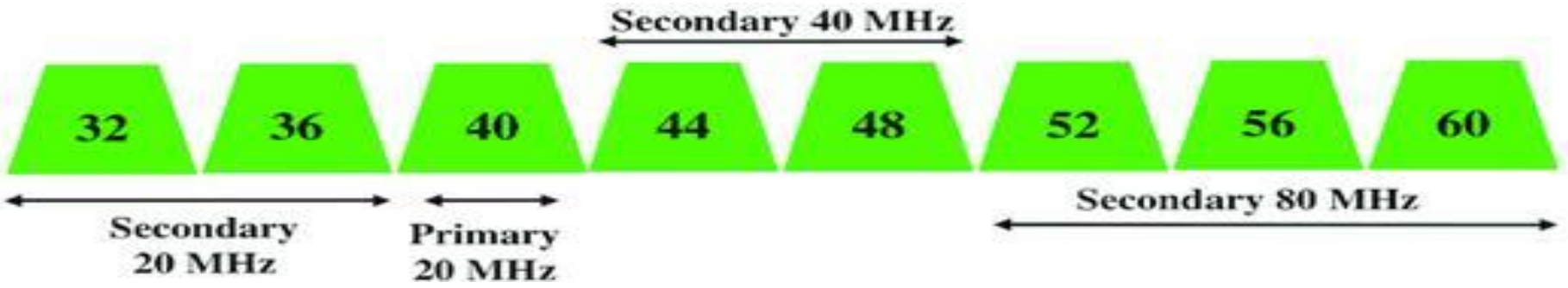

ESP32_MODULE copy
ESP WROOM 32
EN
USB
5v 3a power supply
ESP32-CAM
U1
PCA9685PW
EXTCLK
VDD
VSS
SDA
SCL
OE
GND

WI-ESP32 CSI


TX
ESP32
LoS
Raw
CSI
RX1
ESP32
On device functions
Pre-processing
(PCA, DWT)
Deep
Learning
Transfer
Learning
Real time
prediction
WIFI AP
NLoS
RX2
ESP32
Sniffing


Espressif ESP32
WROOM32-U Devkit Setup
Wi-Fi Anteena Attached
Using the SMA Connector
on the IPEX Pigtail Cable
IPEX Pigtail Cable
Attached Using the U.FL
Connector on ESP32
SMA Connector
U.FL Connector
ESP-32 WROOM32U
Wi-Fi + Bluetooth Module
Development Kit
With ESP32 Module & GPIO Pins

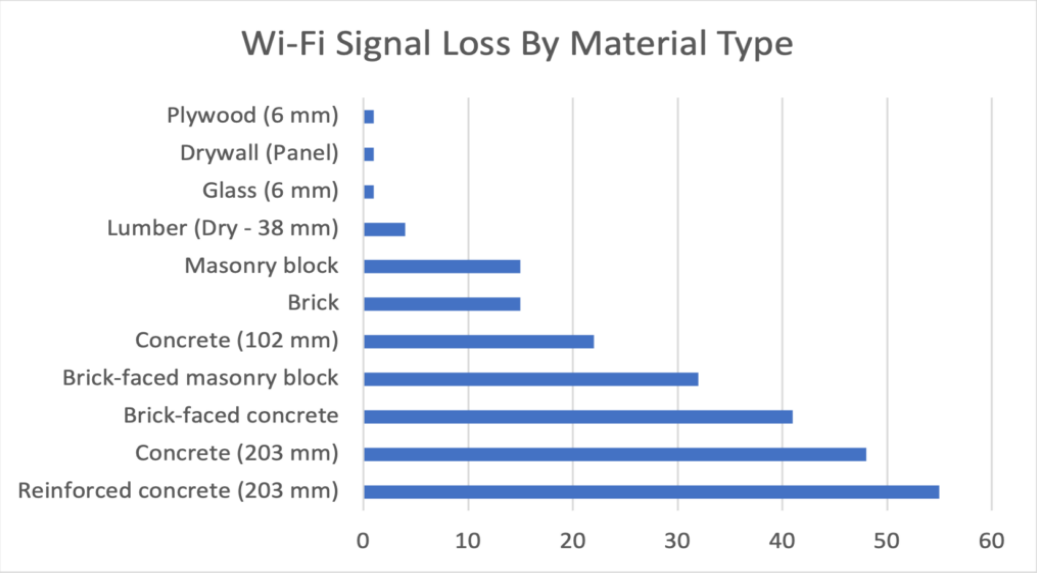

Espressif ESP32
Client - Server Architecture
Request
Response
ESP32 In Station
Mode - Client Device
ESP32 In AP
Mode - Server Device
Window's 10 Based Device to Communicate With ESP32 AP
Over Serial Port


Secondary 40 MHz
32
36
40
44
48
52
56
60
Secondary
20 MHz
Primary
20 MHz
Secondary 80 MHz

PROCESS

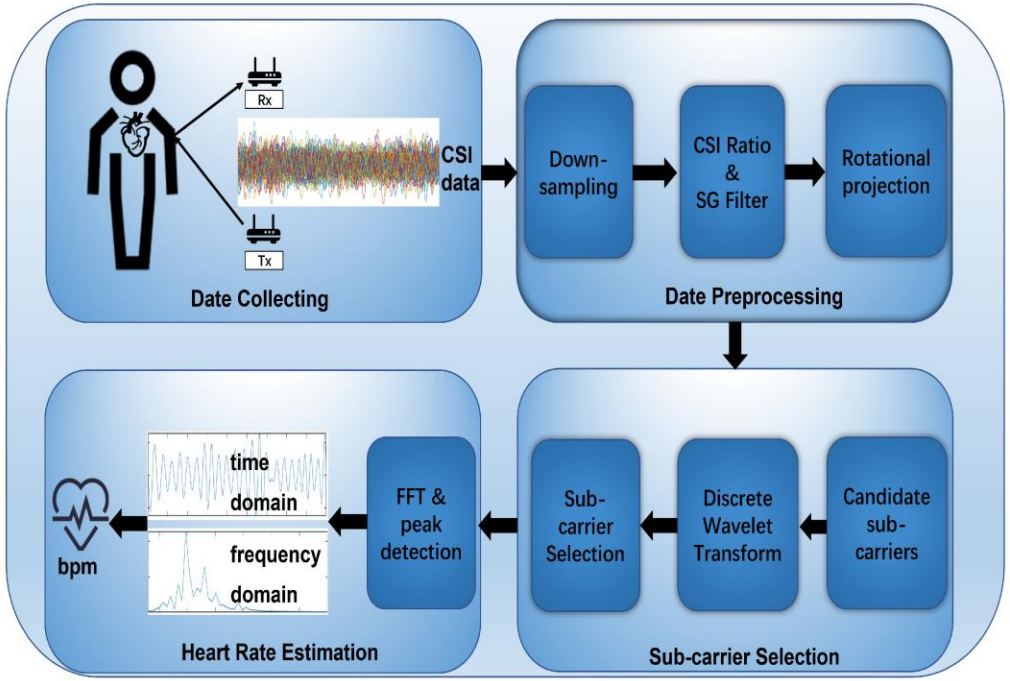
- Understanding to take what meterial to go with to make it light weight
- Identified electronic component to taken such as servo motors and cameras and sensors
- Assigning better wifi technology to make make it cheap and less expensive
- Detailing the coding and design from the previous review
- Make better freedom of movement for sleek design

RESULT



Material	2.4 GHz	5 GHz
Wooden Door	4 dB	7 dB
Concrete Wall	20 dB	30 dB
Plain Glass Window	3 dB	8 dB
Steel Door	20 dB	30 dB
Human body	3 dB	5 dB
Trees/Vegetation	0.5 dB/mtr	1 dB/mtr

Attenuation/Absorption Figures For Common Objects



CONCLUSION

In conclusion, the rubble rescue snake robot proves to be a valuable asset in disaster response scenarios. Its ability to maneuver through rubble and debris, coupled with its capacity to perform search and rescue operations, makes it a promising tool for enhancing the efficiency and safety of emergency response efforts. As technology continues to advance, further improvements in the design and capabilities of such robots can be expected, contributing to more effective disaster management and saving lives in critical situations.

REFERENCES

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- Two new design concepts for snake robot locomotion in unstructured environments Pal Liljeb ˚ack, Kristin Y. Pettersen, ØyvindStavdahl, and Jan Tommy Gravdahl
- SenSnake: A snake robot with contact force sensing for studying locomotion in complex 3-D terrainDivya Ramesh, Qiyuan Fu, Chen Li1