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Towards Wi-Fi Radar in Collapsed Structures

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***Abstract*—Recent years have witnessed an increased dependency of IoTs in our daily lives. Wi-Fi that was once a mode of Internet connectivity is also being used as IoT particularly Wi-Fi signals are acting like sensors. Currently, there are many novel applications of these signals as sensors such as breathing detection, sleep monitoring, indoor localization, human computer interaction to name a few. All these applications work for normal indoor environments as Wi-Fi signal is very weak to penetrate through heavy obstacles. This work investigates a similar problem of Wi-Fi signal coverage in complex environments such as collapsed structures. The objectives of this paper are first to consider a debris scenario and then Wi-Fi signal coverage in this collapsed structured debris model is to be worked out. We have proposed a novel Wi-Fi Radar approach which exploits the existing path loss models with radar range equation for computation of signal coverage. We predefine Signal to Noise Ratio (SNR) threshold for various modulation schemes adopted for comparison to figure out the best case of signal reception. Further, we perform simulations on Wi-Fi Halow as Wi-Fi Radar to verify our approach. Moreover, we compare our results at various antenna gains, signal intensities and SNR thresholds. Comparison of results put emphasis on the low transmission power with better antenna gains to achieve the desired objective. This work paves way for the ubiquitous post-disaster rescue. This is because of the fact that signal coverage in collapsed structure may also exploit the concept of channel state information for breathing detection in the future.**

***Index Terms*—Wi-Fi radar, Wi-Fi signal collection, IoT, collapsed structure, coverage**

I. Introduction

Nowadays, our lives have become more dependent on ubiquitous solutions. This is because of an increasing trend on the use of IoTs [1]. These devices primarily consist of sensors and wearables but now focus is being shifted to device free communication [2]. It has become possible with the application of wireless signals as sensors. This essentially include Wi-Fi signals acting as sensors as it has been observed that these signals have more role than being sole communication medium for Internet connectivity [3]. These wireless signals have found tremendous importance for indoor environments where most of the IoTs [4] are deployed and also GPS does not work well for indoors [5].

Currently, most of the applications of Wi-Fi signals emerge from simple indoor environments. Some of these are; indoor localization [5], breathing detection [6] [7], sleep monitoring [8], human computer interaction [9], activity recognition [10] and fall detection [11]. Indoor environments are bit complex in nature that is why these are subject to research. Wireless signals face much attenuations in these environments because of non-line of sight (NLOS) communication and cause multipath scenario. As the signal penetrates through indoor physical spaces, these civil structures convey the required information which typifies the complexity of under consideration environment.

Breathing detection and indoor localization are two of the most interesting applications of Wi-Fi signals as sensors. But these are limited to very simple indoor case with transmitter receiver approach. These applications will be more fruitful if considered in more complex scenario such as collapsed structures where there is a need to rescue the people but Wi-Fi signal coverage under these environments is still a big challenge. It is because of multiple objects constituent of various materials that cause more signal distortion eventually completely fading the wireless signals [12] [13]. Yet, we need to have better coverage as it can lead to post disaster rescue [14]. It is also because of the existing solutions which are quite expensive, non-ubiquitous and not available in developing countries where most of the collapses occur. So, motivated by this, the goal of this work is to have deep research about signal penetration for collapsed environments.

The main objective of this work is to focus on Wi-Fi signal coverage in collapsed structures. We employ Wi-Fi Halow operating at sub 1GHz to address this problem. It is primarily designed for IoTs and has better penetration in cluttered environments. We propose a radar based approach where Wi-Fi signals reflect back with proper channel state information. Some studies like [15] [16] propose Wi-Fi Radar technique for sensing and behavior detection but these lack implications for collapsed structures. So, our proposed approach of Wi-Fi radar is quite significant and has more importance than existing work. The main focus of our Wi-Fi radar is to compute coverage of Wi-Fi signals in collapsed environments.

We consider a debris model constituent of brick and concrete materials from an earthquake scenario. We make use of radar range equation and path loss models to map our proposed Wi-Fi radar approach for signal coverage through debris model. It is assumed that Wi-Fi Halow transmitter is placed outside of the debris to model like real environment. The transmitter continuously sends pulses like radar which pass through debris and face attenuations because of complexity of materials and layout eventually causing multipath. These attenuations, multipath fading, scattering and reflections weaken Wi-Fi signals. So, some of the transmitted pulses reflect back

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as echo while others are damped. We have modeled collapsed structure having specification of brick 10.5″and concrete 8″. We consider these materials based on the construction style found in developing countries. Range of Wi-Fi radar can be calculated from received signal's SNR above than a predefined threshold to ensure the better reception of echo as it contains channel state information (CSI) which can be used for rescue.

The main contributions of this paper are:

- We present coverage models for Wi-Fi radar in collapsed structures. These are echo and debris models that cope with rubble from earthquake scenario. We consider debris constituent of brick and concrete materials found in developing countries where the most of collapses occur.
- We present Wi-Fi radar range by employing radar range equation and path loss models.
- Finally, we consider Wi-Fi Halow(sub 1GHz) through our proposed cluttered debris model which is validated our Wi-Fi for low power through proper simulations.

The remainder of paper is organized as follows: Section II provides more depth on background and related work whereas Section III describes our models for Wi-Fi radar. We discuss our coverage range of our proposed approach in Section IV. Simulation results have been provided in Section V. Section VI completely analyzes the work and compare it prior works. Finally, Section VII concludes the paper.

II. Background and Related Work

In this section, we provide background and relevant work to have better understanding for our research problem. Firstly, we discuss the complexity of problem. This includes behavior of wireless signals for debris scenario. Thereafter, existing tools and techniques for rescue have been presented. Finally, we discuss some techniques from adjoining areas which can be used for disaster case. At the end, we provide our problem statement by considering background and related work.

Wireless signals are adversely affected in complex indoor environments. It becomes even worse in case of collapsed structures as there are multiple layers of debris which causes more reflections, attenuations, fading and other related issues [12]. Although, there is literature which investigate the behavior of radio signals for debris scenario but presented techniques are not much successful and cannot be termed as ubiquitous. A study was conducted by DiCarlofelice and E. DiGiampaolo [17] for an historic town,"LAquila"which was severely hit by an earthquake. Similarly, a study was conducted for various radio bands [50MHz, 150MHz, 225MHz, 450MHz, 900MHz, 1.8GHz] by [12]. There are also some studies on structural health monitoring such as [18] [19] [20] [21] that provide insight about applications of wireless sensors for complex structures.

Now, let us discuss the existing techniques and approaches that make use of wireless signals for possible rescue under collapsed environment [4]. These are wireless sensors [22] [23] and radars [24]. Both techniques have their own advantages but radar based sensing is more preferred as it can provide deep penetration through dielectric barriers. The most famous approaches radar types for rescue operations are IR-UWB radars [25], Ultra-wideband (UWB) radars [26], Continuous Wave Stepped Frequency (CW-SF) Ground penetrating radar [27] and Doppler radars [24] [28]. But these radar technologies are not favorable because cost and availability in developing countries is a big issue.

The most important task to deal with fading and attenuations under debris is to study the path loss models. Although, there is enough literature for path losses encountered to signal for indoor and outdoor environments, yet there are very few works for debris scenario like [29]. There is a survey comprising of path loss models spanning over period of 60 years in [4]. There are also some studies related to losses for Wi-Fi bands such as [30] and [31]. These works provide us insight how can we map path losses in collapsed structures.

In a nutshell, we observe that wireless signal is highly affected in collapsed structures. There is also inference that most of the rescue solutions are mainly based on radars and cannot be regarded as ubiquitous. The cost and availability is also an important criteria for better solution where current solutions does not fit well. According to our study, there is no solution based on application of Wi-Fi signals as sensors for possible rescue. So, this work put emphasis on the most important problem of coverage which Wi-Fi signal encounter in collapsed environments.

III. Problem Formulation

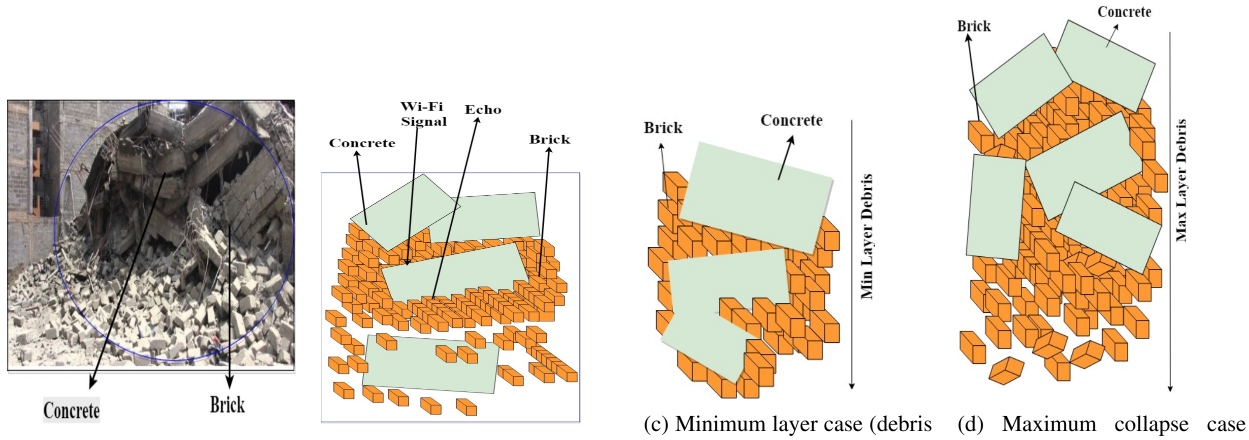
In this section, we present coverage models for Wi-Fi radar to formulate our problem. Firstly, we discuss the echo model which is the most important part of Wi-Fi signal reception. Secondly, we present debris model based on construction style of developing countries. Finally, we analyze Wi-Fi radar models as these help us in computing coverage of Wi-Fi signals in collapsed structures.

A. Echo Model

Indoor environments have relatively complex structures as these are constituent of multiple objects, walls, halls etc., so wireless signal faces many attenuations and becomes weak. When it comes to collapsed structure, the case becomes more worse as even single wall may turn up to multiple objects. It is evident that by considering whole collapse structure where debris has hundreds of pieces, wireless signal penetration becomes a nightmare. And it becomes even worse for weak Wi-Fi signal to penetrate into it.

In order to simplify the problem, let us consider a small indoor collapsed structure consisting of brick and concrete only as shown in Fig 1a. This shows that aforementioned structure has turned into multi object scenario each objects having different thickness level which defines the Wi-Fi signal penetration.

In order to address the coverage issue, we employ echo model which works like a radar. Wi-Fi transmitter radiates its signals simultaneously that can take many paths but for simplicity of problem we have only considered directional lobe of antenna. When this signal passes through collapsed structure



(a) Simple collapsed structure (b) Echo model (c) Minimum layer case (debris model) (d) Maximum collapse case (debris model)

Fig. 1: Illustration of collapsed structure with echo and layered models

as model shown in Fig 1b, it will face multiple attenuations and fading. This weak signal will return back after facing so much reflections. We have also considered the SNR threshold in conjunction with minimum detectable signal (MDS) for a given radio which can ensure quality reception of echo.

B. Debris Model

Selection of proper debris is pivotal to estimate the coverage. Collapsed structures may have multi-material debris but here we only consider brick and concrete based debris. We assume that after collapse, structure turn up into pieces laying over each other. We also assume that collapse is caused by an earthquake. We define layers based on this fact of pieces laying over each other and make a debris model like in Fig 1c. Debris has vertical and horizontal layers but more important are vertical layers as these define the depth of debris. The signal penetration of horizontal and vertical layers will be almost same but in order to address the most important depth issue, we only consider vertical layers. All debris materials as considered above have their own attenuation behavior for various frequencies. We have considered both normal depth and deep depth cases with Fig 1c showing the common depth scenario whereas Fig 1d depicting complex debris layers. It is evident that each adding piece will cause more obstructions, so deeper the debris, higher the attenuation which results in lower penetration.

C. Problem Definition

Let us analyze coverage models for Wi-Fi radar. Echo model provides us information about the behavior of Wi-Fi signal which is very weak. It faces many attenuations, fading, reflections and multipaths. We mainly focus on reflected signal that may have significant CSI. Similarly, debris model provides details about the nature of collapsed structure that can be considered for develpoing countries where most of the collapses occur. So, in brief, our problem is "to find coverage (that may provide us desired echo for rescue) in collapsed structure based on minimum detectable signal threshold". This coverage various with respect to transmitter intensities, antenna gains, minimum detectable signal threshold and debris model. We estimate the coverage with these aforementioned aspects and predict the Wi-Fi radar signal behavior for collapsed structures.

IV. Wi-Fi Radar Range

In this section, we present the mathematical formulation of Wi-Fi radar based on coverage models as discussed earlier . We make use of echo that works on radar principle [32] to compute coverage of Wi-Fi radar in our debris model.

Let us consider the echo model as shown in Fig 1b. Under normal condition, Wi-Fi transmitter radiates pulses simultaneously which may take various paths. But to simplify the approach, we assume directional pattern of antenna as it can assist for avoidance of multiple aliased signals reflected from unwanted sources. It is also assumed that Wi-Fi radar is placed outside of debris to map it like a practical case.

Let us consider the two-way radar equation to drive the range of our proposed Wi-Fi radar. It is dependent on antenna gains, signal intensities, cross sectional area and distance under normal scenario. It is given as follows;

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} \tag{1}$$

Since $\lambda = \frac{c}{f}$; so, (1) can be modified as;

$$P_r = P_t G_t G_r \left(\frac{c^2 \sigma}{(4\pi)^3 f^2 R^4}\right) \tag{2}$$

where P_t and P_r are transmit and received power, whereas G_t and G_r are corresponding antenna gains respectively. σ is cross sectional area which in our case is debris area while R and f denotes the range and frequency respectively. Now, in order to find returned signal from debris, we first consider signal at ruin site which is given as;

$$\begin{Bmatrix} Signal\,Received \\ at\,Debris \end{Bmatrix} = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2} \tag{3}$$

Since $G_r = \frac{4\pi\sigma}{\lambda^2}$, so signal reflected from debris will be;

$$\begin{Bmatrix} Signal\,Reflected \\ from\,Debris \end{Bmatrix} = \frac{P_t G_t \lambda^2 4\pi\sigma}{(4\pi R)^2 \lambda^2} \tag{4}$$

(3) and (4) are used to calculate the received signal at the input of Wi-Fi radar.

$$\begin{Bmatrix} Received\,Signal \\ at\ \textit{Wi-Fi Radar} \end{Bmatrix} = \frac{P_t G_t \lambda^2 4\pi\sigma}{(4\pi R)^2 \lambda^2} \times \frac{G_r \lambda^2}{(4\pi R)^2} \tag{5}$$

On reducing the above equation to log form, we get;

$$\begin{aligned} P_R = P_T + G_T + G_R + 20log(\frac{\lambda}{4\pi R}) \\ + 10log(\frac{4\pi\sigma}{\lambda^2}) + 20log(\frac{\lambda}{4\pi R}) \end{aligned} \tag{6}$$

Let us consider 4^{th} and 6^{th} term of (5). Both of them are same and represent free-space loss in $-\beta_1$ form . So, the only remaining term is 5^{th} which reflects the radar cross section and known as target gain factor.So, (6) can be modified as;

$$P_R = P_T + G_T + G_R + G_\sigma - 2\beta_1 \tag{7}$$

where $\beta_1 = 20log(\frac{4\pi f R}{c})$ and $G_\sigma = 10log(\frac{4\pi\sigma}{\lambda^2})$. Now, (7) provides information about strength of received signal at input of Wi-Fi Radar in log form. It also consist of free space path loss factor. But in real scenario, Wi-Fi signal penetration through collapsed structures comprise two path losses. We assume that signal will firstly travel in free-space before entering into debris. Thereafter, it will travel in cluttered environments causing multi-paths, fading and attenuations. We formulate this assumption as follows;

$$PL = PL_{free-space} + PL_{debris} \tag{8}$$

It can be observed from (7) that free space path loss is already dealt. The only remaining term is PL_{debris}. In order to introduce path loss in debris, we consider X_G. It includes all possible path losses encountered to Wi-Fi signal. It can be formulated with number of layers from selected debris materials along-with the attenuation factor AF these encounter at Wi-Fi Halow frequency. We have considered only brick and concrete scenario as per our site survey. X_G can be formulated as in (9), where m and n refers to number of brick and concrete layers respectively.

$$\begin{aligned} PL_{debris} = X_G = m * AF(Brick\,Layer) \\ + n * AF(Concrete\,Layer) \end{aligned} \tag{9}$$

Now, there is need to incorporate the losses faced by Wi-Fi radar in (7) which will yield the following relation;

$$P_R = P_T + G_T + G_R + G_\sigma - 2\beta_1 - X_G \tag{10}$$

In order to compute coverage, we reconvert log form to ordinary one and make use of (5) which gives us range in power form.

$$R^4 = \frac{P_t G_t G_r}{P_r}(\frac{\lambda^2}{4\pi})(\frac{4\pi\sigma}{\lambda^2})(\frac{\lambda^2}{4\pi})\frac{1}{X_g} \tag{11}$$

Finally, by doing some mathematics, we get following relation for coverage computation with all possible losses from debris.

$$\textit{Wi-Fi}\,Radar\,Range = R = \sqrt[4]{\frac{P_t G_t G_r}{P_r}(\frac{\lambda^2\sigma}{(4\pi)^3})\frac{1}{X_g}} \tag{12}$$

(12) provides the complete relation for coverage computation in our considered debris environment. P_t,G_t,G_r and P_r are known terms of antenna gains power intensities whereas σ denotes the debris area under observation. Under normal conditions, it is $1m^2$. P_r is the minimum detectable signal which can provide us desired echo. It means the strength of received signal which conveys proper information about breathing signals under debris. (12) in log form can be given as follows;

$$\begin{aligned} 10logR \cong \frac{1}{4}[P_T + G_T + G_R + 10log\sigma - P_R - 20logf \\ - 30log(4\pi) + 20log(c) - X_G] \end{aligned} \tag{13}$$

Let us consider $K_1 = 20log[4\pi/c]$; so, (13) will yield the following relation,

$$\begin{aligned} 10logR \cong \frac{1}{4}[P_T + G_T + G_R + 10log\sigma - P_R \\ - X_G - 20logf - K_1 - 10.99dB] \end{aligned} \tag{14}$$

Finally, Wi-Fi Radar range through log form can be computed as;

$$\textit{Wi-Fi}\ Radar\ Range = R = 10^{\frac{Q\,dB}{10}} \tag{15}$$

Furthermore, Wi-Fi signals have feature known as channel state information (CSI) which contains the sensing information. This CSI can further help in post-disaster rescue. In order to achieve required echo, the received signal to noise ratio (SNR) should be above or equal to a pre-defined threshold given below;

$$SNR \geq SNR_T \tag{16}$$

V. Simulations

This section discusses the simulation method and provide results. Simulation parameters vary with the environments primarily because of regulatory bodies like Federal Communications Commission (FCC)[1].

A. Simulation Method

Right selection of simulation parameters is essential to have better results. We have performed simulations on MATLAB 17a on 64bit OS with 16GB RAM and Intel(R) Xeon(R) 3.3GHz CPU as per simulations parameters shown in Table II.

[1] https://www.fcc.gov/tags/radio-rules

TABLE I: Coverage Range with Various Materials

Transmit Power (dBm)	Max Antenna (dBi)	Range in Collapsed Structure (m)							
		QAM256 R=5/6 MS=-70dBm Min Layer 6b+3c	QAM256 R=5/6 MS=-70dBm Max Layer 12b+5c	QAM256 R=3/4 MS=-72dBm Min Layer 6b+3c	QAM256 R=3/4 MS=-72dBm Max Layer 12b+5c	QAM16 R=3/4 MS=-71dBm Min Layer 6b+3c	QAM16 R=3/4 MS=-71dBm Max Laye 12b+5c	QAM16 R=1/2 MS=-75dBm Min Layer 6b+3c	QAM16 R=1/2 MS=-75dBm Max Layer 12b+5c
30	6	0.9157	0.0058	1.0275	0.0065	0.9700	0.0061	1.2212	0.0077
24	12	1.2935	0.0082	1.4514	0.0092	1.3702	0.0086	1.7249	0.0109
23	13	1.3702	0.0086	1.5374	0.0097	1.4514	0.0092	1.8272	0.0115
						QAM64 R=3/4 MS=-78dBm	QAM64 R=3/4 MS=-78dBm	QAM64 R=5/6 MS=-77dBm	QAM64 R=5/6 MS=-77dBm
13	23	2.4165	0.0152	2.7114	0.0172	3.8299	0.0242	3.6157	0.0228
10	26	2.8689	0.0181	3.2189	0.0205	4.5469	0.0287	4.2925	0.0271

TABLE II: Simulation Parameters

Parameter	Values
Operation Frequency	(902, 915,917)MHz
Transmission Power	(30, 24, 23, 13, 10) dBm
Antenna Gains	(6, 12, 13, 23, 26) dBi
Radar Cross Section	$4m^2$
Modulation Type	QAM256, QAM64, QAM16
Channel BW at QAM256	1MHz
Chennel BW at QAM64	1MHz
Channel BW at QAM16	16MHz, 1MHz
MS Threshold at QAM256	-70dBm,-72dBm
MS Threshold at QAM64	-77dBm, -78dBm
MS Threshold at QAM16	-71dBm, -75dBm
Debris Type	Brick, Concrete
Attenuation of Brick 10.5″	7dB at 900 MHz
Attenuation of Concrete 8″	23dB at 900 MHz
Minimum Debris Layers	9 (6b+3c)
Maximum Debris Layers	17 (12b+5c)

We have considered Wi-Fi Halow operating at three frequencies as provided in Table II to work well with Wi-Fi radar. These are regulated by IEEE Task Group [33]. We have considered the frequency case for US(902MHz), Japan(915MHz) and Korea(917MHz). These countries have their own spectrum limits and power considerations for Wi-Fi Halow as in [33]. Similarly variance in transmission power and antenna gains is regulated with FCC para 17.245 rules for PTMP (Point to multi-point). Antenna gain varies from 6dBi to 26dBi in relation with transmitted power.Wi-Fi Halow follows same behavior for power increase in relation with decrease in antenna gain to that of 2.4GHz and 5GHz spectrum as given in regulations[2].

As mentioned earlier that collapse structure may constitute various materials. We have considered two types of debris constituent's based on real construction scenarios in developing countries. These are brick 10.5″and concrete 8″. The depth of these materials define the complexity of collapsed structures. The attenuations caused by single layers of under consideration materials have been provided by Digi [3]. We also select debris layers which defines the nature of collapsed structure. Most of the buildings in developing countries are not sky scrappers; so, we have assumed debris layers between 9 to 17 for simulations in order to have insight about Wi-Fi Halow Signal in collapsed environments.

The minimum detectable signal threshold which is much important for better echo reception; specifically for our case; is assumed to be -70dBm and -72dBm for QAM256 case with 1MHz channel bandwidth. Similarly, for lower modulation scheme i.e., QAM16, -71dBm and -75dBm values have been considered for MDS threshold with 16MHZ and 1MHz channel bandwidth respectively. We also consider QAM64 with 1MHz channel width having -77dBm and -78dBm MDS for lower power cases. Higher QAM ensures better data rate but noise and interference are also evident. That is why, we have considered both low and high QAM case to have better understanding of Wi-Fi radar.

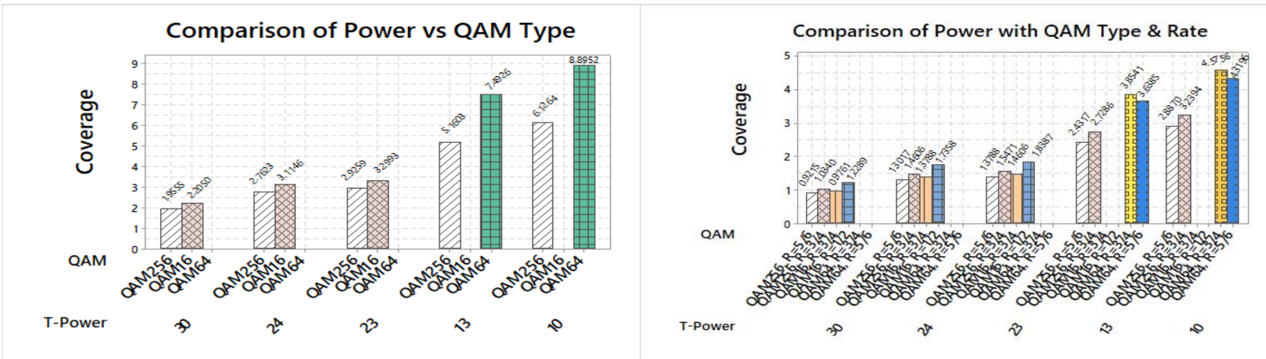
B. Simulation Results

We performed simulation on afore-discussed parameters. Results as displayed in Table I have shown an increasing trend of coverage with lowering the transmitter intensity. Table I also depict Wi-Fi radar behavior for different debris layers across varied signal intensities and antenna gains. Overall, we performed 40 simulations with varied parameters. Finally, we compare the results for best power level which should be low enough to fit it for IoT based solutions.

Let us consider the Wi-Fi radar range at higher power with lower antenna gains for varied QAM cases. We illustrate the simulations provided in Table I with Fig 2. We observe that increase in power weakens the echo reception as reflections are

[2]https://www.air802.com/fcc-rules-and-regulations.html

[3]http://ftp1.digi.com/support/images/XST-AN005a-IndoorPathLoss.pdf



(a) Signal intensity vs Modulation scheme

(b) Signal intensity vs Rate of each modulation scheme

Fig. 2: Wi-Fi radar signal intensity vs Modulation schemes

more evident. On the contrary, low power with lower QAM schemes, Wi-Fi radar has relatively better coverage range as shown in Fig 2b

VI. Performance Analysis

In this section, we provide in-depth analysis of our work with relevant background, contributions and prospective future application.

In this study, we proposed Wi-Fi radar to have better coverage in collapsed structures. These environments are very much complex in nature as debris forms multi-layered scenario where Wi-Fi signals is highly affected from attenuations. This is why that the most of rescue operations are manual across the world. Recently, some studies like [24] [17] [27] proposed radar based approaches that make use of wireless signals but could not provide appreciable results. Although, these provided insight about application of wireless signals under debris scenario but still cannot be regarded as ubiquitous. Cost and availability are another factors that motivate to find an alternative.

We formulate Wi-Fi radar to have better echo reception. Path loss modelling under debris is a big challenge for Wi-Fi radar as normal radar based techniques does not consider losses for debris as in [4] [34] [35]. We make use of modified path loss model from [4] [34] which take complex structure into consideration and map it to our proposed Wi-Fi radar approach.

Let us discuss the possible application of our proposed Wi-Fi Radar. The biggest challenges to have better rescue are breathing detection and locating the alive ones under the debris. So, there is need to figure out existing work on these challenges. Interestingly, there are some studies like [6] [7] [36] for breathing detection and [5] [8] [37] [38] for localization by employing Wi-Fi signals. But limitations of these work is that normal indoor environments are subject to evaluation and no work has been done for debris case. So, this provide us insight that effective coverage of Wi-Fi signals in collapsed structures can pave way for possible application of these works in rescue. This essentially increases the worth of our study.

Finally, we conclude our analysis with focus on IoT based rescue solutions. Wi-Fi signals operate at three different frequencies i-e., 5GHz, 2.4GHz and recently proposed sub 1GHz. We make use of Wi-Fi Halow (sub 1GHZ) for our Wi-Fi radar approach. It has better penetration in cluttered environment and has been primarily designed for IoT related applications. So, application of Wi-Fi Halow to Wi-Fi Radar adds more worth to our work.

VII. Conclusion

In this study, we proposed Wi-Fi radar for better coverage of Wi-Fi signals in collapsed structures. In order to meet our objective, we modified existing path loss modeling and radar techniques by using communication mechanism of Wi-Fi signals. We compared performance of Wi-Fi radar while employing various standards and also cross-verified with existing literature. As a conclusion, it was figured out that our proposed Wi-Fi radar can play a vital role in better coverage for Wi-Fi signals which can further be used for rescue efforts in future. It also emphasis on the ubiquitous post-disaster rescue as our opted Wi-Fi Halow has been primarily designed for IoTs. So, in short, we can expect IoT based rescue solution in future.

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