STAR

System for Tracking Animals using Radars

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Energy and Environment

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- A discussion on the current methods on the monitoring of animals in Wildlife reserves/sanctuaries and zoos
- Introduction to contactless methods using radars
  - FMCW
- Methodology of STAR
  - Use of MATLAB
  - Range and Velocity estimation
  - Hardware used and features

PROBLEM STATEMENT

- Extinction of over 18 species of wild animals in the last century
- Despite efforts taken through wildlife reserves and sanctuaries, poaching remains to be a threat
- Locating and monitoring the movement and vitals of the animals in reserves are challenging

CURRENT METHODS

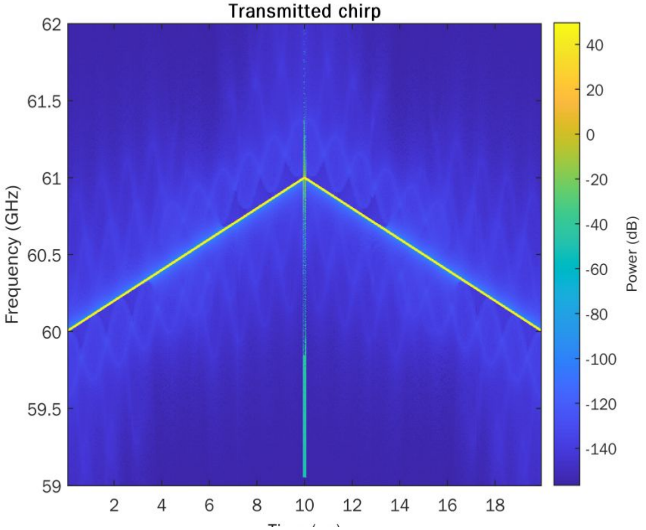
- Existing methods involve use of cameras, which prove to be disadvantageous because of their limited field of vision and range, and poor performance in harsh weather conditions.
- While microchip implants that use may help track the different animals of the same species, it cannot actively locate or track the vitals of said animals.
- GPS devices are also not the best option as they are susceptible to damage and are sometimes too large to be implanted into animals.

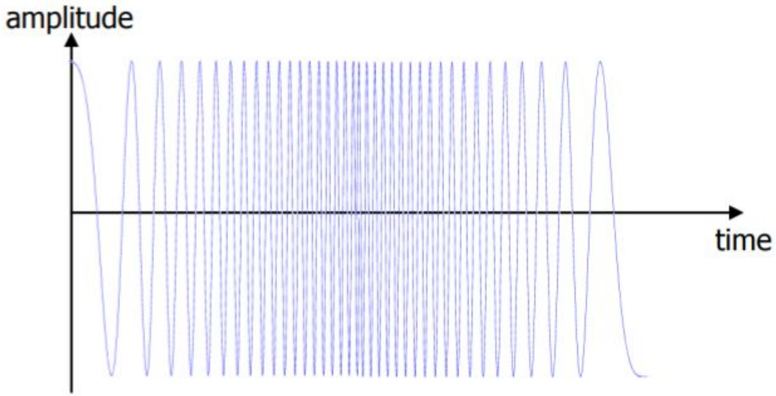
OBJECTIVES OF STAR

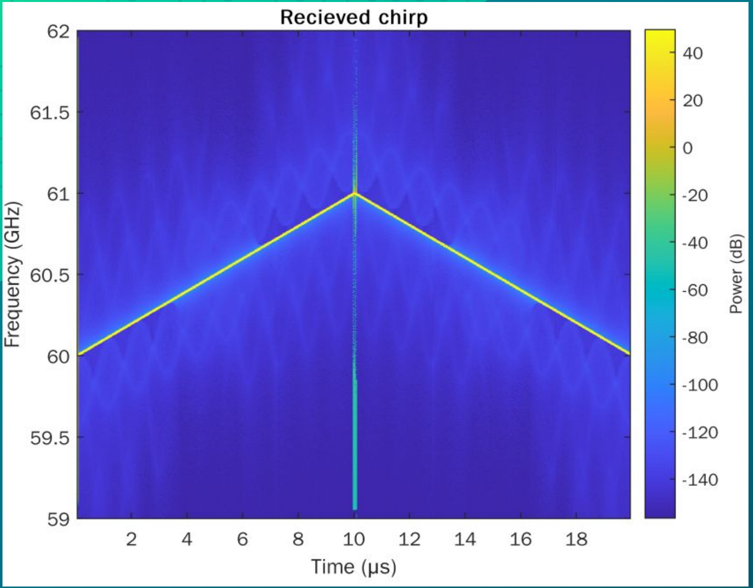
- The main objectives of this project are to:
  - → Detect and measure vital signs of animals.
  - → Tracking both animal and human movements to prevent poaching and hunting in wildlife sanctuaries/restricted areas.
- This will be accomplished using FMCW Radar.

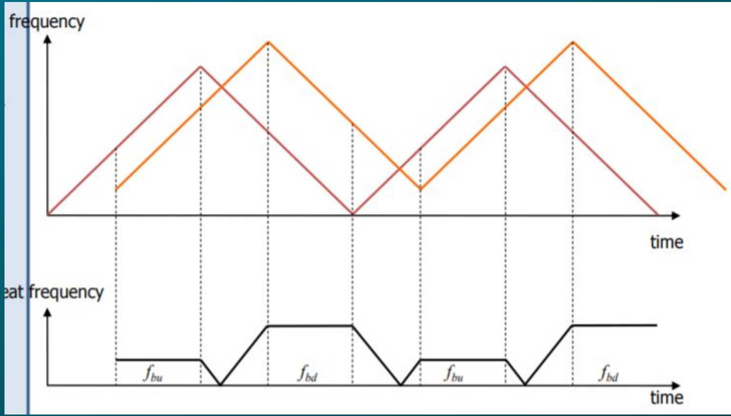
VELOCITY/RANGE ESTIMATION

METHOD 1: Using triangulated frequency









Beat frequency components due to range and Doppler frequency shift:

$$f_b = \frac{B_{sweep}}{T_s} \cdot \frac{2R}{c}$$

$$f_D = \frac{2v_r}{\lambda}$$

that are superimposed as

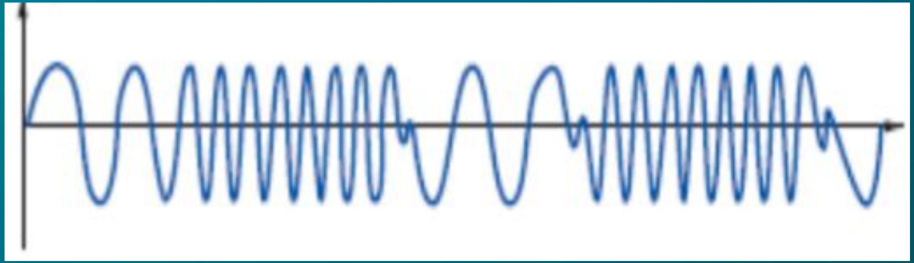
$$f_{bu} = f_b - f_d$$

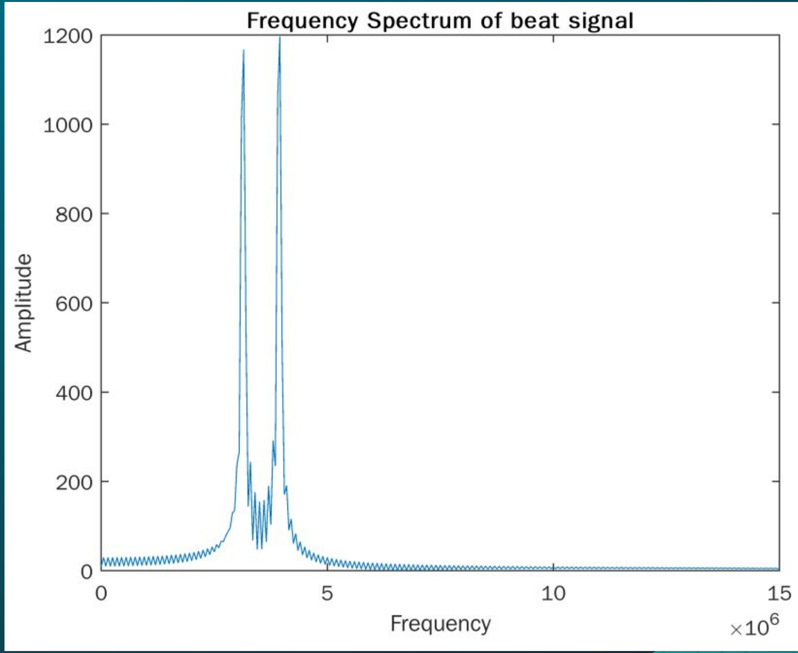
$$f_{bd} = f_b + f_d$$

so range and radial velocity can be obtained as

$$R = \frac{cT_s}{4B_{sweep}}\left(f_{bd} + f_{bu}\right)$$

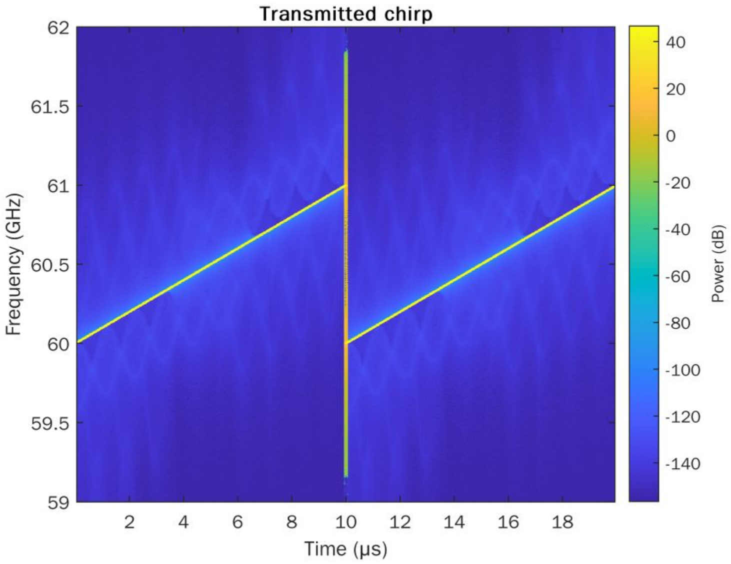
$$v_r = \frac{\lambda}{4}\left(f_{bd} - f_{bu}\right)$$

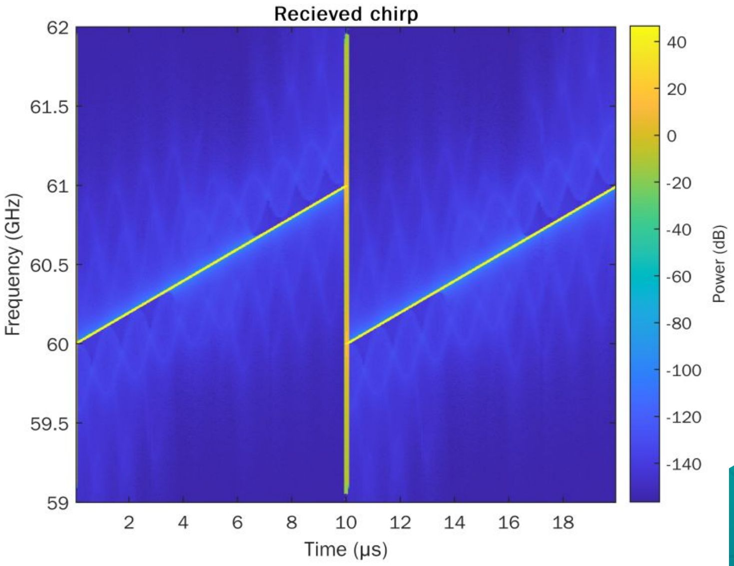



Frequency Spectrum of beat signal
1200
1000
800
600
400
200
0
Amplitude
0
5
10
15
Frequency
$\times10^6$

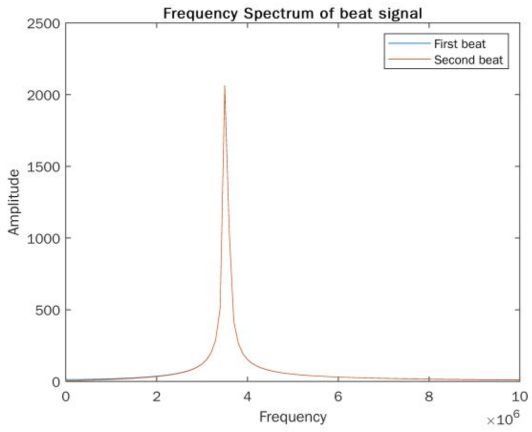
VELOCITY/RANGE ESTIMATION

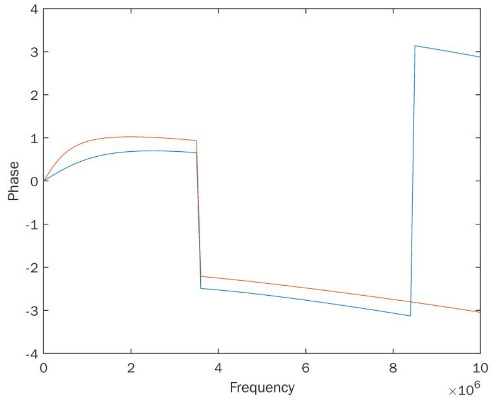
METHOD 2: USING SAWTOOTH FREQUENCY WAVES





BEAT SIGNAL





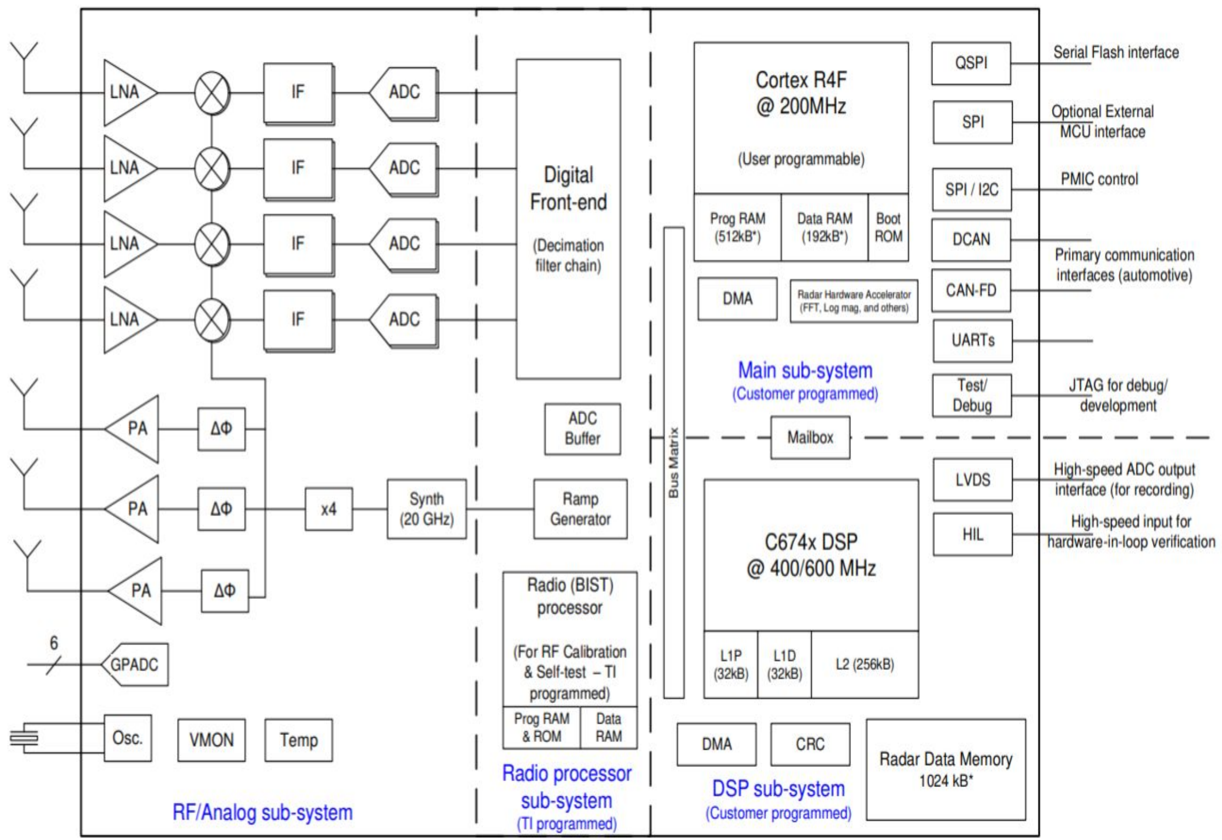
Estimating Velocity

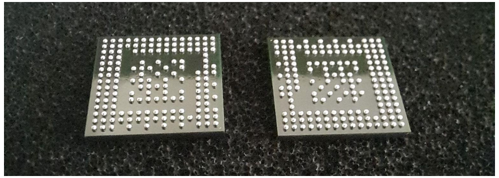
```
[max_val,i] = max(abs(beat_fft_1))

max_val = 2.0615e+03
i = 699966

f_beat = abs(f_new(i))

f_beat = 3500000

r = beat2range(f_beat,K,c) %range

r = 5.2500

range_error = (d1+d2)/2 - r

range_error = 0.0501

w1 = (angle(beat_fft_1(i)))

w1 = -0.6575

w2 = (angle(beat_fft_2(i)))

w2 = -0.9394

w = unwrap([w1,w2])
```

5

```
w = 1×2
   -0.6575   -0.9394

v_e = lambda1*(w(1)-w(2))/(4*pi*(L-1)*ts)

v_e = 11.2149

error = abs(abs(v_e)-abs(v_o))

error = 0.1149
```

HARDWARE

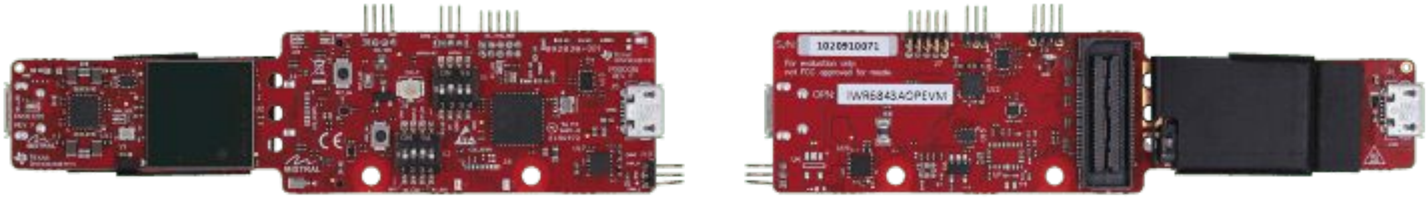




AWR1843

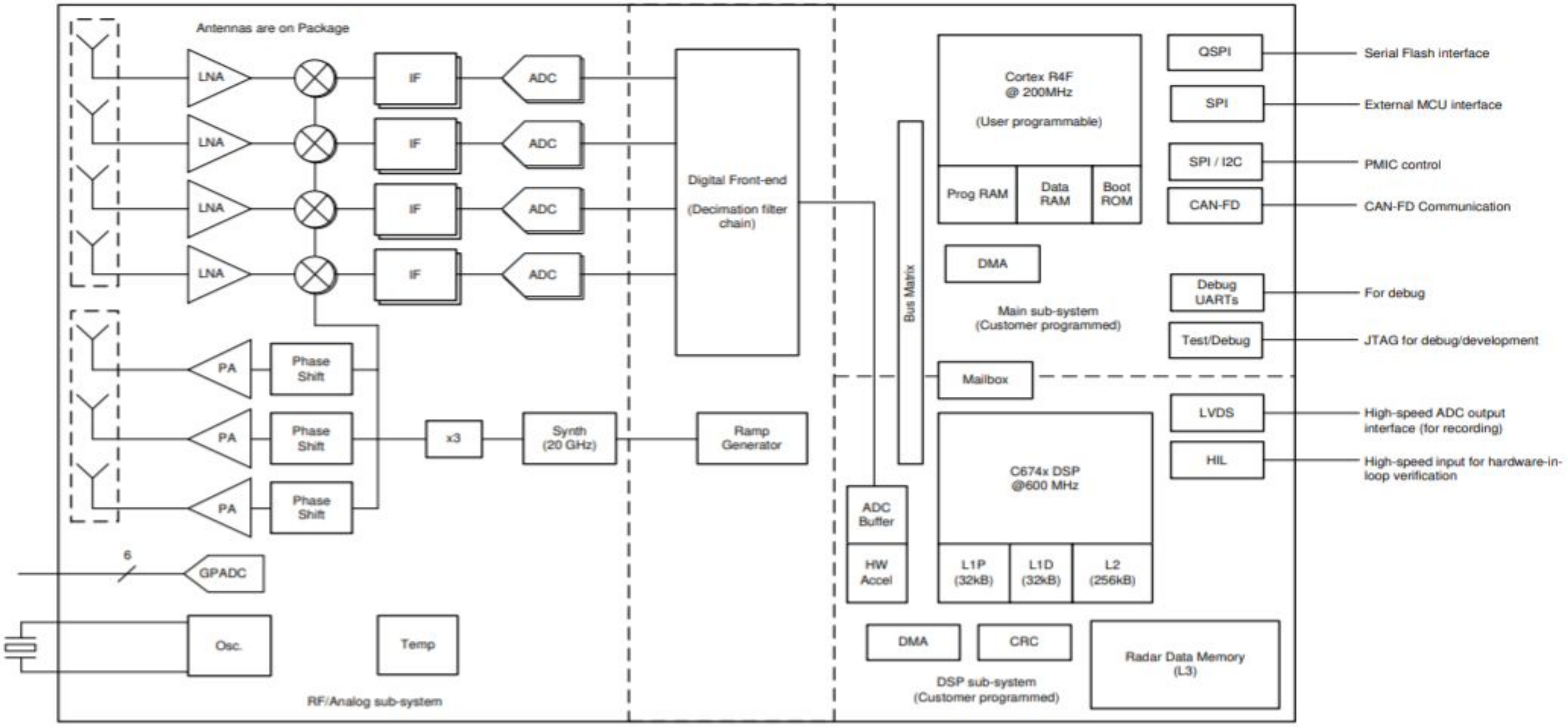
Single-chip 76-GHz to 81-GHz automotive radar sensor integrating DSP, MCU and radar accelerator

IWR6843AOP EVALUATION MODULE



The IWR6843 antenna-on-package (AoP) evaluation module (EVM) is an easy-to-use 60-GHz mmWave sensor evaluation platform used to evaluate the IWR6843AOP product, which integrates a wide field-of-view (120 degrees FoV) antenna. This EVM enables access to point-cloud data and power over a USB interface.

MODULE ARCHITECTURE



How are we going to work with the hardware?

1. **Developing firmware for the Radar Sensor**
   - Involves writing codes to instruct the radar to send the mmwave wave from the transmitter, receive the reflected wave in the receiver, processing the signal, etc.
2. **Flashing Firmware to the Board**
   - Involves changing the configuration of board for flashing and flashing the firmware onto the board using uniflash.
3. **Configuring the Radar Subsystem**
   - Involves configuring the range resolution, velocity resolution, the number of active transmitters and receivers, the ADC sampling frequency, chirp parameters, the type of data to be processed, etc using an API interface.
4. **Working with communication protocol (UART-USB interface)**
   - to enable communication with the Radar through the PC

WHY MONITOR VITAL SIGNS?

- Measuring the heartbeat and respiration of small conscious animals is important for assessing their health and behavior.
- Change in heart rate may be a suitable parameter for studying both the quality of a stressor as well as an animal's response to environmental challenge
- Reduces unnecessary animal deaths
- Detects signs of life in certain restricted areas