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% Gunshot data set for the 10 shots fired at President Trump's
% rally in Butler, PA on July 13, 2024
%
% Initial public release: 2024 Aug  9
% Date of last update:    2024 Aug 21 (B)
%
% Revision history
%
% (A)   2024 Aug 16
%       Location movement updated for Ross, TMX and DJStew.
%       Added fifth recording source: Police Cruiser.
%       Adjusted timing of reports 6 & 7 on the Podium mic by 2 & 3
%       milliseconds, respectively. These reports were overshadowed in the
%       audio by the preceeding supersonic cracks, making estimation
%       necessary.
%
% (B)   2024 Aug 21
%       The model was updated to use bullet velocity and location to
%       calculate accurate boom times based on the measured cract times.
%       Location movement updated for TMX and DJStew.

% This data was produced by Greg Nichols by carefully analyzing the audio
% tracks and video content of five videos from that day:
%
% 1. Ross!
%    https://www.tmz.com/2024/07/13/trump-rally-gunman-seen-opening-fire-shooting-
gets-killed-new-video-clip/
%
% 2. "He's got a gun", credit TMX
%    https://www.foxnews.com/video/6357914248112
%
% 3. DJ Stewart, extended cut
%    https://youtu.be/28lxF9LONGk?t=285
%
% 4. Broadcast audio from Trump's podium mic
%    https://rumble.com/v56qifh-trump-maga-rally-in-butler-pa-rav-live-team-
coverage.html
%
% 5. Butler Township Police Cruiser
%    https://mega.nz/file/GNxR0IwT#wclLmF7BggxCMkAhQ9b-yst-guyiFicHaVCpEVzBk0w
%
% Knowing the exact position of the recording sources is an essential
% requirement for being able to perform TDOA analysis. Each of the first
% three videos was carefully examined frame by frame to deduce the position
% as the recording device moved. Sources 1, 4 & 5 were static, but sources 2
% and 3 had a significant amount of movement during the gunshots.

% Position data for the five recording sources at each of the ten shots.
% The columns are in UTM format:
% Meters East, meters North and meters of elevation
%
% Data format is: [Easting, Northing, Altitude], all in meters
%
Ross=[
 586684.00, 4523541.00, 2;
```

```
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586684.00, 4523541.00, 2;
 586686.50, 4523545.72, 2
 ];
TMX=[
 586742.00, 4523497.00, 2;
 586742.00, 4523497.00, 2;
 586740.00, 4523498.00, 2;
 586736.00, 4523501.00, 2;
 586736.00, 4523501.00, 2;
 586736.00, 4523501.00, 2;
 586736.00, 4523501.00, 2;
 586736.00, 4523501.00, 2;
 586731.00, 4523501.00, 2;
 586729.00, 4523510.00, 2
];
%
DJStew=[
 586770.00, 4523488.00, 1;
 586772.00, 4523487.00, 1;
 586774.00, 4523486.00, 1;
 586777.00, 4523483.00, 1;
 586778.00, 4523484.00, 1;
 586778.00, 4523484.00, 1;
 586778.00, 4523484.00, 1;
 586778.00, 4523484.00, 1;
 586782.00, 4523482.00, 1;
 586776.00, 4523483.00, 1
];
%
Podium = [586730, 4523399, 3];
%
Cruiser = [586793, 4523524, -1];
%
%
base = 407; %meters above sea level
%
Ross(:,3) = Ross(:,3) + base;
TMX(:,3) = TMX(:,3) + base;
DJStew(:,3) = DJStew(:,3) + base;
Podium  = repmat(Podium+[0 0 base],10,1);
Cruiser = repmat(Cruiser+[0 0 base],10,1);
shooter = [586768.51, 4523528.24, base+5];
north_barn = [586779.00, 4523406.00, base+7];
south_barn = [586763.00, 4523361.00, base+7];
light_pole = [586724.46, 4523429.46, base+7];
first_floor_window1 = [586750, 4523514, base+2];
first_floor_window2 = [586765, 4523513, base+2];
second_floor_window = [586738, 4523539, base+5];
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wall_vent = [586765, 4523514, base+3.5];
northern_AGR_bldg = [586796, 4523617, 10];
covered_bleacher_west = [586550, 4523282, base+6];
covered_bleacher_east = [586598, 4523266, base+6];
potential_cs1 = [586760, 4523430, base+1];
%
c = 351.18; %m/s  speed of sound at 408m altitude and 93°F (33.9°C)
%
%
% These are the times the gunshots were heard by each mic.
% The times were determined by zooming in to the millisecond level
% and marking the onset of each gunshot at the very leading edge
% of the shot's audio waveform
%
Sources = {'Ross'; 'TMX'; 'DJStew'; 'Podium','Cruiser'};
% All times are "crack" times unless noted
Report = [ ...
0.000 0.855 1.527 4.307 4.562 4.745 4.921 5.080 5.949 16.027; %Ross
0.000 0.853 1.531 4.324 4.580 4.765 4.941 5.100 5.935 16.029; %TMX
0.000 0.858 1.538 4.333 4.589 4.773 4.954 5.109 5.874 15.932; %DJStew
0.000 0.854 1.527 4.310 4.566 4.748 4.927 5.085 5.579 15.591; %Podium
0.000 0.854 1.528 4.310 4.566 4.750 4.926 5.086 6.062 16.031];%Cruiser, Shot 9 is
boom
%
% The five sources need to be aligned with these steps:
% 1. Choose any one of the 10 shots
% 2. Hypothesize its location
% 3. For all ten shots, calculate the amount of time it would take
%    for the rifle report to arrive at the recording device
% 4. Slide each row left/right to achieve the calculated amount
%    of time offset for the gunshot you chose in step 1
%
% And here is the processed data. These are all boom times, computed from
% crack time, bullet velocity and distance. This is what's needed to
% perform TDOA localization.
%
% Booms = [...
% 0.244 1.099 1.771 4.551 4.806 4.989 5.165 5.324 6.232 16.415;
% 0.117 0.970 1.644 4.430 4.686 4.871 5.047 5.206 6.068 16.281;
% 0.115 0.970 1.648 4.441 4.694 4.878 5.059 5.214 6.005 16.195;
% 0.384 1.238 1.911 4.694 4.950 5.132 5.311 5.469 5.963 15.988;
% 0.073 0.927 1.601 4.383 4.639 4.823 4.999 5.159 6.131 16.318];
```