CLAIMS

1. A system operative to estimate a location of a projectile launch, the system comprising one or more processing circuitries configured to perform (i), (ii) or (iii):

   (i) obtain, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,

   obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{shockwaves}$ informative of shock waves generated by a motion of the projectile, and

   use D_{flash} and $D_{shockwaves}$ to estimate the location of the projectile launch;

   (ii) obtain, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,

   obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the projectile, and

   use data D_{flash} and data $D_{acoustic_impact}$ to estimate the location of the projectile launch;

   (iii) obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the projectile, and data D_{blast} informative of a blast generated by the projectile launch, and

   use $D_{acoustic_impact}$ and D_{blast} to estimate the location of the projectile launch.

2. The system of claim 1, configured to perform (i), wherein the system is further configured to:

   use $D_{shockwaves}$ to estimate a time $t_{shockwaves}$ at which at least some of the shock waves are sensed by the acoustic sensors, and use $t_{shockwaves}$ to estimate the location of the projectile launch, or

   use $D_{shockwaves}$ to determine a direction $DR_{shockwaves}$ at which at least some of the shock waves are sensed by the acoustic sensors, and use $DR_{shockwaves}$ to estimate the location of the projectile launch.

3. The system of claim 1 or of claim 2, configured to perform (i) or (ii), wherein the system is further configured to:

use data D_{flash} to obtain a time t_{flash} which is an estimate of a time t_0 at which the projectile has been launched, and use the time t_{flash} to estimate the location of the projectile launch, or

use data D_{flash} to estimate a direction DR_{flash} at which the projectile has been launched, and use the direction DR_{flash} to estimate the location of the projectile launch.

4. The system of any one of claims 1 to 3, configured to perform (i), wherein the system is operative to determine the location of the projectile launch based on D_{flash} and $D_{shockwaves}$ when (a), (b) or both of (a) and (b) is met:
(a) a blast generated by the projectile launch is sensed by the acoustic sensors with a frequency which is below a detection threshold, wherein when the blast generated by the projectile launch is sensed by the one or more acoustic sensors with a frequency equal to or below said detection threshold, said blast cannot be identified in the acoustic data provided by the acoustic sensors;
(b) a blast generated by the projectile launch is sensed by the acoustic sensors with a signal to noise ratio which is below a detection threshold, wherein when the blast generated by the projectile launch is sensed by the one or more acoustic sensors with a signal to noise ratio equal to or below said detection threshold, said blast cannot be identified in the acoustic data provided by the acoustic sensors.

5. The system of any one of claims 1 to 4, wherein at least one of (a) or (b) is met:
(a) the imaging device includes a plurality of light photodiodes;
(b) the projectile is a supersonic projectile.

6. The system of any one of claims 1 to 5, configured to perform (i), wherein the system is further configured to perform (a), (b) or (c):
(a) use a model to estimate the location of the projectile launch, wherein the model is operative to estimate, for a given location of the projectile launch, a time $\hat{t}_{shockwaves}$ and a direction $\widehat{DR}_{shockwaves}$ at which the shock waves are sensed by the acoustic sensors;

(b) use a model to estimate, for each of one or more candidate locations of the projectile launch, a time $\hat{t}_{shockwaves}$ and a direction $\widehat{DR}_{shockwaves}$ at which the shock waves are sensed by the acoustic sensors, use $D_{shockwaves}$ to determine a time $t_{shockwaves}$ and a direction $DR_{shockwaves}$ at which at least some of the shock waves are sensed by the acoustic sensors, and use $D_{shockwaves}$, $t_{shockwaves}$, $\widehat{DR}_{shockwaves}$ and $\hat{t}_{shockwaves}$ to estimate the location of the projectile launch;

(c) use a model to estimate, for a plurality of candidate locations of the projectile launch, a time $\hat{t}_{shockwaves}$ and a direction $\widehat{DR}_{shockwaves}$ at which the shock waves are sensed by the acoustic sensors, and

use:

$DR_{shock_{waves}}$, $t_{shock_{waves}}$, and

$\widehat{DR}_{shockwaves}$ and $\hat{t}_{shockwaves}$ determined for the plurality of candidate locations,

to determine a given candidate location of the projectile which meets an optimization criterion.

7. The system of claim 6, wherein the model uses:

a modelled kinematic behavior of the projectile;

an estimate $\hat{P}_{launch}$ of the location of the projectile launch;

a time t_{flash}, which is an estimate of a time t_0 at which the projectile has been launched, wherein t_{flash} has been determined using data D_{flash}; and

a direction DR_{flash}, which is an estimate of a direction of the projectile launch, wherein DR_{flash} has been determined using data D_{flash}.

8. The system of any one of claims 1 to 7, configured to perform (i), wherein the acoustic data includes data D_{blast} informative of a blast generated by the projectile launch, wherein the system is configured to use D_{flash}, $D_{shockwaves}$ and D_{blast} to estimate the location of the projectile launch, and a firing line direction of the projectile.

9. The system of claim 8, configured to:

use D_{flash} and D_{blast} to estimate the location $\hat{P}_{launch}$ of the projectile launch,

use a model to estimate, for the location $\hat{P}_{launch}$ of the projectile launch and one or more candidate firing line directions of the projectile, a time $\hat{t}_{shockwaves}$ and a direction $\widehat{DR}_{shockwaves}$ at which the shock waves are sensed by the acoustic sensors,

use $D_{shock_{waves}}$ to determine a time $t_{shock_{waves}}$ and a direction $DR_{shock_{waves}}$ at which at least some of the shock waves are sensed by the acoustic sensors,

use:

$DR_{shock_{waves}}$, $t_{shock_{waves}}$, and

$\widehat{DR}_{shockwaves}$ and $\hat{t}_{shockwaves}$ determined for the one or more candidate firing line directions of the projectile,

to estimate the firing line direction of the projectile.

10. The system of any one of claims 1 to 9, configured to perform (i), wherein the system is further configured to:

perform a determination of a content of the acoustic data, wherein said determination enables to identify whether the acoustic data includes (a) or (b):

(a) data $D_{shockwaves}$ informative of shock waves generated by a motion of the projectile shock waves, wherein a blast generated by the projectile launch cannot be identified in the acoustic data,

(b) data $D_{shockwaves}$ informative of shock waves generated by a motion of the projectile shock waves and data D_{blast} informative of a blast generated by the projectile launch, and

trigger an estimation method of the location of the projectile launch which depends on this determination.

11. The system of any one of claims 1 to 10, configured to perform (i), wherein the system is operative to be mounted on a moving platform, wherein the system comprises, or is operatively coupled to a sensor operative to provide data $D_{inertial}$ informative of a direction of the moving platform or of the system over time, wherein the system is configured to use D_{flash}, $D_{shockwaves}$ and $D_{inertial}$ to estimate the location of the projectile launch.

12. The system of any one of claims 1 to 11, configured to perform (ii), wherein the system is further configured to:

use $D_{acoustic_impact}$ to determine a time t_{impact} which is an estimate of a time at which the impact of the projectile has occurred, and use t_{impact} to estimate the location of the projectile launch; or

use data D_{flash} to obtain a time t_{flash} which is an estimate of a time t_0 at which the projectile has been launched, and use the time t_{flash} to estimate the location of the projectile launch; or

use $D_{acoustic_impact}$ to determine a time t_{impact} which is an estimate of a time at which the impact of the projectile has occurred, use data D_{flash} to obtain a time t_{flash} which is an estimate of a time t_0 at which the projectile has been launched, and use t_{impact}, t_{flash} and parameters informative of a kinematic behavior of the projectile to estimate the location of the projectile launch.

13. The system of any one of claims 1 to 12, configured to perform (ii) to estimate the location of the projectile launch in a scenario in which:

the projectile has impacted a platform on which the acoustic sensors are mounted; or

the projectile has impacted an obstacle located in front or in the vicinity of the acoustic sensors such that shock waves generated by the projectile cannot be sensed by the acoustic sensors.

14. The system of any one of claims 1 to 13, configured to perform (iii), wherein the system is further configured to:

use $D_{acoustic_impact}$ to determine a time t_{impact} which is an estimate of a time at which the impact of the projectile has occurred,

use D_{blast} to determine a time t_{blast} at which the blast has been sensed by the acoustic sensors, and

use t_{impact} and t_{blast} to estimate the location of the projectile launch.

15. The system of any one of claims 1 to 14, wherein the system is mounted on at least one of: a military vehicle, a tank, an aircraft, a vehicle traveling on land, a vehicle traveling at sea, a vehicle traveling in the air.

16. The system of any one of claims 1 to 15, wherein the projectile includes a bullet, a rocket, a missile, a shell, or ammunition.

17. The system of any one of claims 1 to 16, further comprising an electronic card embedding the imaging device, the acoustic sensors, and the one or more processing circuitries.

18. A platform comprising:
    - an imaging device,
    - acoustic sensors, and
    - a system operative to estimate a location of a projectile launch, according to any one of claims 1 to 17.

19. A non-transitory computer readable medium comprising instructions that, when executed by one or more processing circuitries, cause the one or more processing circuitries to perform (i), (ii) or (iii):
    (i) obtain, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,
    obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{shockwaves}$ informative of shock waves generated by a motion of the projectile, and
    use D_{flash} and $D_{shockwaves}$ to estimate the location of the projectile launch;
    (ii) obtain, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,
    obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the projectile, and
    use data D_{flash} and data $D_{acoustic_impact}$ to estimate the location of the projectile launch;
    (iii) obtain, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the

projectile, and data D_{blast} informative of a blast generated by the projectile launch, and

use $D_{acoustic_impact}$ and D_{blast} to estimate the location of the projectile launch.

20. A computer-implemented method, comprising performing (i), (ii) or (iii):

(i) obtaining, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,

obtaining, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{shockwaves}$ informative of shock waves generated by a motion of the projectile, and

using D_{flash} and $D_{shockwaves}$ to estimate the location of the projectile launch;

(ii) obtaining, from an imaging device, data D_{flash} informative of an optical event associated with the projectile launch,

obtaining, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the projectile, and

using data D_{flash} and data $D_{acoustic_impact}$ to estimate the location of the projectile launch;

(iii) obtaining, from acoustic sensors, acoustic data, wherein the acoustic data includes data $D_{acoustic_impact}$ informative of a sound generated by an impact of the projectile, and data D_{blast} informative of a blast generated by the projectile launch, and

using $D_{acoustic_impact}$ and D_{blast} to estimate the location of the projectile launch.