Improved mortar setup technique

Danie de Villiers
CSIR, Defence Piece Safety and Security program

ABSTRACT

Mortars will still play an important roll in modern warfare. This paper describes a unique way of setting up a mortar with minimum of extra equipment. A mortar can be set-up, by using the current mechanical mortar sight and a prismatic mirror with a bearing sensor. This concept focuses directly on one of the most cumbersome aspects of a mortar set-up, namely the use of aiming posts. The prismatic mirror and bearing dials is described as well as the required setup procedures. The measurement of effectiveness, of a mortar system, showed that the concept has many advantages.

1. Introduction

The mortar as an indirect weapon still has an important place in modern warfare. However, it is necessary to investigate technologies that can make mortar systems lighter, more responsive and more lethal, while simultaneously reducing collateral damage.

Previous studies on the setting up of mortars have shown that the method of using aiming posts needs to be improved [1]. The SANDF artillery has taken the lead by replacing the aiming post with a prismatic mirror similar to the mirror used on the Ratel attack vehicle. The CSIR has devised a concept of improving the way the mirror is used by adding a bearing dial to the prismatic mirror.

The prismatic mirror with a bearing dial was tested against the measure of effectiveness of a mortar system.

2. Prismatic mirror description

Mortars are traditionally aimed by using a compass, two aiming posts and a mechanical sight. It is possible to improve the current mortar systems by using a prismatic mirror and a new improved set-up procedure.

The prismatic mirror with a bearing sensor as indicated in Figure 1 replaces the aiming posts.

Figure 1: Prismatic mirror

Figure 1 shows the mirror mounted on a bearing dials similar to the one used on the mortar sight. The bearing dials and mirror are mounted on a tripod. The prismatic mirror shows your reflection irrespective of the height you are looking from into the mirror. The dials are calibrated in mils and keep track of any bearing changes of the mirror. Both dials can be adjusted by sliding them to the correct bearing value and from there it will change when the user turns the mirror. The black dial is numbered anti-clockwise and is used to keep track of the bearing which the mirror is on. The white dial is numbered clockwise and works together with the same white dial on the mortar sight to determine the bearing of the mortar pipe.

The prismatic mirror is set up in front of the mortar as indicated in Figure 2.

Figure 2: Prismatic mirror and mortar

The prismatic mirror is placed about 2 m in front of the mortar. The prismatic mirror is used as the reference for setting up the mortar. The operator aims at the mirror and by ensuring that the reflection of the sight lines up with where the sight is aiming, he knows that the mortar is perpendicular with the mirror. After the first shot the operator lines up with the mirror again and thereby ensuring that the mortar is still on the setup bearing.

3. Setup procedure

The short (450 mm) prismatic mirror mounted on a tripod is placed in front of the mortar at a distance of about 2 m. The first step is to orientate the mirror, and this can be done by using one of the following procedures, in the order of less accurate to more accurate:

- Take a compass bearing on a distant object and aim the mirror at this object.
- Fit the mirror assembly with a compass (could also be an electronic compass).
- Fit the mirror assembly with a GPS compass which could also provide the mortar position.
- Use an electronic map to get the bearing of a distant object (for instance a mountain peak) and aim the mirror at this object.

Slide the black bearing dial on the mirror to the determined bearing value.

By looking through the mortar sight, line up the mirror and mortar pipe. (This is done by lining up the mortar sight with the sight reflection in the mirror). Slide the bearing value from the black dial on the mirror on both the white dials of the mortar sight and the mirror. The mirror provides the reference bearing for the mortar sight and the mirror is used as the reference in case, firing causes the mortar to move Figure 3.

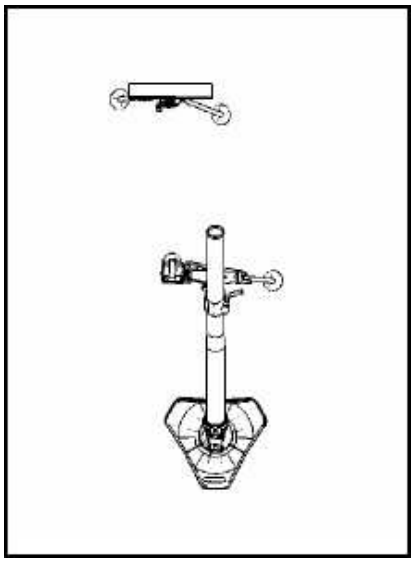

Figure 3: Mortar aligned with mirror

When the mortar now needs to be set on a target bearing or a correction bearing, do the following: Turn the optical sight on the mortar to the required bearing on the white dial.

Swing the mortar pipe until the mortar sight again lines up with the mirror. This is standard procedure but only works in a small arc of fire, which depends on the length of the mirror and distance from the pipe.

When the required bearing change is too large, the mortar sight cannot be aligned with a standard mirror. But with this new concept the white dial on the mirror provides the user with adjusted values to ensure that the optical sight can be lined up with the mirror.

The following unique method can be followed when there is a relatively large bearing change: Turn the optical sight on the mortar to the required bearing on the white dial. Swing the mortar pipe until the mortar sight nearly lines up with the mirror Figure 4.

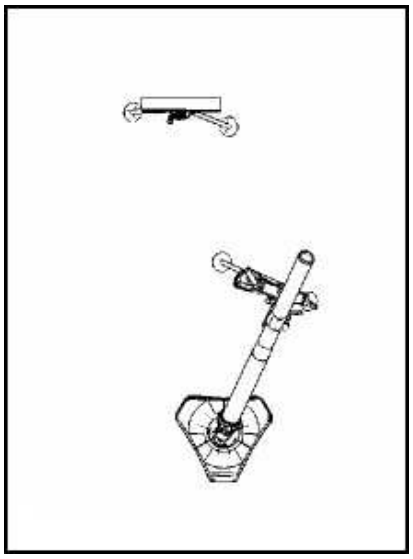

Figure 4: Sight on required bearing

Turn the mirror towards the sight and use the bearing dial to adjust the bearing value on the optical sight Figure 5.

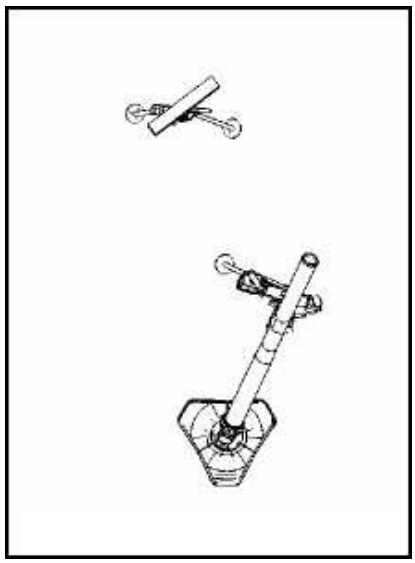

Figure 5: Align mirror with sight

Now swing the mortar pipe until the sight reflection lines up with the sight. The

mortar pipe is now on the required target bearing Figure 6.

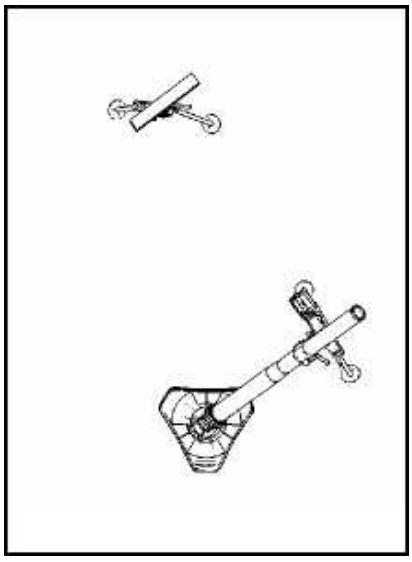

Figure 6: Add mirror angle to the sight

The uniqueness of this method lies in the fact that the mirror bearing is tracked and is used to provide all the bearing information to the mortar sight. In the old system the mirror is fixed and is only used as a reference while it is positioned in the arc of fire. For more detail see the patent application as listed in [2].

4. For a platoon of mortars

The advantages of using the prismatic mirror become even more apparent when four mortars needs to be setup in parallel.

The following procedure suggested means for setting up the first mirror and transferring the bearing to the other mirrors. This is required for doing parallel aiming of the mortars. The top view of the mirror is shown in Figure 7.

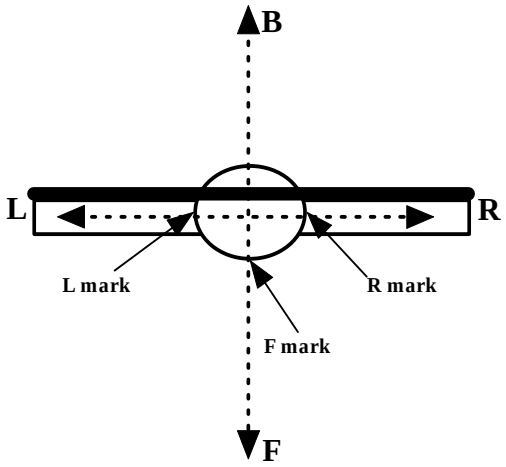

Figure 7: Mirror top view

From Figure 7:
L – left side of mirror
R – right side of mirror
F – front side of mirror
B – back side of mirror

After setup the mortar will be in front of the mirror and the target at the back of the mirror. On the dial are three marks to be used when reading the bearing value. The "F mark" indicates the bearing to the target.

To setup the mirror turn the mirror sideways to a known reference point Figure 8.

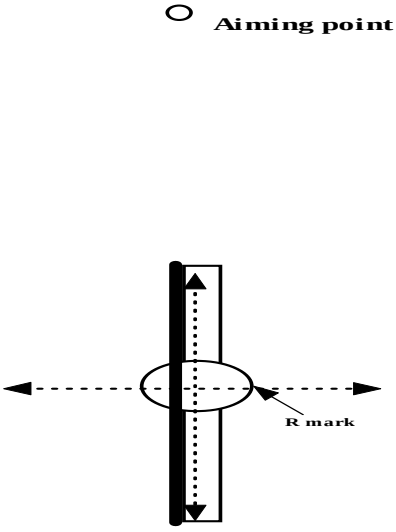

Figure 8: Aiming to a reference point

Figure 8 shows how the length of the mirror can be used to aim to reference point when setting up the mirror. The bearing value to the reference point will be slided onto the dial at the "R mark". This ensures that the reading will be corrected by 90 degrees when the mirror is turned to face the mortar.

For parallel setup of the mortars, the first mirror will be used to setup the other mirrors Figure 9.

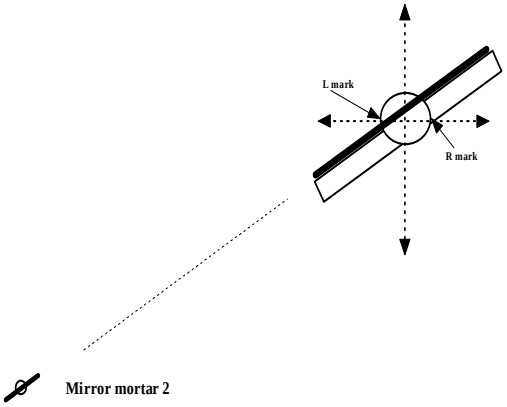

Figure 9: Aiming mirror to mirror

Mirror 2 aims to mirror 1 as described in "aiming to a reference point". Mirror 1 aims to mirror 2 and reads the bearing value of from the mark on the side where mirror 2 is. In this case the "L Mark". This value is used by mirror 2 and slided onto its "R mark".

5. Improvement

It can be seen that the prismatic mirror is a big improvement on the use of the aiming posts. Advantages of this method are the following:

- It is just an add-on to existing mortar sights and requires no change to current mortar sights.
- It is faster than previous set-up procedures of two aiming posts. It is also easier to be used when getting four mortars onto a parallel bearing.
- It improves the reaction speed of engaging opportunity targets.
- It provides a reference for the first target but at the same time can be used as reference to a new target.
- It provides a big arc of fire with no parallax problems.
- It can be used at night. It does not have a thermal image which the enemy can detect (such as laser beams for alignment).
- The mirror is close to the mortar (2 m) and not up to 60 m away as are aiming posts. Therefore it can be used by embedded mortars.
- It is cost effective.
- No regular calibration is needed since the system is not directly on the mortar when firing.
- No extra calculations are required by the user when changing the mortar line of fire.
- If the mirror set-up is accurate, the first hit probability is improved and the use of mortars becomes more cost effective.
- It can be packed up quickly and moved to a new position.
- It can be fully digitised with a GPS compass, tilt sensor for the mortar pipe and shaft encoder to track the bearing.

6. References

[1] Goncalves, D. Mortar weapon system uncertainty analysis. DEF 2003/306;

[2] PCT Patent Application No. CT/IB2008/051163; CSIR; "Advanced Prismatic Mirror Reference Method For Mortars"