The algorithm relies on three main steps:

1. **Objective:** How can the shape be estimated from on-board data?
2. **Contribution:** Shape from Silhouettes during Approach

### Why Autonomy?

Current navigation approach:
- Localization of the probe and small body characterization are performed off-ground thanks to optical and radiometric data
- Long-term planning is scheduled on ground and up-linked to the spacecraft and it must be designed with high accuracy
- The probe has no knowledge of the dynamical environment but executes ground-defined commands at specific times

![Autonomy](image)

- **Reliable**
- **Flexible scientific planning**
- **Expensive**
- **Constant operation monitoring**
- **No reactivity**

### Why exploring small bodies?

Some difficulties arise:
- The gravity field of the small bodies is highly irregular
- Small bodies are fast rotators
- Density, shape, axis orientation, material are poorly known before arrival

### Overview of the PhD

The PhD research focuses on increasing the probe autonomy around the small body to allow on-board localization and characterization of the small body with vision-based navigation, i.e. cameras, and characterize the uncertainties in the estimated quantities, i.e. spacecraft state and small body parameters.

### Contribution: Shape from Silhouettes during Approach

**Objective:** How can the shape be estimated from on-board data?

The algorithm relies on three main steps:

1. **Step 1:** Silhouette Extraction
   - Self-shadowing is compensated in the silhouettes extraction
   - The shape reconstruction captures concavities and the overall shape

2. **Step 2:** Construct a discrete approximation

3. **Step 3:** Reconstruct the shape approximation

### Conclusion and Future work

In conclusion:
1. Uncertainty of the spherical harmonics coefficients has been computed.
2. A shape from silhouette algorithm is being developed and tested on real images. Results are promising and would allow navigation during approach.

Future work includes:
1. Fusioning the spherical harmonics UQ with the shape from silhouette algorithm to increase on-board dynamical characterization of the small body and improve navigation performances
2. Develop VBN algorithms (SLAM and model-based tracking) that consider the shape deduced from silhouettes

### Publications


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