



## Adoption of Multiagent System Methodology for Remote Sensing Image

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**Abstract-** Image classification involves classifying the image based on the regions. But, in remote-sensing image classification, the mixed pixels pose a major problem. The subpixel spatial attribution of the pixel is unknown due to the problem of mixed pixel. A fine resolution map of class labels can be obtained by subpixel mapping technique based on multiagent system. Multiagent system effectively solves the problems of mixed pixel namely- Boundary mixed pixels and Linear mixed pixels. Multi agent system includes three agents namely- mixed pixel detection agent, subpixel mapping agent, and decision agent. Mixed pixel detection agent finds the type of mixed pixel present in an image. Based on identified mixed pixel corresponding mixed pixel mapping agent is applied. Decision agent resolves the conflicts between the mixed pixel detection agent and subpixel mapping agent. To evaluate the performance of subpixel mapping algorithm the experiments with artificial images and remote-sensing images are proposed.

**Keywords:** Remote sensing, subpixel mapping, multiagent system.

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### I. INTRODUCTION

Remote sensing has become an important source of land cover information of spatial and temporal scales. Remote sensing images are dominated by mixed pixel, which contain more than one class on the ground. Soft classification techniques and spectral unmixing algorithms have been used to obtain subpixel information [1]–[2]. By these techniques, the subpixel spatial attribution of the pixel is unknown. Atkinson have proposed subpixel mapping technique [3] to obtain subpixel location. Where pixels are divided into subpixel to obtain subpixel location of each class in a pixel. By subpixel mapping these subpixels [4] are assigned to different classes, with the constraint that the total number of subpixels of a given class is directly proportional to the percentage cover of that class for the original larger pixel [3]. Soft classification [5] or spectral unmixing [6] obtains a classification map with a finer resolution by subpixel mapping technique. Fisher [7] suggested four types of pixels: discrete subpixel, boundary pixels, intergrade pixels and linear subpixels. Many traditional subpixel mapping techniques ignore the different structures in mixed pixels and consider the mixed pixels as an identical type

In remotely sensed images boundary mixed pixels and linear mixed pixels are common. The Mixed pixel determination and implementation of corresponding approach is a critical problem. To solve this problem, for remote sensing image a multiagent system (MAS) based on subpixel mapping is proposed.

### II. BACKGROUND

#### A. Subpixel mapping

The subpixel mapping technique can obtain the subpixel location of each class in a pixel into subpixels. These subpixels are assigned to different classes by subpixel mapping, with the constraint that the total number of subpixels of a given class is directly proportional to the percentage cover of that class for the original larger pixel.

#### B. Multiagent system

Agents are multiple interacting computing elements that the multiagent system composed [3]. An agent is an encapsulated computer system that is situated in some environment, either geometrical or numerical, and is capable of flexible, autonomous action in that environment, in order to meet its design objectives [4]. It has characteristics such as autonomy, social ability, reactivity and proactivity [5].

In an MAS, agents are located in the environment, where one agent coordinates with the other in the environment. However, conflicts may occur between the agents since the objective of one agent may be different from another. In such cases to overcome this conflict consultation mechanism is used.

### III. IMPLEMENTATION

#### A. Multiagent System using subpixel mapping

The proposed method proposes mixed pixel detection method based on MAS to conduct subpixel mapping. Mixed pixel detection involves the identification of type of the mixed pixel in an image. Then the corresponding subpixel mapping is performed based on type of mixed pixel. The proposed method is designed to consist of three layers, as

follows. In the first layer, mixed pixel detection agents (MPDAs) are used to detect the different features in mixed pixels, including boundary-mixed pixels and linear mixed pixels. The middle layer consists of mixed pixel mapping agents (MPMAs) that reconstruct features with different subpixel mapping algorithms based on MPDAs. The highest level consists of decision agents (DAs) that coordinate the contradictions between MPDAs and MPMAs.

A is an set of agents in a MAS and is given as

$A = \{AP, AM, AD\}$ . Where AP is mixed pixel detection agent, AM is mixed pixel mapping agent and AD is decision agent. Furthermore, AP+ is the offspring agent of AP, and AP- is the parent agent. Agents are defined by a universal structure. For example consider MPDA,  $A^P$  the structure can be represented by

$\langle E^P, \Gamma^P, R^P, B^P \rangle$ :

- 1)  $E^P$  is the environment information of agent  $A^P$ .
- 2)  $\Gamma^P$  is the status of current agent  $A^P$ .
- 3)  $R^P$  is the rule library of agent  $A^P$ .
- 4)  $B^P$  is a set of behavioural patterns of agent  $A^P$ .

**Mixed pixel detection agent.**

Type of the mixed pixel is first determined to reconstruct the various features in a mixed pixel. A mixed pixel detection agent is utilized to detect the type of mixed pixel structure. As only two type mixed pixels are taken into consideration, the agent can be simplified as a linear subpixel feature detection agent. Verify every possible line across the central pixel to determine linear subpixel feature [8]. The following formula represents all the lines across central pixel.

$$L_\lambda: X=Y*\tan\beta_\lambda+C. \beta_\lambda=\Theta+\lambda r.$$

Where  $\beta_\lambda$  is the angle between the current line  $L_\lambda$  and  $L_b$  and  $\beta_\lambda \in \{\beta | -\Theta \leq \beta \leq \Theta\}$  and  $\Theta = \arctan(D)$ .

Final structures such as rule behaviour and behavioural patterns are used to determine if there is a linear subpixel feature. The rule library  $R^F$  and the behavioural pattern  $B^F$  can be given as:

$$R^P : B^P = \begin{cases} B_P^P & \text{flag} = 0 \\ B_L^P & \text{flag} = 1 \\ B_B^P & \text{else} \end{cases}$$

Where  $B_P^P, B_L^P, B_B^P$  are the behaviours to create a pure SMA, linear SMA, boundary SMA.

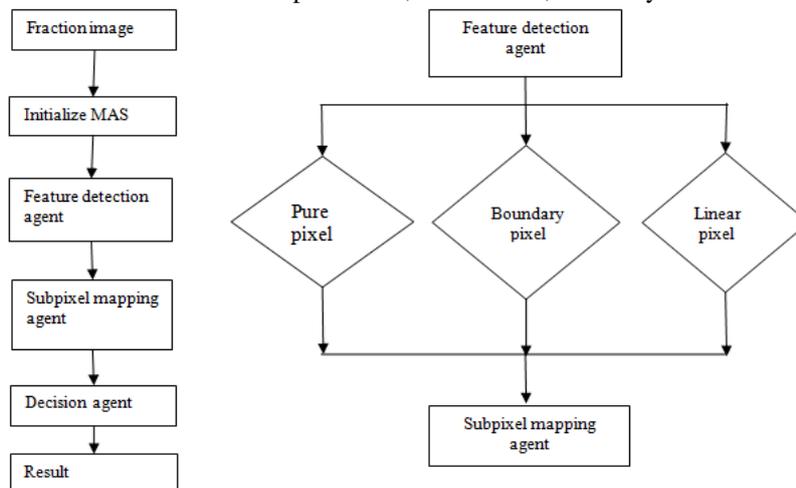


Figure1: Model architecture

**Mechanism of the subpixel mapping agent**

Mixed pixel detection agent determines the type of mixed pixel, and then the corresponding mixed pixel mapping based on subpixel mapping is implemented for different type of pixels. The subpixel mapping agent can be represented as

$A^M = \{A_P^M, A_B^M, A_L^M\}$ . Where  $A_P^M$  is the pure subpixel,  $A_B^M$  is the boundary subpixel and  $A_L^M$  is the linear subpixel. The environment can be given as  $E^M = \{\Omega^M \cup \{\epsilon^M\}\}$ . The status can be given as  $\Gamma^M = \{\eta^M, \delta^M, f^M\}$ . Whether the current agent  $A^M$  is a parent agent or offspring agent can be determined by  $\eta^M$ . If  $\eta^M=1$ , then the agent  $A^M$  is a parent agent or else  $\eta^M=0$ . Dominant class in the pixel is given by  $\delta^M$ .  $f^M$  is used to control the diffusion.

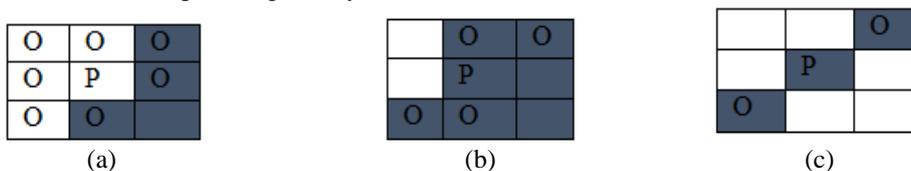


Figure 2 Diffusion of different types of pixel. (a) Central pure pixel is diffuse to its neighbouring pixels that contain same class. (b) Central boundary pixel diffuse to its neighbouring mixed pixels that have same land cover classes. (c) Central linear subpixel will diffuse along the detected direction of the line.

**Decision agent**

Agent with single function cannot obtain best result due to the existence of different types of mixed pixels. Each agent has its own particular aims, beside the common objective. Task and aims of one agents differs from another. so consultation mechanism is needed to resolve the conflicts. Hence to solve this problem MAS has provided a one special agent called decision agent to resolve the conflicts that may arise between the agents.

Environment of decision agent  $A^D$  can be given as  $E^D = P_{i,j}$ . the status  $\Gamma^D = \{A^M, Pf\}$ , where  $A^M$  is the current SMP agent and Pf is the type of pixel.

**IV. RESULTS**



Figure 4: Input image and output image. Showing different classes where blue: ocean .green: forest. Pink: land.

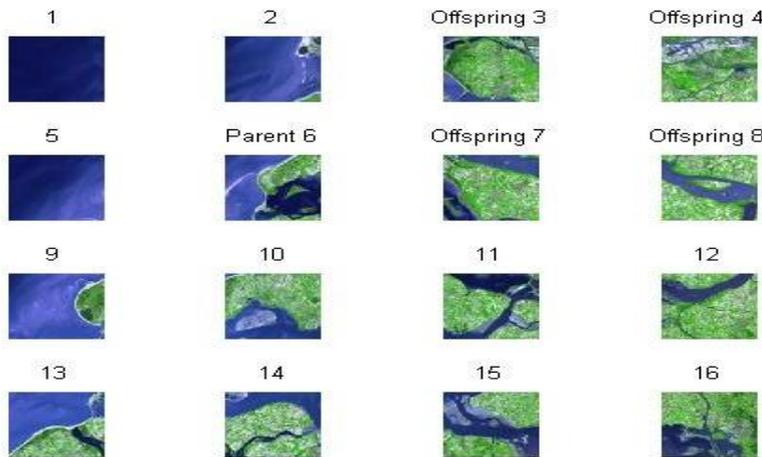


Figure 5: Parent and Offspring agent.

**V. CONCLUSIONS**

In this project an adaptive subpixel mapping system based on a multiagent system is developed. The system consists of three agents namely mixed pixel detection agent, subpixel mapping agent and a decision agent. The algorithm is tested on both satellite imagery and on artificial multispectral images. The results show that the system can map up to a maximum of four features on both artificial and satellite imagery.

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