

# **A CIRCUIT BOARD PROCESSING SYSTEM USING LOCAL THRESHOLD VALUE IMAGE ANALYSIS**

## **BACKGROUND**

### **5 Field**

Embodiments of the present disclosure relate to a circuit board processing system. In particular, embodiments of the present disclosure relate to a circuit board processing system configured to process a panel, and a corresponding packaged module processing system and method for fabricating packaged modules.

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### **Description of the Related Technology**

In electronics applications, packaged modules are manufactured in a number of fabrication process steps. Such process steps can include imprinting of characters to provide, for example, identification of the packaged modules during various stages of the process steps.

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Fabricating packaged modules, such as power amplifiers, can be challenging. Many variables can lead to the production of defective modules. For instance, impurities may unintentionally be introduced during different stages of production by, for example, the fabrication environment or the operators of the fabrication and/or packaging machines. Further, scratches or other damage may occur from drops, bumps, vibrations, etc. during fabrication and/or packaging of the modules.

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In addition to the monetary loss caused by the loss of revenue from defective modules, manufacturers expend resources, both monetary and personnel, to identify and remove from the production lines the defective modules. Further, interrupting production to identify and remove defective modules can reduce a manufacturer's yield leading to additional losses.

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Molding flashing is excess plastic that forms on the surface of injection molded parts and can cause damage to identifiers or characters on a panel or circuit board preventing identification of a particular module.

## **SUMMARY**

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According to one aspect, there is provided a circuit board processing system configured to process a panel, the system comprising a character recognition system configured to

obtain a digital image of a character imprinted on a surface of the panel, the character recognition system being further configured to: perform image analysis on the digital image of the character, the image analysis including applying a local threshold value to one or more localities of the digital image to provide a binarized image of the character; and classify the character based on the image analysis, the local threshold value applied to each locality of the one or more localities being based on pixel information around each respective locality.

In one example, the image analysis further comprises, after applying the local threshold values, applying contrast equalization to the digital image of the character.

In one example, the character recognition system is further configured to apply a fragmented search region to the digital image to obtain less than a whole of the character and apply the image analysis to the less than a whole of the character.

In one example, the character recognition system is further configured to determine the fragmented search region based on analysis of damage to the character.

In one example, if the character cannot successfully be classified based on the image analysis, the character recognition system is further configured to apply a global threshold value to the binarized digital image to provide a second binarized digital image of the character.

In one example, the character recognition system is further configured to iteratively apply global threshold values to provide a series of binarized digital images of the character, each iteration having a different global threshold value, until the character can be successfully classified.

In one example, the pixel information comprises one or more pixel intensity values of neighboring pixels to a pixel of each respective locality.

In one example, the image analysis comprises applying local threshold values to a plurality of localities of the digital image to provide a binarized image of the entire character.

In one example, the panel comprises an array of units that are joined together, each unit having a surface, the panel including a surface outside of the array of units.

In one example, the character is imprinted on the surface of each unit.

According to another example, there is provided a packaged module processing system comprising: a circuit board processing system configured to process a panel having an array of units that are joined together, each unit having a surface, the panel including a surface outside of the array of units; a module processing system configured to produce a number of packaged modules from the array of units, such that each packaged module includes a surface; and a

character recognition system configured to obtain a digital image of a character imprinted on a surface of the panel, the character recognition system being further configured to: perform image analysis on the digital image of the character, the image analysis including applying a local threshold value to one or more localities of the digital image to provide a binarized image of the character; and classify the character based on the image analysis, the local threshold value applied to each locality of the one or more localities being based on pixel information around each respective locality.

According to another aspect, there is provided a method for fabricating packaged modules, the method comprising: forming or providing a panel having an array of units that are joined together, each unit including a surface, the panel including a surface outside of the array of units; producing a number of packaged modules from the array of units from the array of units, such that each packaged module includes a surface; and performing a character recognition process to obtain a digital image of a character imprinted on each of some or all of the surface of the panel, the surface of each unit, and the surface of each packaged module, the character recognition process including performing image analysis including applying a local threshold value to one or more localities of the digital image to provide a binarized image of the character; and classifying the character based on the image analysis, the local threshold value applied to each locality of the one or more localities being based on pixel information around each respective locality.

In one example, performing the image analysis further comprises, after applying the local threshold values, applying contrast equalization to the digital image of the character.

In one example, performing the character recognition process further comprises applying a fragmented search region to the digital image to obtain less than a whole of the character and applying the image analysis to the less than a whole of the character.

In one example, performing the character recognition process further comprises determining the fragmented search region based on analysis of damage to the character.

In one example, if the character cannot successfully be classified based on the image analysis, the character recognition process further comprises applying a global threshold value to the digital image to provide a second binarized digital image of the character.

In one example, the character recognition process further comprises iteratively applying global threshold values to provide a series of binarized digital images of the character, each iteration having a different global threshold value, until the character can be successfully classified.

In one example, the pixel information comprises one or more pixel intensity values of neighboring pixels to a pixel of each respective locality.

In one example, the character recognition process further comprises applying local threshold values to a plurality of localities of the digital image to provide a binarized image of the entire character.

In one example, the character is imprinted on the surface of each unit.

According to another aspect, there is provided a circuit board processing system configured to process a panel, the system comprising a character recognition system configured to obtain a digital image of a character imprinted on a surface of the panel, the character recognition system being further configured to: apply a fragmented search region to the digital image to obtain less than a whole of the character and apply image analysis to the less than a whole of the character; and classify the character based on the image analysis.

In one example, the character recognition system is further configured to determine the fragmented search region based on analysis of damage to the character.

In one example, the character recognition system is configured to determine the fragmented search region to exclude at least some damage to the character based on the analysis of damage to the character.

In one example, the image analysis comprises applying a local threshold value to one or more localities of the digital image to provide a binarized image of the character, the local threshold value applied to each locality of the one or more localities being based on pixel information around each respective locality.

In one example, the pixel information comprises one or more pixel intensity values of neighboring pixels to a pixel of each respective locality.

In one example, the image analysis further comprises, after applying the local threshold values, applying contrast equalization to the digital image of the character.

In one example, if the character cannot successfully be classified based on the image analysis, the character recognition system is further configured to apply a global threshold value to the binarized digital image to provide a binarized digital image of the character.

In one example, the character recognition system is further configured to iteratively apply global threshold values to provide a series of binarized digital images of the character, each iteration having a different global threshold value, until the character can be successfully classified.

In one example, the image analysis comprises applying local threshold values to a plurality of localities of the digital image to provide a binarized image of the entire character.

In one example, the panel comprises an array of units that are joined together, each unit having a surface, the panel including a surface outside of the array of units.

5 In one example, the character is imprinted on the surface of each unit.

According to another example, there is provided a packaged module processing system comprising: a circuit board processing system configured to process a panel having an array of units that are joined together, each unit having a surface, the panel including a surface outside of the array of units; a module processing system configured to produce a number of packaged  
10 modules from the array of units, such that each packaged module includes a surface; and a character recognition system configured to obtain a digital image of a character imprinted on a surface of the panel, the character recognition system being further configured to: apply a fragmented search region to the digital image to obtain less than a whole of the character and apply image analysis to the less than a whole of the character; and classify the character based on the  
15 image analysis.

According to another aspect, there is provided a method for fabricating packaged modules, the method comprising: forming or providing a panel having an array of units that are joined together, each unit including a surface, the panel including a surface outside of the array of units; producing a number of packaged modules from the array of units from the array of units, such that  
20 each packaged module includes a surface; and performing a character recognition process to obtain a digital image of a character imprinted on each of some or all of the surface of the panel, the surface of each unit, and the surface of each packaged module, the character recognition process including applying a fragmented search region to the digital image to obtain less than a whole of the character and applying image analysis to the less than a whole of the character; and classifying  
25 the character based on the image analysis.

In one example, the performing the character recognition process comprises determining the fragmented search region based on analysis of damage to the character.

In one example, the performing the character recognition process comprises determining the fragmented search region to exclude at least some damage to the character based on the analysis  
30 of damage to the character.