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(54) **PROJECTION DISPLAY APPARATUS, SYSTEM, AND METHOD**

(75) Inventors: **Aram Mooradian**, Kentfield, CA (US);  
**Andrei V. Shchegrov**, Campbell, CA (US);  
**Jason P. Watson**, San Jose, CA (US)

(73) Assignee: **Novalux, Inc.**, Sunnyvale, CA (US)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

|                   |         |                  |            |
|-------------------|---------|------------------|------------|
| 5,410,560 A *     | 4/1995  | Taira            | 372/181    |
| 5,489,984 A       | 2/1996  | Hariharan et al. |            |
| 5,585,913 A       | 12/1996 | Hariharan et al. |            |
| 5,704,700 A *     | 1/1998  | Kappel et al.    | 353/31     |
| 5,748,317 A       | 5/1998  | Maris et al.     |            |
| 6,271,921 B1      | 8/2001  | Maris et al.     |            |
| 6,317,170 B1 *    | 11/2001 | Hwang et al.     | 348/750    |
| 6,400,449 B2      | 6/2002  | Maris et al.     |            |
| 6,947,459 B2 *    | 9/2005  | Kurtz et al.     | 372/43.01  |
| 6,975,294 B2 *    | 12/2005 | Manni et al.     | 345/83     |
| 6,975,366 B2 *    | 12/2005 | Flint            | 348/744    |
| 2006/0023757 A1 * | 2/2006  | Mooradian et al. | 372/18     |
| 2006/0268241 A1 * | 11/2006 | Watson et al.    | 353/94     |
| 2006/0280219 A1 * | 12/2006 | Shchegrov        | 372/99     |
| 2007/0147458 A1 * | 6/2007  | Watson et al.    | 372/50.124 |
| 2007/0153862 A1 * | 7/2007  | Shchegrov et al. | 372/50.124 |
| 2007/0153866 A1 * | 7/2007  | Shchegrov et al. | 372/50.124 |

\* cited by examiner

*Primary Examiner*—Melissa Jan Koval

(74) *Attorney, Agent, or Firm*—Cooley Godward Kronish LLP

(57) **ABSTRACT**

In an apparatus, system, and method for generating a projected display, a light source generates red, green, and blue light using arrays of extended cavity surface emitting semiconductor lasers. The beams of individual lasers overlap and have a distribution of optical attributes selected to reduce speckle on a display surface.

**30 Claims, 5 Drawing Sheets**

