Fiber Optic Light Source Scheme For Modular Remote Illumination Of Incubator-Based Live-Cell Microscopy

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BACKGROUND

Live cell microscopes are bulky, limiting costly incubator space. The type and number of light sources is also limited by space constraints inside the incubator. Incubator stage-top microscopes are generally either thermally or gas-inefficient and/or contain limited space for samples, often with constraints on the physical format of samples. Further, placing heat-generating light sources inside an incubator disrupts the temperature and humidity regulation inside the incubator by providing a localized point source of heat not under control of the incubator environmental feedback controller.

Additionally, electronics placed inside the warm, humid and acidic environment of a cell culture incubator suffer accelerated wear and corrosion. Either equipment lifecycles are reduced or construction of these devices is more costly.

TECHNOLOGY DESCRIPTION

This is a design of microscope where the microscope (stage, lenses, lens barrel, optical filters, positioning apparatus) are designed to be used inside a cell culture incubator for imaging biological samples which need to be in an incubator for metabolic homeostasis and/or sterility reasons. Microscopes which fulfil this purpose of microscopy of living samples while they are being grown are called live-cell microscopes.

In general, there are two existing designs of live cell microscope. The first are microscopes which are free-standing outside of an incubator and have a miniature incubator environment on the microscope stage and the microscope itself is outside the incubator. This constrains the microscope to samples of shapes and sizes acceptable to the miniature incubator environment and couples the biological homeostasis equipment to the microscope equipment.

The second is a smaller microscope that is placed inside of an incubator in their entirety and include all of the optics, positioning apparatus and light sources for the microscope in a single monolithic unit which must all fit inside the cell culture incubator, often not leaving much space for anything else.

This design is similar to the second approach, but is distinguished by having a light source separate from the rest of the microscope and coupled to one or more fiber optic cables. These fiber optics terminate in a detachable port attached to the optical apparatus of the in-incubator microscopes. The fiber optic cables may include light diffusers, collimators and, in the case of fluorescence microscopy, excitation filters. The light sources may be broad spectrum light sources for white light, reflected light or transillumination or

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OTHER INFORMATION

KEYWORDS

live cell microscopy, light microscopy, in-incubator microscopy, fiber optic light source, light source, illumination

CATEGORIZED AS

- **Engineering**
  - Engineering
- **Sensors & Instrumentation**
  - Analytical
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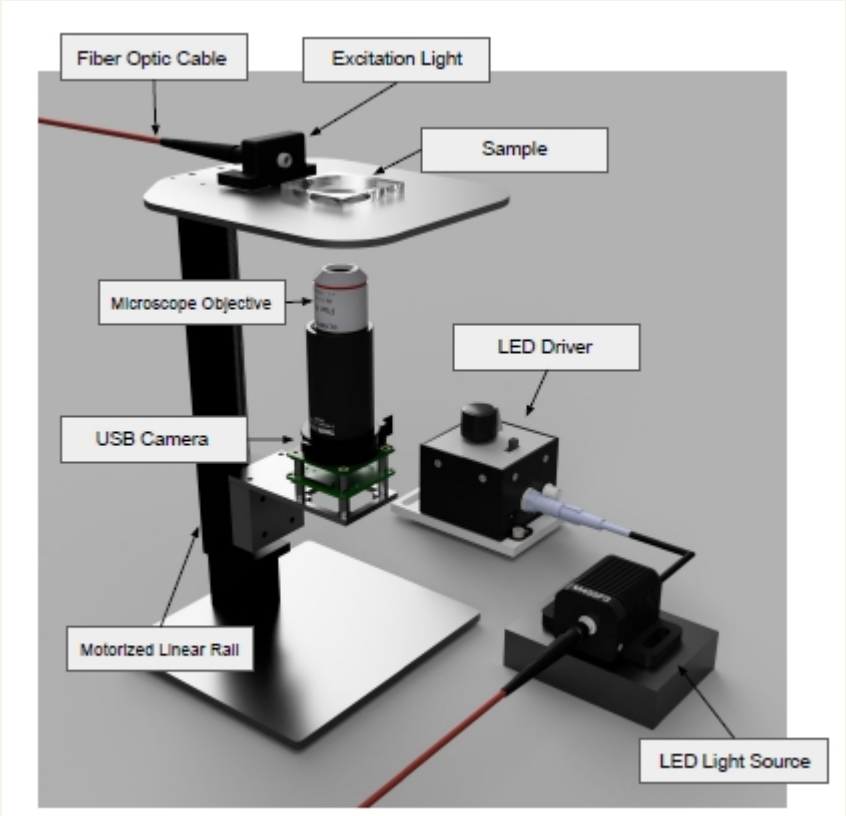
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they might be narrow spectrum light sources, such as fiber coupled LEDs or lasers which are used for excitation of fluorescent samples for fluorescence microscopy. For fluorescence microscopy, a broad spectrum light source with a bandpass filter may also be used.

The fiber optic connection of the microscope is placed so as to illuminate the sample. This is via a part with a fiber optic port interposed in the microscope optical path such that the light emanating from the fiber illuminates the sample via epifluorescence using a dichroic mirror or beamsplitter. This part may allow automatic switching of a filter by having an inner component which holds multiple dichroic mirrors or beamsplitters at said angle and which can be positioned to place any of these optical elements in the path of the fiber optic illumination. The design places the light sources, which are bulky, heat producing and sensitive to their environment, outside of the incubator, where they are in a normal room environment, have access to cooling and are not subject to the space constraints of a cell culture incubator. The fiber coupled design of the microscope setup has the additional benefit that it renders the microscope setup modular and the light sources may be changed out between microscopes.

Details

- Off the shelf components paired with laser cut sheet metal, which are all rated to survive indefinitely in an incubator
- Raspberry Pi HQ Camera, which uses a 12.3 megapixel Sony IMX477 sensor that captures images at up to 4056 x 3040 pixels
- Linear rail for motorized focus control
- Compatible with traditional microscope objectives
- Fluorescence excitation from Thorlabs LEDs with fiber optic cables
- Can be modified to incorporate 6 separate cameras instead of for six well cell culture plates
- 1 well version costs less than $2000



APPLICATIONS

Live cell microscopy

ADVANTAGES

Unconstrained by in-incubator space requirements, allowing more space in-incubator for more samples or equipment or multiple microscopes.

Harsh environment of the incubator does not effect the electronics of the light source.

Limits the number of components which must be sanitized to be placed in the aseptic incubator environment.

No need to account for the heat of a light source.

Avoids costly and non-standard (with respect to lab power, alarm, gas source etc) microscope stage or in-microscope incubator solutions

Can be used with any incubator.

Allows sharing of light sources between microscopes.

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

- A Modular In-Incubator Microscope for Longitudinal Live Cell Microscopy - 03/05/2026

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Dual Gasket System For Gas-Tight But Biocompatible Cell Culture Vessel Sealing
- "Incubator-Free" Vessels For Cell Culture Which Do Not Use An Air Intermediate For Gas Regulation

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