Supporting information

S1 Table. Bill of materials of the components used to build the microscope.

\*This cost is estimated considering a $70, 1Kg PLA filament roll.

\*\*This component is optional. Use an existing monitor or TV with HDMI to visualize Raspbian OS and microscope GUI.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Description** | | **Manufacturer** | | | | **PN** | | | **QTY** | | | **Cost each**  **(USD)** | | | **Total** | | |
| ***Mechanical assembly*** | | | | | | | |  | | | | | | | | | |
| 3D printed parts (10 pieces, ≈ 35 gr. PLA) \* | | | | | | | |  | | | | | | | | | |
|  | | | | | | | | **Sub-total Mechanical** | | | | | | | | | |
|  | | | ***Electronic components*** | | | | | | | | | | | | | |  |
| *4N25 Optocupler* | | | On  Semiconductor | | | | 4N25SM | | | | 3 | | $0.60 | | | | 1.8 |
| *BJT TIP-41* | | | On  Semiconductor | | | | MJB41CG | | | | 3 | | $1.44 | | | | 4.32 |
| Voltage regulator LM317 | | | Texas Instruments | | | | LM317DCYR | | | | 3 | | $0.95 | | | | 2.85 |
| 3 mm White LED | | | Lumex | | | | SLX-LX3054UWC | | | | 1 | | $0.70 | | | | 0.7 |
| UV SMD LED, 385 nm | | | Vishay | | | | VLMU3500-385120 | | | | 1 | | $11.46 | | | | 11.46 |
| High power Green LED, 535 nm | | | Multicomp | | | | OSW-4334 | | | | 1 | | $10.78 | | | | 10.78 |
| High power Blue LED, 475 nm | | | Multicomp | | | | OSW-6303 | | | | 1 | | $11.68 | | | | 11.68 |
| 100 Ω SMD resistor | | | Yageo | | | | RC0402JR13100RL | | | | 3 | | $0.02 | | | | 0.06 |
| 1 kΩ SMD resistor | | | Yageo | | | | RC0402JR-131KL | | | | 3 | | $0.02 | | | | 0.06 |
| 10 kΩ SMD resistor | | | Yageo | | | | RC0402FR1310KL | | | | 6 | | $0.02 | | | | 0.12 |
| 2.2 Ω SMD resistor | | | Bourns | | | | CRM2512-JW2R2ELF | | | | 1 | | $0.19 | | | | 0.19 |
| 3.3 Ω SMD resistor, 2512 | | | Bourns | | | | CRS2512-FW3R30ELF | | | | 3 | | $0.44 | | | | 1.32 |
| Male pin header (40 pins) | | | MCM | | | | PH1-40-UA | | | | 1 | | $0.47 | | | | 0.47 |
| FR-4 plain copper board\* | | | Mextronics | | | | TGN-16 | | | | 1 | | $0.42 | | | | 0.42 |
|  | | |  | | | | **Sub-total Electronics** | | | | | | | | | | ***46.23*** |
|  | | |  | ***Electrical*** | | | | | | | | | |  | |  | |
| Power supply charger 3.4 V - 12 V, 500 mA | | | Steren | ELI-055 1 | | | | | | | | | | 9 | | 9 | |
|  | | |  | **Sub-total Electrical** | | | | | | | | | |  | | ***9*** | |
|  |  | | ***Optical*** | | | | | | | | | | |  | |  | |
| UV filter (High-pass) |  | | Roscolux | | #3114 - THOUGH  UV | | | | | 1 | | | | 0.19 | | 0.19 | |
| Green Wratten filter (Bandpass) |  | | Kodak | | #58 Wratten filter | | | | | 1 | | | | 0.12 | | 0.12 | |
| Red Filter (High-pass) |  | | Roscolux | | #19 - FIRE | | | | | 1 | | | | 0.19 | | 0.19 | |
| CMOS Camera 8 Mpx |  | | Raspberry Pi | | RPI 8MP  CAMERA BOARD | | | | | 1 | | | | 26.44 | | 26.44 | |
|  |  | |  | | **Sub-total Optical** | | | | | | | | |  | | ***26.94*** | |
|  |  | | ***Computer system*** | | | | | | | | | | |  | |  | |
| Single board computer |  | | Raspberry Pi | | Raspberry Pi 2  Model B 1 | | | | | | | | | 40 | | 40 | |
| 7" Touchscreen Display\*\* |  | | Raspberry Pi | | Touch display 1 | | | | | | | | | 78 | | 78 | |
|  |  | |  | | **Sub-total Computing** | | | | | | | | |  | | ***118*** | |
| ***Total*** | | | | | | | | | | | | | | | | |  |

**S2 Table. Comparison of the number of pieces for *DIY* manufactured microscopes**. Only assembly elements (fabricated, reused or adapted) that make operational the optical system structure of the microscopes are considered. Each of these microscopes is capable to perform observations in both brightfield and fluorescence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Microscope** | **# Pieces** | **Authors** | **Reference** |
| 1 | 100€ Microscope | 32 | Chagas et. al. | [17] |
| 2 | "Mini microscope" | 11 | Zhang et. al. | [16] |
| 3 | Automated microscope | 9 | Schaefer et. al. | [5] |
| 4 | ScanDrop Sensor | 9 | Golberg et. al. | [29] |
| ***5*** | ***"BioARTS Microscope"*** | ***6*** | ***Tristan et. al.*** | ***This work*** |

**S3 Table. Cost comparison for different filter cubes for fluorescence microscopes.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Brand** | **Filter?** | **Cost (USD)** | **Link** |
| 1 | ***Edmund*** | Included | 995 | *https://www.edmundoptics.com/f/pre-mounted-fluorescence-filter-cube-sets/14754/* |
| 2 | ***Thorlabs*** | Not Included | 472.77-500.09 | *https://www.thorlabs.com/newgrouppage9.cfm?objectgroup\_id=5007* |
| 3 | ***Semrock*** | Optional | 350.00-695.00 | *https://www.semrock.com/cubesholders.aspx* |
| 4 | ***Chroma*** | Included | 235.00-725.00 | *https://www.chroma.com/products/cubes-sliders-and-rings/leica?sord=desc* |

**S1 Video. Assembly of the microscope.**

**S2 Video. Operation of the microscope.**

**S3 Video. Tracking of cells flowing in a microfluidic channel.**

**S4 Video. Time lapse of THP-1 cells growing on a flat surface.**



**S1 Fig.** **Photograph of the 3D-printed pieces used to assemble the miniature microscope**.

A picture containing device

Description automatically generated

**S2 Fig**. **Design of the microscope tube**. (Left) Front view of the mechanical tube of the microscope. Thread pitch is 1 mm. (Right) Cross-sectional view of the mechanical tube, showing the lens attached to the top of the tube. All dimensions are in mm.

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**S3 Fig**. **Schematic and PCB layout of the electronic control unit.** (a) Circuit design. (b) Printed circuit board layout.

A screenshot of a cell phone

Description automatically generated

**S4 Fig**. **Graphic User Interface (GUI) to control the microscope.** The GUI was coded in Python by combining Tkinter, picamera and OpenCV libraries.



**S5 Fig**.  **Analysis of the illumination uniformity at an angle of 0° for all the channels**. Each row corresponds to a different LED; the angle and the digital color channel analyzed are indicated on the top right corner. R: Red, G: Green, B: Blue. Fluorescence intensity has been normalized to a maximum value of 1.



**S6 Fig**. **Analysis of the illumination uniformity at an angle of 22° for all the channels**. Each row corresponds to a different LED; the angle and the digital color channel analyzed are indicated on the top right corner. R: Red, G: Green, B: Blue. Fluorescence intensity has been normalized to a maximum value of 1

A screenshot of a cell phone

Description automatically generated

**S7 Fig**. **Analysis of the illumination uniformity at an angle of 45° for all the channels**. Each row corresponds to a different LED; the angle and the digital color channel analyzed are indicated on the top right corner. R: Red, G: Green, B: Blue. Fluorescence intensity has been normalized to a maximum value of 1

A picture containing wall

Description automatically generated

**S8 Fig**. **Comparison of images captured with both microscopes.** Brightfield and fluorescence micrographs captured with our microscope using plastic filters (left) or Zeiss filters (right). THP-1 cells stained with different fluorochromes: EthD-1 (red), Calcein-AM (green) and DAPI (blue). Images using all filters were acquired for each fluorochrome. Graphs show intensity profile of two cells across all channels, showing that there is no fluorescence bleed-through between channels.

A close up of a map

Description automatically generated

**S9 Fig**. **Negative control experiments.** Traces of fluorescence intensities from single wells for the negative control experiment shown in Fig 6.

A close up of a device

Description automatically generated

**S10 Fig**. **Assay inside a cell culture incubator**. (a) Photograph of the inside of a cell culture incubator showing the microscope and the microcomputer Raspberry. (b) Photograph of the cell culture chamber made of PDMS.

***See original files in the following link:***