

# OfficePal User Guide

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# 1 Introduction

This is the user guide for OfficePal, and it is recommended that you read through this guide in its entirety before beginning to set up and operate the robot. OfficePal is a friendly office desk helper who will take on employees' menial tasks with the intent of promoting increased productivity by allowing them to shift their focus onto more important tasks. OfficePal utilises vision line following algorithms along with task scheduling logic to travel between desks. The attached tray acts as a tool for delivering items such as paperwork, stationary, drinks and snacks around the office. Employees can send OfficePal to any desk that they please by issuing commands through the specially designed web application. OfficePal and the environment in which it operates are intended to depict a scaled-down version of what the fully funded product would be capable of. (*Figure 1*).

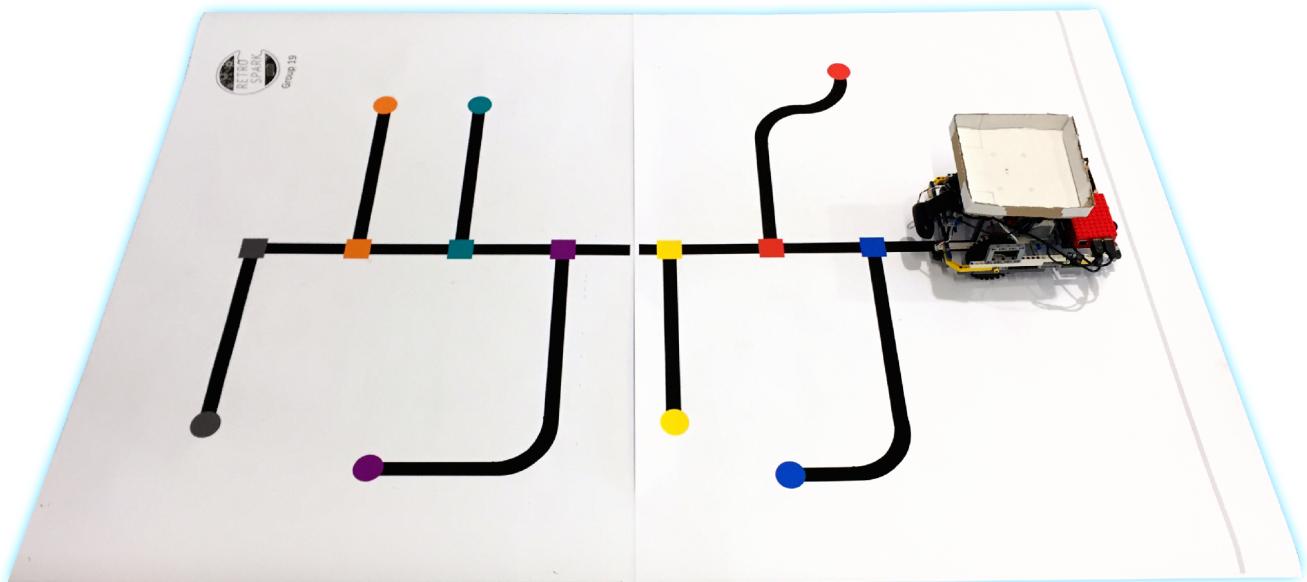


Figure 1: OfficePal in the Environment

## 2 Design Specifications

### 2.1 Hardware Overview

*Table 1* shows the main components of OfficePal's design along with references that correlate with *Figures 2,3 and 4*.

Table 1: Physical components

Ref.	Components	Quantity
R1	Raspberry Pi 3	1
R2	Arduino Board	1
R3	Lego MINDSTORM EV3	1
R4	Large Motor	2
R5	Large Lego Wheel	2
R6	USB Camera	2
R7	Small Castor Wheel	1
R8	IR Sensor	4
R9	3D Printed Tray	1

### 2.2 Power

All electronic aspects of OfficePal are powered by the EV3's internal battery.

<b>Battery Life</b>	1.5 hours assuming moderate usage.
<b>Checking battery level</b>	Monitor battery level by looking at the indicator on the top right hand side of the EV3 screen.
<b>Recharging</b>	To recharge the EV3 plug the charger into a wall plug and connect it into the EV3's charging socket( <i>Figure 3</i> ). It takes approximately 3 hours to regain full charge from an empty battery.

### 2.3 Navigating the EV3

If a user wishes to explore the EV3 they can use the controls shown in *Table 2* with references correlating to *Figures 5 and 6*.

Table 2: EV3

Ref.	
E1	Select
E2	Left
E3	Right
E4	Up
E5	Down
E6	Back
E7	Battery Indicator
E8	Charging Port

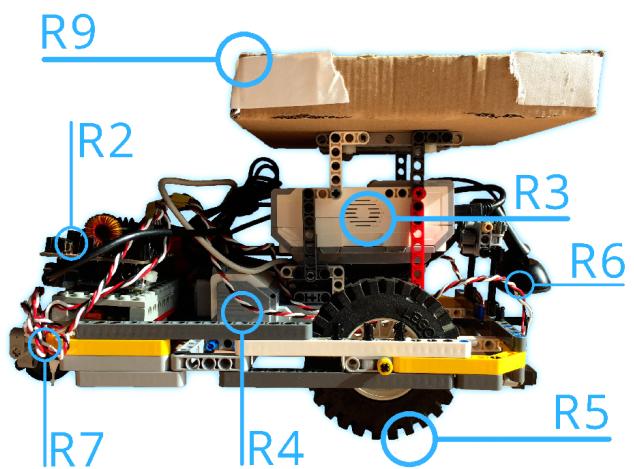


Figure 2: Side view

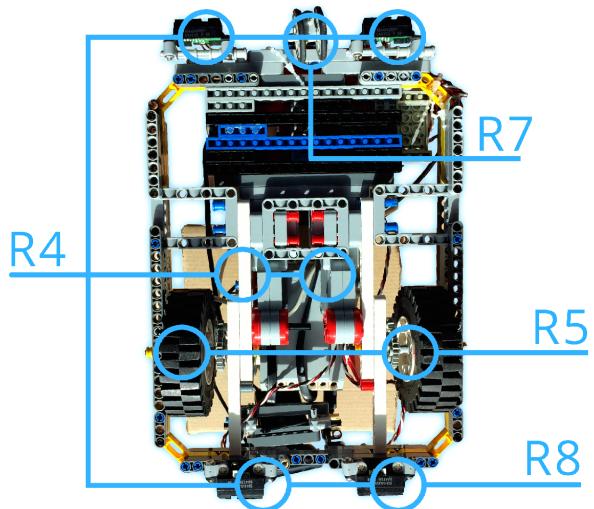


Figure 3: Bottom view

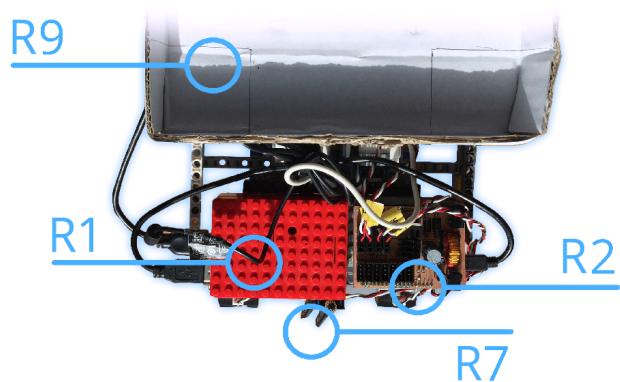


Figure 4: Top view

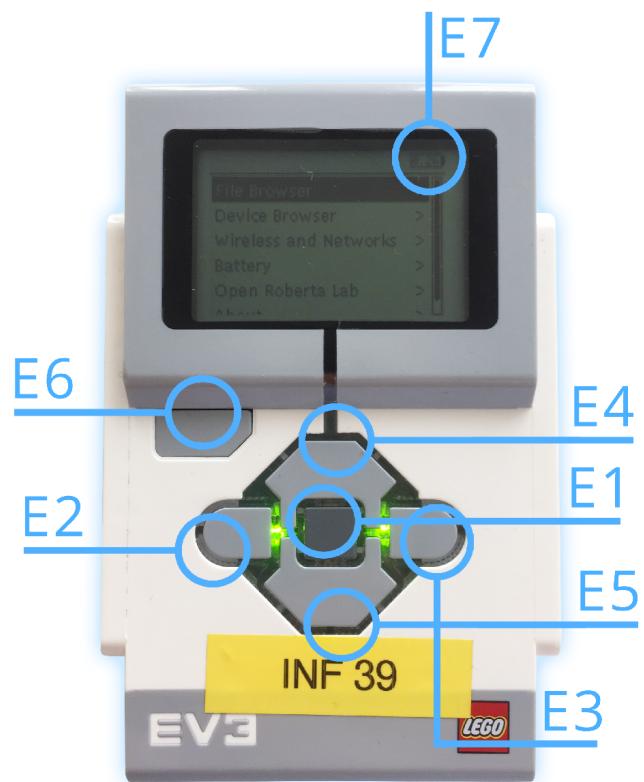


Figure 5: Side view



Figure 6: Bottom view

## 3 Getting Started With OfficePal

### 3.1 What's In the Box?

Before getting OfficePal up and running you should first check that all of the necessary equipment is provided and that you have access to a computer, laptop or mobile device with access to the internet.

Equipment provided:

1. The robot (OfficePal)
2. Office environment
3. EV3 charging cable

### 3.2 Connecting OfficePal to a network

1. Turn on OfficePal by Holding down the power button (*E1 in Figure 2*) on the EV3.
2. Connect the Raspberry Pi to your computer via an Ethernet cable or a USB-A cable.
3. Now you should be able to control the Raspberry Pi through ssh. If you are a Windows user please look into PuTTy. Connect using the command `ssh pi@rspi.local`.
4. Edit the network configuration file using `sudo nano /etc/wpa_supplicant/wpa_supplicant.conf`.
5. In that file please add the following configuration with your Wi-Fi details.

```
network={  
    ssid="your_SSID"  
    psk="your_PSK"  
    key_mgmt=WPA-PSK  
}
```

6. Reboot using `sudo reboot`

### 3.3 Setting up OfficePal and the Working Environment

Now that Officepal is connected to a network, follow the proceeding steps to make it operational.

1. It is recommended that OfficePal has a fully charged battery before operation.
2. Make sure that OfficePal is powered on.
3. The provided environment (*Figure 7*) must be taped to a flat surface as smoothly as possible to ensure optimal traction for wheels (The floor of a well-lit room is recommended).
4. Check if motors are connected and if the Raspberry Pi has two USB A and one Micro USB B plugged into it.
5. Place OfficePal on the dock with the camera facing the same direction as the black line.

You are now ready to use the web application to call OfficePal to desks.

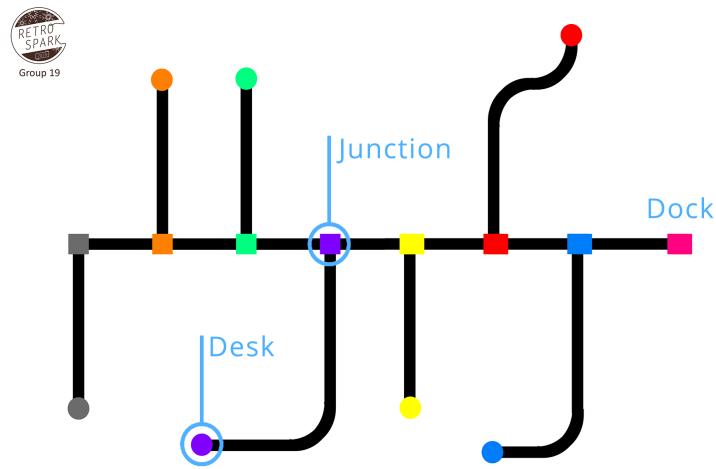


Figure 7: Office Layout

### 3.4 Using the Web Application to Call OfficePal

#### 3.4.1 Getting started with the web application

You will be provided with a link to the web application that controls your instance of OfficePal. This is a link specific to your OfficePal, and must not be shared with external parties, hence why it is not included in this general guide. The web application is hosted on Dataplicity: this service allows remote access to the Raspberry Pi, which hosts the application. The application is accessible both on desktop and mobile devices. The application starts as soon as OfficePal is powered on, thus there is no further action that needs to be taken by the user to launch the application: simply navigate to the link provided. If the application does not appear to be running, please refer to the troubleshooting guide ([Section 4](#)).

*Figure 8* indicates the different components of the application, with reference numbers used in further sections of the document.

#### 3.4.2 Calling OfficePal to a Desk

By clicking on the desired desk in the web application (or tapping if they are on a mobile device), the user will call OfficePal to that desk. OfficePal will wait for a few seconds after having arrived to a desk before moving to its next destination, in order to allow the user time to place or remove their delivery from the tray. A simple workflow, if a user at desk 1 wants to get a document signed by a user at desk 2, would be as follows:

1. User 1 calls OfficePal to desk 1
2. Once arrived, the user puts the document on OfficePal's tray
3. User 1 calls OfficePal to desk 2
4. Once arrived, user 2 signs the document and places it back on the tray
5. User 2 calls OfficePal to desk 1
6. User 1 is able to retrieve their signed document.

Example of:

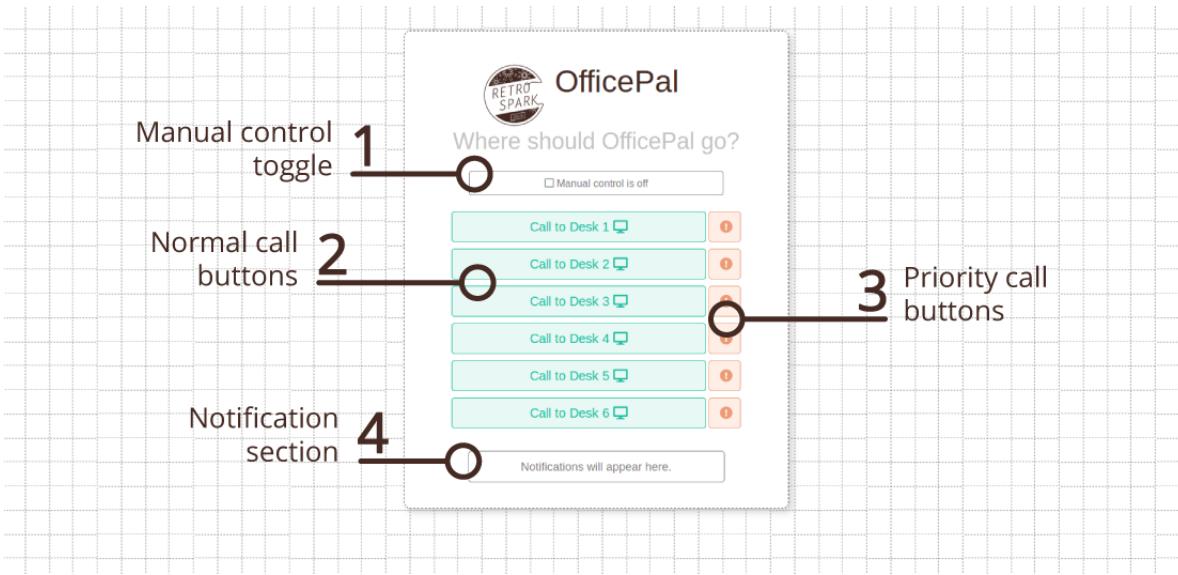


Figure 8: Web Application Components

- A successful call (*Figure 9*)
- An unsuccessful call (*Figure 10*)

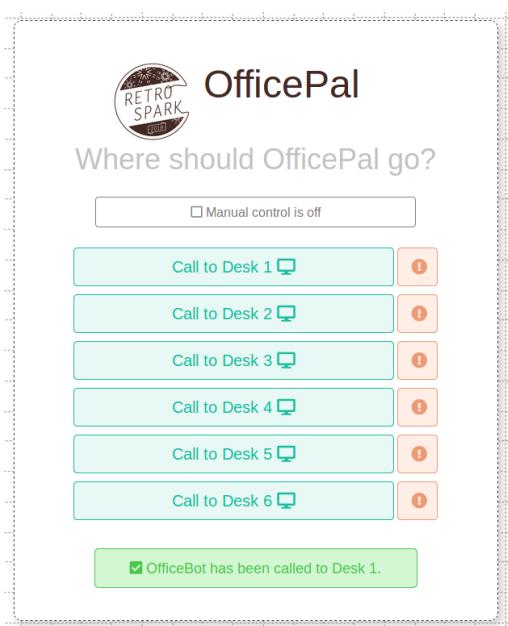


Figure 9: Successful call

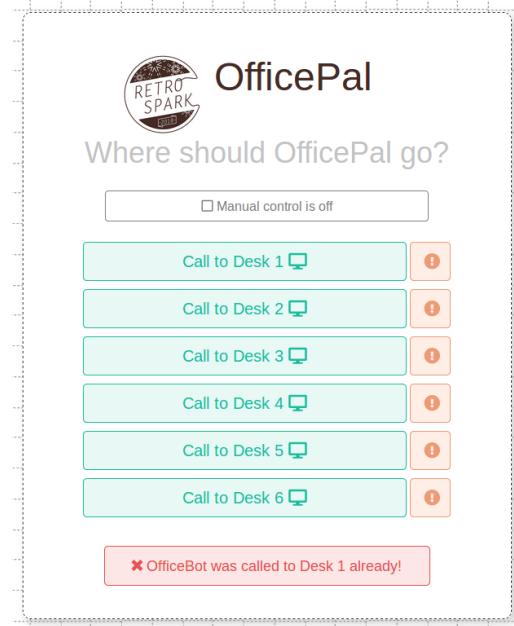


Figure 10: Unsuccessful call

### 3.4.3 Features

**Notifications** The user will receive notifications in the notification section (*see ref. 4 in Figure 8*) as to whether the desk they have called to has been added to the job queue successful. The notification will state that the call has failed if OfficePal already has that desk in its job queue.

**Manual control** The manual control toggle, which disables the application and enables you to test OfficePal with a controller, is detailed in the section titled **3.4 Manual Joystick Control**.

**Task Ordering** Every time a desk is called, OfficePal adds the request to the task list. OfficePal then goes to each desk until it completes all tasks. However, it does not go to each desk in the order they were added to the task list; instead, it uses the information on the desk locations to calculate the next closest location to navigate to, allowing the OfficePal to work through its task list more quickly. If you wish for your call to ignore the queue and be prioritised, please refer to the next paragraph.

**Priority Calls** On the application, each desk has an orange exclamation mark button next to it. If your delivery is urgent, you can select this button instead of the main desk call button in order to prioritise your call. This will place your call ahead all normal priority task in the task list, but behind any already existing priority calls. The priority tasks are executed sequentially, ignoring any task ordering method until it is finished with priority tasks.

It is recommended not to overuse the priority call feature, as having a task list full of priority calls prevents the task ordering method from improving OfficePal's order of navigation, causing the delivery process to be slowed down. If you are concerned about normal calls being delayed significantly due to the presence of priority calls, it should be noted that a system is put in place to ensure that after a certain number of deliveries, the normal calls will eventually get executed, even in the presence of priority calls.

In summary, a simple workflow of how OfficePal handles normal and priority requests is detailed in *Table 3*.

Table 3: Example workflow handling normal and priority calls

Steps	Action	Task List	Comments
1	Call to 1	1	
2	Call to 2	1, 2	
3	OfficePal arrives at desk 1	2	
4	Priority call to 3	3, 2	3 gets pushed ahead in the list
5	Priority call to 4	3, 4, 2	4 gets pushed ahead of 2, but behind the older priority call of 3
6	Call to 5	3, 4, 2, 5	normal call
7	OfficePal arrives at desk 3	4, 2, 5	
8	OfficePal arrives at desk 4	2, 5	At this point, all priority calls have been handled, so the task ordering method will kick in, reordering the next destination to be 2 or 5 depending on which is closer to 4
9	The last two calls (2, 5) are executed	empty	

### 3.5 Manual Joystick Control

OfficePal also comes with a **Manual Control** feature which enables the user to control it with a Bluetooth controller. This feature may be more suitable for users who are more technically inclined. This allows the user to test mobility of the robot and the state of the communication interfaces of OfficePal. Instructions on how to do so are as follows:

1. Enter pairing mode on the Bluetooth controller.
2. Log in to the Raspberry Pi through Dataplicity (<http://dataplicity.com/>) and pair the controller by typing the following commands into the command-line interface.
  - `sudo bluetoothctl` - Enter the password provided with your OfficePal.
  - `agent on`
  - `agent-default`
  - `scan on`
  - Find your controller on the list and copy its MAC address which should be in the format XX:XX:XX:XX:XX:XX
  - `pair [your controller]`
  - Now your controller should always connect to the Raspberry Pi automatically when both are powered on.
3. Enable **Manual Control** from the webapp as shown in Figure 8

The PS4 controls are shown in *Figure 12*. The user should check that the robot can move forwards/backwards and left/right. If any of these movements are malfunctioning, please refer to the troubleshooting guide. (**Section 4**).



Figure 11: Application when manual control is enabled



Image from [walmart.ca](#)

Figure 12: PS4 Controls

### **3.6 Safety Information & Inappropriate Operation**

OfficePal comprises electrical components as well as moving parts such as gears and wheels. As a precaution to prevent injury to users or damage to OfficePal, users should abide by the following rules:

- Refrain from touching and picking up OfficePal while it is in operation.
- Keep long hair away from moving parts.
- Keep a safe distance from the specially designed routes that it follows while in operation.
- Do not expose OfficePal to moisture.
- OfficePal should not be picked up by the EV3 and should instead be picked up with a firm grip on the sides of the Lego chassis.
- Refrain from detaching any cables while OfficePal is in operation.

## **4 Troubleshooting Guide**

### **4.1 EV3 Rebooting**

Rebooting the EV3 can help solve most issues with OfficePal's performance. To do this, hold down both the select button and back button simultaneously until it turns off (information on the EV3 button layout is presented in **Section 2.3**). The EV3 will reboot shortly. You should ensure OfficePal is placed back onto the dock (please refer to *Figure 7* and **Section 3.2**). It should also be noted that rebooting the EV3 clears OfficePal's task list, thus any calls that were requested before the reboot will have to be re-entered (refer to **Section 3.3.2** for instructions on how to do this).

## 4.2 Common Issues

The table below presents problems that may occur while using OfficePal and how to solve them.

Problem	Solution
OfficePal has strayed away from the line or environment	<ul style="list-style-type: none"> <li>In this occurrence it is likely that there has been a mistake in the vision line following. The best plan is to reboot OfficePal (<b>Section 4.1</b>).</li> <li>If there are shadows on the environment it is recommended to relocate it to an area with less shadows as they can confuse the vision accuracy.</li> </ul>
Manual control shows issues with OfficePal's movement	<ul style="list-style-type: none"> <li>All wires should be tied out of the way of the wheels. If this is not the case and a loose wire that is creating friction with the wheels and hence causing mobility issues; re-bundle the wires with a zip tie ensuring they are away from the wheels.</li> <li>The environment may not have been taped smoothly enough to a surface and is therefore causing traction issues.</li> </ul>
Web application is not running	<ul style="list-style-type: none"> <li>Ensure that OfficePal is turned on.</li> <li>Ensure that the Raspberry Pi is powered on (visible red light on the device); if it is not, check whether the wires that lead out of the Pi are well connected to the EV3.</li> <li>Ensure you are accessing the correct Dataplicity link.</li> <li>Reboot OfficePal (<b>Section 4.1</b>): this will restart the web application.</li> </ul>
OfficePal encountered an obstacle and stopped	<ul style="list-style-type: none"> <li>OfficePal is equipped with obstacle detection, which stops it when an obstacle is detected. Removing the obstacle will trigger OfficePal to resume its route.</li> </ul>
OfficePal has encountered an obstacle and has not stopped	<ul style="list-style-type: none"> <li>Check that there are no wires obstructing the IR sensors or any materials stuck to them.</li> <li>In this situation it is recommended to reboot OfficePal (<b>Section 4.1</b>).</li> </ul>
OfficePal is arriving at incorrect destinations	<ul style="list-style-type: none"> <li>There has likely been an error in the path following logic.</li> <li>Please refer to the reboot guide to fix this issue.</li> </ul>
The EV3 has switched off or has become unresponsive	<ul style="list-style-type: none"> <li>The battery may have died and in that case will need to be charged. Refer to the Power section of this guide (<b>Section 2.2</b>).</li> <li>The EV3 may have crashed and requires a reboot. Refer to the reboot guide (<b>Section 4.1</b>).</li> </ul>