InfrAlign Drill Buddy documentation

Business model

Customer need:
The problem of unaligned drilling is annoying, expensive, and dangerous. Most existing solutions to this problem use either a mechanical extension - which is cumbersome and annoying - or a visual laser guide - which is imprecise, and requires supervision.
The **InfrAlign Drill Buddy** infrared laser leveling drill extension addresses several critical customer needs and pain points, making it a valuable addition to any DIY enthusiast or professional tradesperson's toolkit.

1) Angle precision: The device lets the user know if it’s not leveled perfectly to the surface. It also provides intuitive instructions on how to correct the alignment.
2) Distance precision: The drill depth is displayed, taking messy workarounds with tapes and guesswork out of the picture.
3) Ease of use: The distance measurement can be started with the press of a button and displayed as an easy to digest number. The drill angle is displayed as part of an LED ring - the angle to turn the drill towards perfect alignment is the one with the lit LED.
4) Versatility: Customers often encounter situations where drilling needs to be done in tight spaces or at non-orthogonal angles. The extension caters to this need by offering guidance even in confined or challenging working environments.
5) Efficiency: By providing real-time feedback, the extension helps users complete tasks more efficiently. They can ensure that holes are drilled to the correct depth without repeatedly stopping the drilling, measuring, and resuming drilling.
6) Minimized Errors: The extension minimizes the risk of costly errors. Users can avoid overdrilling or under drilling and drilling the wrong angle, which can lead to structural issues, damaged materials, or the need for additional repairs. This not only saves time but also reduces material waste and costs.
7) Professional Results and Confidence: Everyone wants their projects to look and function as if they were completed by experts. The extension provides the guidance needed to achieve professional-grade results, enhancing the user's satisfaction and confidence in their own skills.

New customers:

The InfrAlign Drill Buddy can capture an enormous market, being a drill extension - rather than a separate product. Users can apply it to their already bought drills easily. This makes sure that old customers are not alienated, while still allowing new customers to join the revolution. Many customer segments have their needs not met by existing offerings on the market. They are:

1. DIY enthusiasts with limited experience: Drilling the correct depth and angle hole is a classic problem for this customer segment. The basic drill doesn't provide an easy solution to either of these problems, making many of these users to outsource their projects.
2. Tech-Savvy users: People who are always looking for the newest innovations would be drawn to the extension. A simple drill is too boring and old-tech for this customer segment, but a creative and intuitive tech solution would draw them in.
3. Aging population: Older people appreciate comfort and ease-of-use. Their low dexterity discourages them from messing around with finicky physical contraptions when they could choose an easy to use solution.
4. Eco-Conscious consumers: We all feel bad when we have to throw away a messed up plank because we made an unsalvageable mistake while drilling a hole. Using the extension would greatly reduce waste not coming from wrong hole positioning.

These user personas don't have these needs covered by existing solutions on the market in a user-friendly way. Our early estimates predict that around 80% of these potential customers would heavily consider purchasing an InfrAlign extension.

Business model:

This revolutionary feature is unique enough to generate viral growth via word of mouth, or DIY influencers. To encourage growth, we plan to partner with DIY enthusiasts who have enough online presence and reach to connect with many potentially interested customers. We also plan to initially bundle the extension at a discounted price compared to separate purchases with newly bought drills, or include them as a gift. Setting up demo stations at hardware stores would also bring in DIY enthusiasts, and they would instantly see the convenience, confidence, and ease of use the extension brings to their life. These investments mean diminished initial profits, but the viral growth engine in the community coupled with the solution's impeccable quality and integration would mean that the product will more than make up for this cost over a short time.

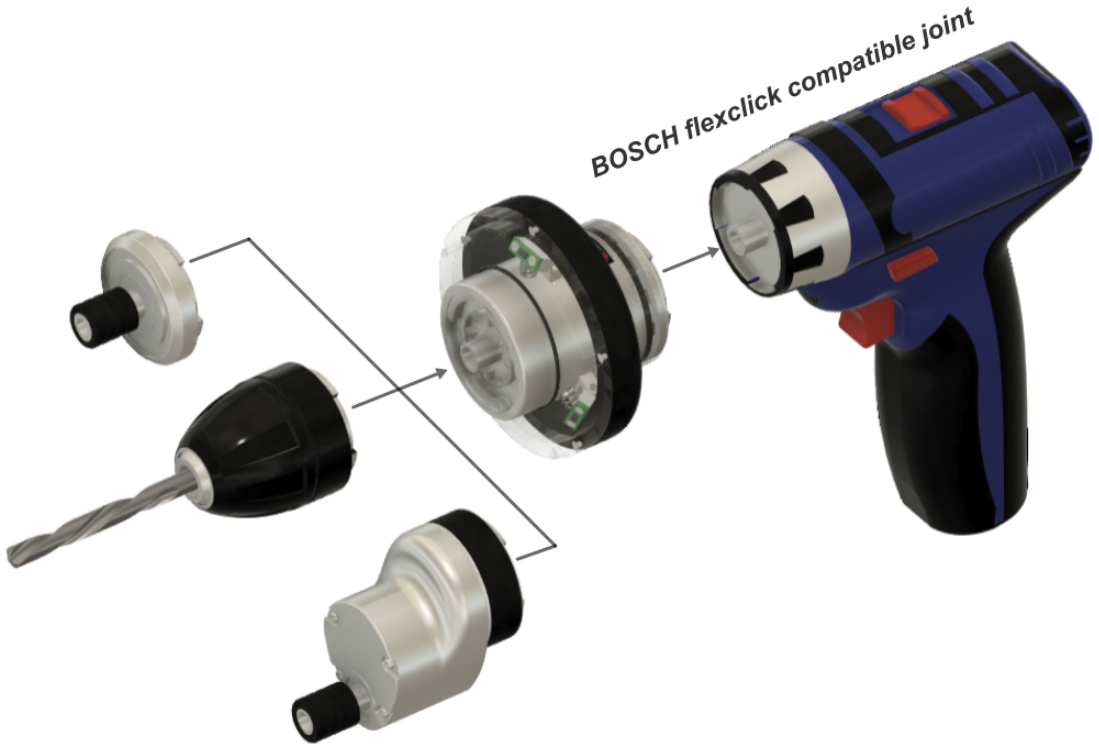
Scalability:

Manufacturing the extension in a way that it fits more types of drills is possible. This means not only DIY enthusiasts, but professionals may also find a use for it. It can be applied to most of Bosch's drill offerings. It can also be manufactured in a way to be applicable to competitors products as well if capturing this segment with existing users would prove to be valuable based on more detailed market research. InfrAlign may also be considered while manufacturing new drill models in the future. The technology may be integrated more closely into the product, and reimagined as a core feature of a drill targeting more specific customer profiles. The problem it solves is universal to every drill user.

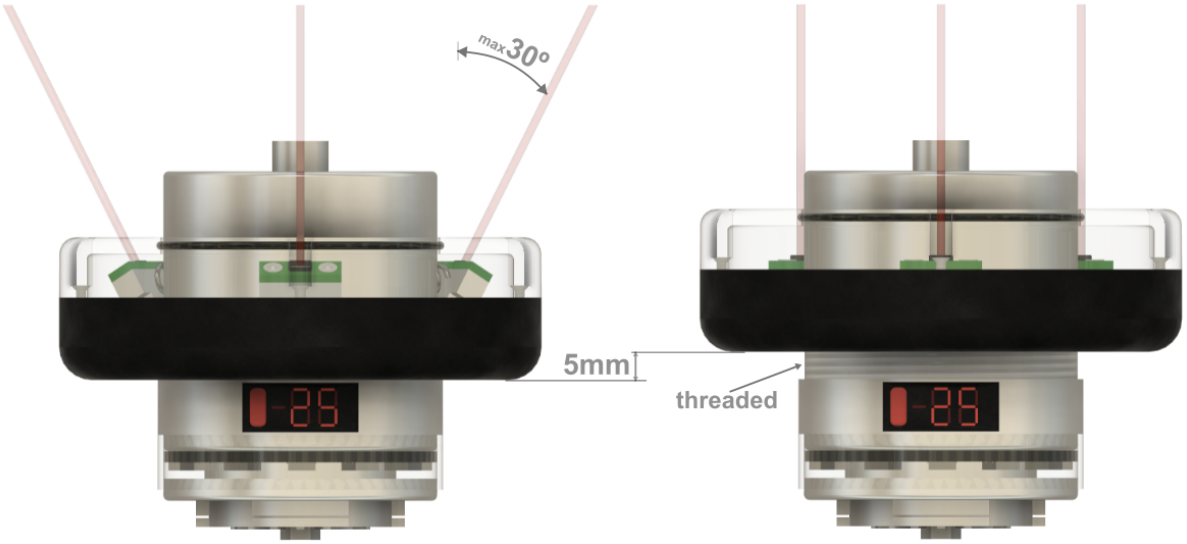
BOM:

Element	Cost [EUR]	Piece	Total [EUR]
IR sensor	3	3	9
7 segment 2 digit LED display	1	1	1
LEDs (for ring)	0.1	12	1
PCB	2	1	2
TOTAL	**-**	**-**	**13**

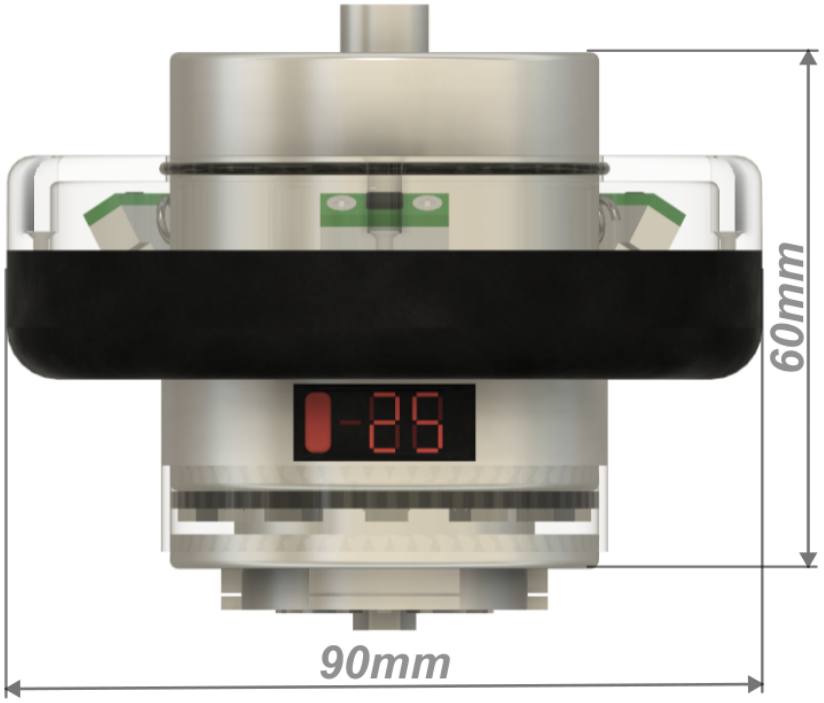
Working concept



The product we have developed is an extension unit designed for compatibility with BOSCH FlexClick capable screwdrivers. This innovative addon enhances precision in screwing and drilling operations by incorporating three infrared distance sensors. The angles of these sensors are adjustable to accommodate various user requirements, with a maximum range of up to 30 degrees. To precisely adjust the angle of the sensors, users simply rotate a threaded ring that moves both backward and forward along a dedicated thread mechanism. This intuitive design ensures accurate and effortless angle customization.



The product boasts a compact and lightweight design, ensuring ease of use without causing any inconvenience to the user during operation. Its dimensions, measuring 90x60mm, make it readily storable alongside other extension units, thanks to its similar size profile.

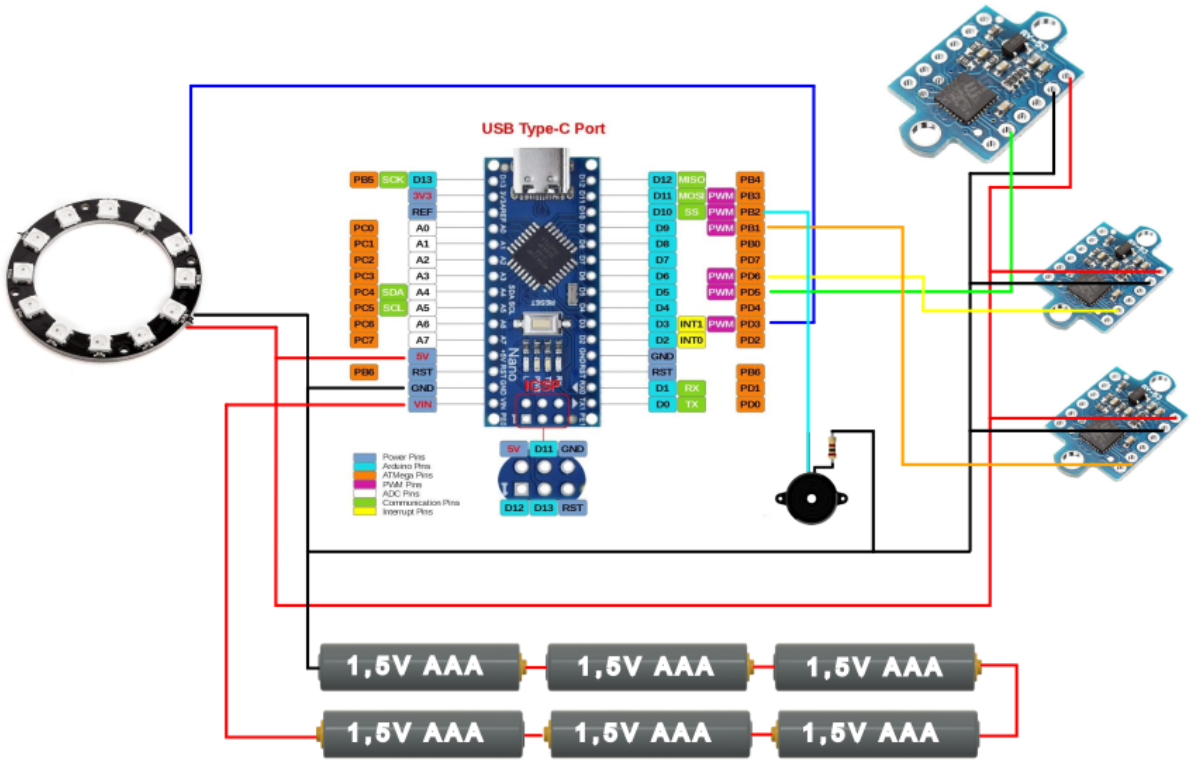


This extension unit delivers exceptional accuracy when used on adequately flat surfaces. Positioned on the product's neck, an LED ring illuminates to indicate the optimal direction for the user to move the screwdriver, ensuring improved perpendicularity. In cases where the angle is incorrect, an audible alert notifies the user, prompting them to check the direction indicated by the blinking LED ring.

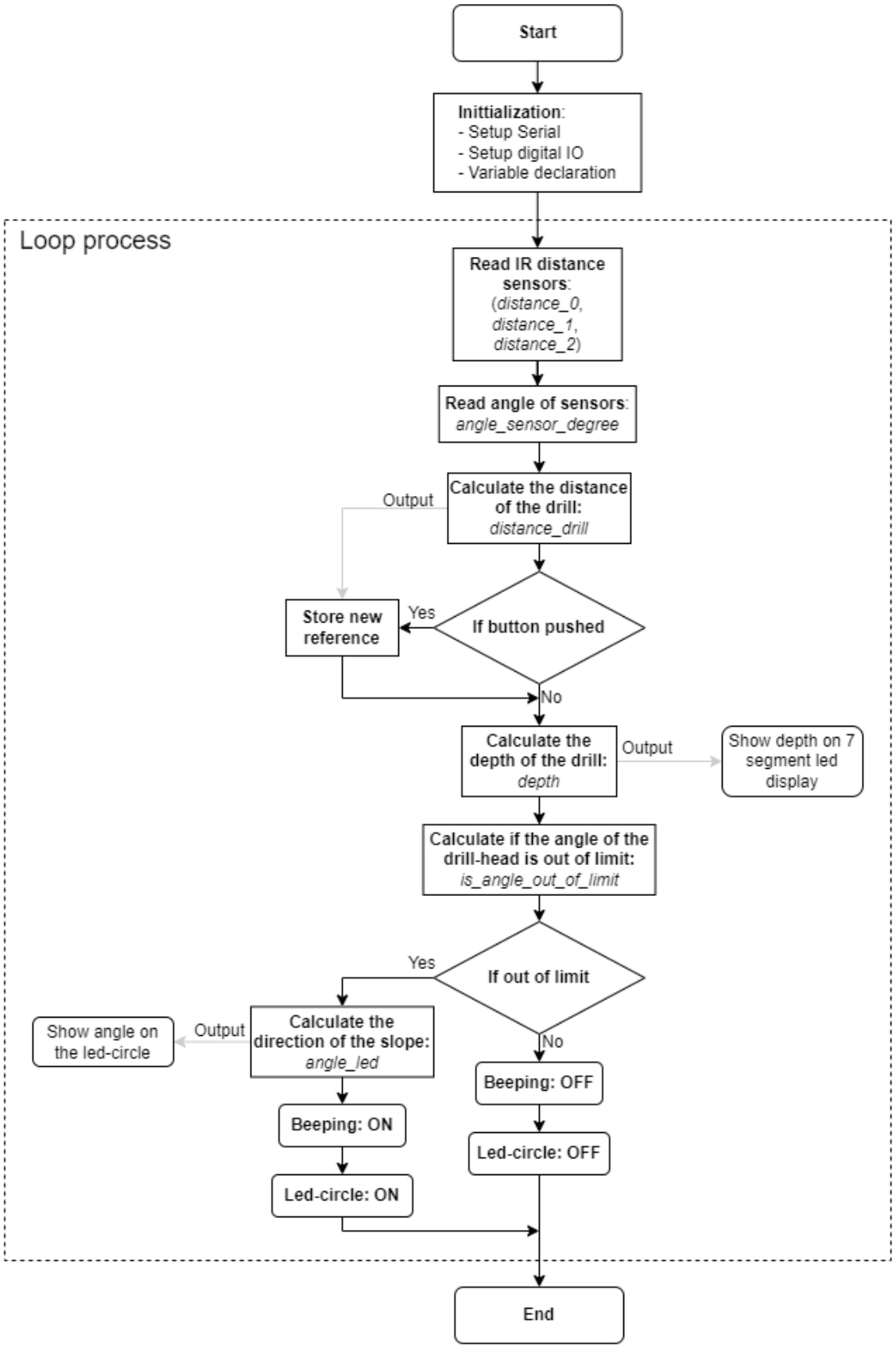
Furthermore, leveraging the capabilities of the three distance sensors, we are able to accurately measure drilling distances. A dedicated button allows users to reset the display to zero, facilitating the tracking of relative movement in the direction of the drill. Presently, we can observe on the screen that the drill has reached a depth of 25 millimeters.

The device is powered by six AAA batteries, conveniently housed within its body, ensuring a prolonged operational lifespan. This is used for the Arduino prototype

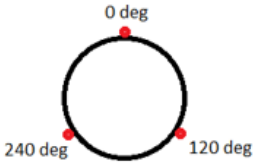
The prototype can be assembled using three infrared sensors, an Arduino Nano 3, a buzzer, six AAA batteries, and an Adafruit 12 LED RGB ring. You can reference the connection schematic provided below for guidance.



Firmware:


Start
Inittialization:
- Setup Serial
- Setup digital IO
- Variable declaration
Loop process
Read IR distance sensors:
(distance_0, distance_1, distance_2)
Read angle of sensors:
angle_sensor_degree
Calculate the distance of the drill:
distance_drill
Output
Store new reference
Yes
If button pushed
No
Calculate the depth of the drill:
depth
Output
Show depth on 7 segment led display
Calculate if the angle of the drill-head is out of limit:
is_angle_out_of_limit
Yes
If out of limit
No
Show angle on the led-circle
Output
Calculate the direction of the slope:
angle_led
Beeping: ON
Led-circle: ON
Beeping: OFF
Led-circle: OFF
End

Deciding the angle of slope during drilling:



d_0 *is at* 0°
d_1 *is at* 120°
d_2 *is at* 240°

Let's have the minimal distance:

$$\mathrm{d_{min}} = MIN(d_0, d_1, d_2)$$

If $\mathbf{d_{min}}$ is d_0, the direction of the slope is between 120° and 240°, so

$$\alpha = \frac{(d_1 - d_0) * 120° + (d_2 - d_0) * 240°}{(d_1 - d_0) + (d_2 - d_0)}$$

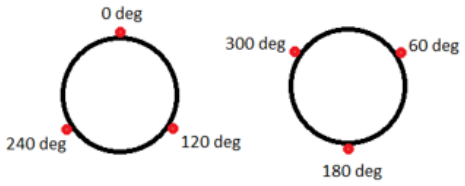
If $\mathbf{d_{min}}$ is d_1, the direction of the slope is between 240° and 360°, so

$$\alpha = \frac{(d_0 - d_1) * 360° + (d_2 - d_1) * 240°}{(d_0 - d_1) + (d_2 - d_1)}$$

If $\mathbf{d_{min}}$ is d_2, the direction of the slope is between 0° and 120°, so

$$\alpha = \frac{(d_0 - d_2) * 0° + (d_1 - d_2) * 120°}{(d_0 - d_2) + (d_1 - d_2)}$$

After that α needs to be shifted by a 60° offset because of the actual sensor placing:



And after that α needs to be shifted by 180° again because we need to show the other side of the ring, in which direction the user should tilt the device.