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July 2026 Patent Analysis
Collaborative Robots (Cobots) in Industrial Manufacturing

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1. EXECUTIVE SUMMARY

This report analyses a curated Espacenet dataset of 1,282 patent families covering collaborative robotics (cobots) in industrial manufacturing, combining safety-oriented manipulator classifications (collision avoidance, speed and force limiting, hand-guided operation) with production-application codes (assembly, welding, material handling, sustainable manufacturing) and an extensive text filter targeting cobot-specific vocabulary (HRC, HRI, fenceless, shared workspace, ISO 15066, ISO 10218).

The landscape reveals a technology that matured slowly between 1975 and the mid-2010s and then entered an inflection phase in 2016, coinciding with the publication of ISO/TS 15066. Filings accelerated further during the COVID-19 period (2020–2023), with priority years 2020–2023 each recording above 130 families, reflecting sustained industrial demand for human-safe automation rather than a temporary pandemic spike.

Geographically, Japan leads applicant-country activity with 1,059 families, followed by the United States (700) and the EU-27 as a combined bloc with 432 families — placing Europe clearly ahead of Korea (239) and China (139) when measured by where patent owners are actually headquartered. This is a structural strength: European cobot innovation is distributed across twelve EU member states rather than concentrated in one economy.

Europe's leadership becomes even more visible at the classification level. The European Patent Office classifies 1,015 of the 1,282 families in the dataset under CPC, more than any other office, including the US (646) and China (659). This makes the EPO the de-facto global reference for how cobot inventions are categorised and confirms the Cooperative Patent Classification system itself (jointly developed by the EPO and USPTO) as the authoritative taxonomy in this domain.

Technology-wise the filings concentrate on the B25J manipulator family: safety-aware motion control (B25J9/1666, B25J9/1674, B25J9/1687) and force/tactile control (B25J13/085) dominate, while the Y02P90/02 tag, used to mark environmentally sustainable production technology, appears on 444 families, reflecting the strong overlap between collaborative automation and the EU's sustainable-manufacturing policy agenda.

On the corporate side, Japanese and Korean industrial OEMs (Fanuc, Seiko Epson, Kawasaki, Yaskawa, Hyundai) lead the applicant ranking, but the top of the table also includes Siemens AG (Germany), alongside substantial EU filing activity from specialised automation firms distributed across Germany, France, Austria, Denmark, Finland, Italy, Sweden and Poland. This distributed industrial footprint, combined with EPO classification leadership and the Y02P90/02 green-production signal, defines Europe's distinctive and durable competitive position in the cobot landscape.

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2. INTRODUCTION

Collaborative robots "cobots" are industrial manipulators engineered to share physical workspace with human operators without the conventional safety cage. They differ from classical industrial robots by design: lighter arms, rounded mechanics, back-drivable joints, torque-limited actuators, and a rich sensor package that supports real-time collision avoidance, speed and separation monitoring, power and force limiting, and hand-guided teaching. These features are the object of the patents analysed here.

The underlying search strategy captures this technology precisely. The query combines five collaborative-safety CPC codes (B25J9/1666, B25J9/1674, B25J9/1676, B25J19/06, B25J13/085) intersected with industrial-application codes covering assembly (B23P19, B23P21), welding (B23K9, B23K37), machining (B24B27), vehicle production (B62D65), material handling (B65G47/90, B65G47/91) and sustainable production (Y02P90/02). A mandatory free-text filter further narrows the scope to documents containing cobot-specific terminology, HRC, HRI, fenceless, shared workspace, ISO 15066, ISO 10218, power and force limiting, hand-guided, and related terms.

The resulting 1,282 patent families represent a focused, policy-relevant view of the field: collaborative robots deployed in industrial production, rather than the broader universe of service robots, medical robots or research prototypes. This scoping is deliberate, it isolates the technology most relevant to Industry 4.0, Industry 5.0 and the EU's reshoring and sustainable-manufacturing agenda.

This report is organised as follows. Section 3 describes the methodology and dataset. Sections 4 and 5 examine temporal dynamics, including the COVID-19 effect. Section 6 maps the geography of publication jurisdictions, and Section 7 focuses specifically on the EU-27 innovation ecosystem. Section 8 analyses technology classification using IPC and CPC codes. Section 9 covers the competitive landscape of applicants and inventors, and Section 10 addresses language distribution. A conclusion closes the report.

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3. METHODOLOGY AND DATASET

All analyses in this report are derived exclusively from a single Espacenet export supplied by the European Patent Office's public database. No external data, rankings, market figures or third-party classifications are used. This methodological discipline ensures that every number in the report is reproducible from the underlying Excel file.

3.1. Search Design

The query combines three logical blocks with AND operators: a collaborative-safety CPC block, an industrial-application CPC block, and a title-abstract free-text block. Only documents satisfying all three conditions are retained. The search language is restricted to English, German and French, Espacenet's native search languages, which ensures consistent semantic interpretation while still capturing the vast majority of globally published cobot inventions through Espacenet's extensive English-language abstract coverage.

3.2. Dataset Composition

The export contains 14 worksheets covering: the full query definition; publication countries (family-level); languages; earliest publication and priority dates; IPC and CPC main groups and subgroups; CPC assigning offices; applicants and inventors with their country of origin. All counts are at the patent-family level (extended INPADOC family) to avoid double-counting related publications.

3.3. Geographic Conventions

In this report, "Europe" refers specifically to the 27 current member states of the European Union. Non-EU European countries such as the United Kingdom, Switzerland, Norway and Liechtenstein are counted separately and are not included in any figure labelled "EU" or "Europe". The regional European Patent (EP) publication route, which is available to applicants worldwide, is analysed as a separate category because it signals strategic intent to cover European markets regardless of applicant origin.

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4. TEMPORAL DYNAMICS – FILING TRENDS

The long-run trend in collaborative-robotics patenting tells a clear story: four decades of slow accumulation followed by an abrupt take-off in the mid-2010s (Figure 1).

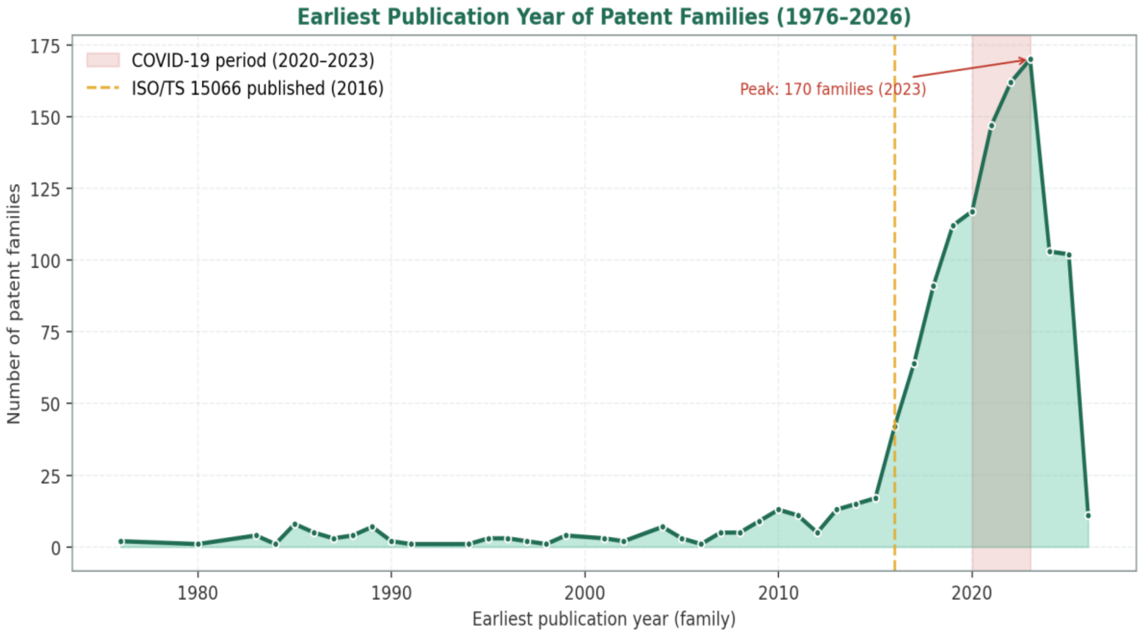

Figure 1 Patent Publications Over Time

Between 1976 and 2014 the field produced fewer than fifteen patent families per year and in many years fewer than five (Figure 2). Patents during this long gestation phase were primarily foundational work on manipulator control, safety interlocks, and teach-pendant programming. The decisive structural shift occurs in 2016, when annual publications jump from 17 (2015) to 42 (2016) — a 147 % year-on-year increase. This aligns precisely with the publication of ISO/TS 15066, the technical specification that codified collaborative-operation safety requirements. For the first time, patent drafters and standards bodies had shared vocabulary (power and force limiting, speed and separation monitoring, hand guiding), and the field's patentability boundary became substantially clearer.

From 2016 onward the curve rises monotonically: 64 families in 2017, 91 in 2018, 112 in 2019, 117 in 2020, 147 in 2021, 162 in 2022, peaking at 170 in 2023 (Figure 3). The subsequent decline (103 in 2024, 102 in 2025, 11 in 2026) is not a contraction in innovation. It reflects the 18-month publication lag inherent to the patent system. Applications with priority dates in 2024–2025 have not yet all been published, and 2026 figures capture only the first few months. The priority-year curve below corrects for this publication delay and is a more accurate signal of underlying filing activity.

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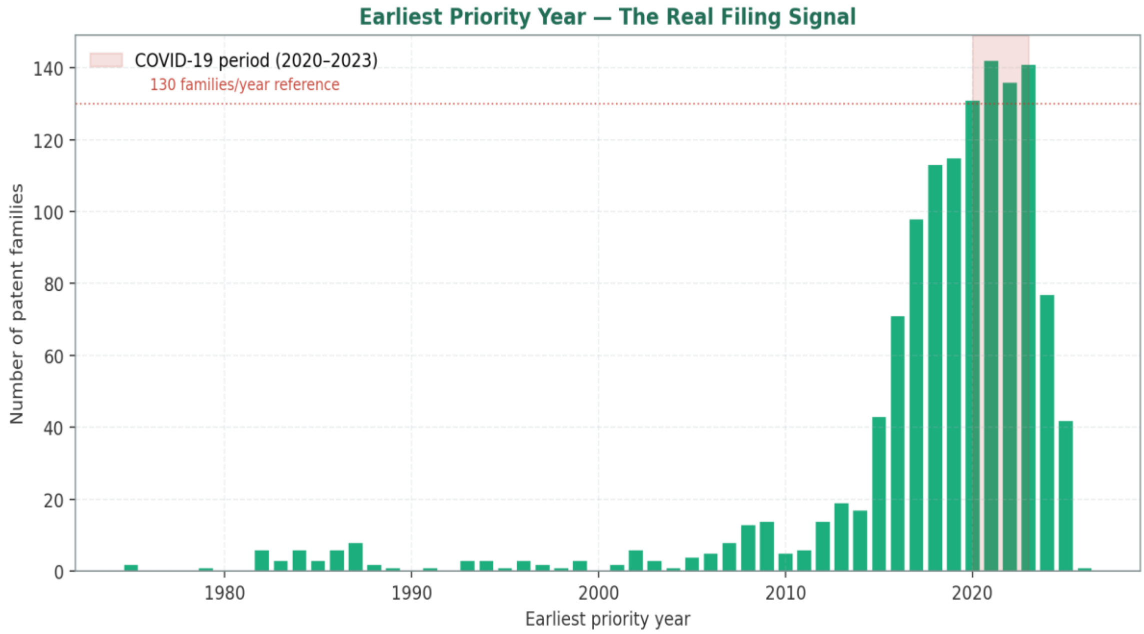

Figure 2 Priority Filing Trends

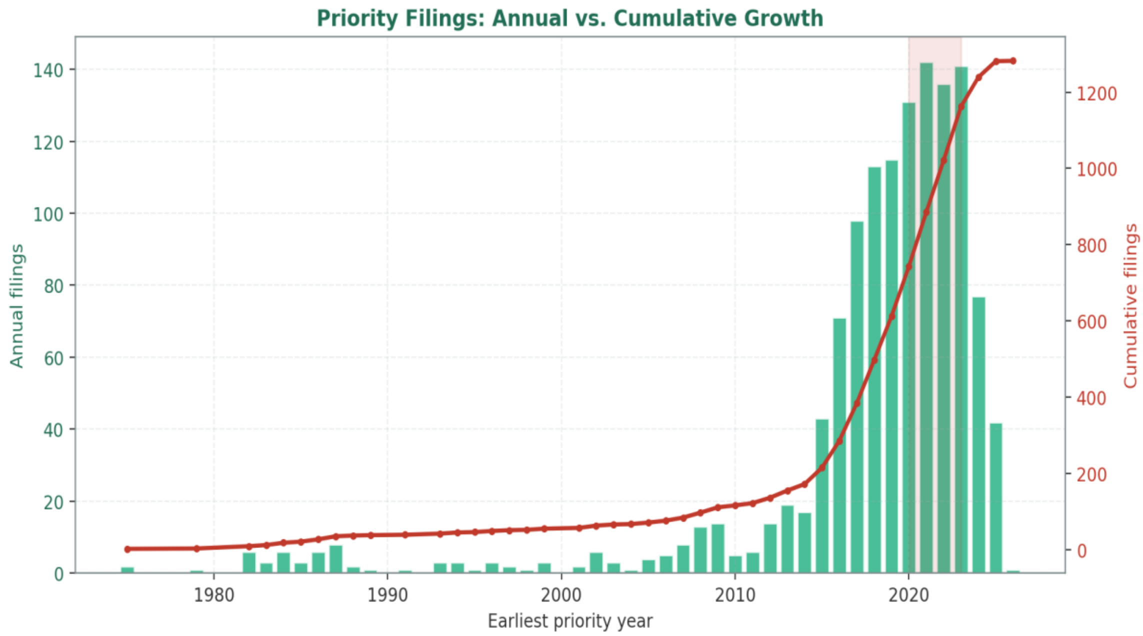

Figure 3 Filing Growth Trends

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5. COVID-19 AS A STRUCTURAL INFLECTION

The COVID-19 pandemic was a once-in-a-generation disruption to industrial production: factories closed, global supply chains fractured, labour availability collapsed in high-contact assembly sectors, and social-distancing rules made shared workspaces, historically the domain of dense human crews, operationally untenable. One would expect a short-term drop in patent filings as R&D budgets were cut. The dataset shows the opposite.

Priority-year filings were 115 in 2019, 131 in 2020, 142 in 2021, 136 in 2022 and 141 in 2023. In other words, 2020, the peak year of lockdowns, already shows a 14 % year-on-year increase over 2019, and the 2020–2023 window averages 137 filings per year, nearly a 20 % step-up over the 2018–2019 average. This is not the profile of a disrupted industry; it is the profile of an industry whose underlying demand driver was amplified by the pandemic.

Three mutually reinforcing dynamics explain this pattern. First, COVID-19 made human-safe automation a strategic imperative rather than a productivity option: manufacturers needed to maintain output with fewer, more distanced workers, which is exactly what cobots enable. Second, labour shortages persisted well after the acute phase of the pandemic, extending the investment case for cobot deployment into 2021, 2022 and 2023. Third, reshoring and supply-chain resilience policies, particularly pronounced in the EU and the US, directed industrial capital toward flexible, reconfigurable production lines, for which cobots are the natural hardware layer.

The post-2023 decline in publication volumes should therefore not be read as the end of this cycle. Priority filings in 2023 (141) are virtually identical to 2021 (142), and the 2024–2025 drop is almost certainly a publication-lag artefact rather than a genuine slowdown.

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6. GEOGRAPHIC DISTRIBUTION - PUBLICATION JURISDICTIONS

The publication-country chart shows where applicants actually sought legal protection. It is a measure of market intent, not of where the technology was invented (Figure 4).

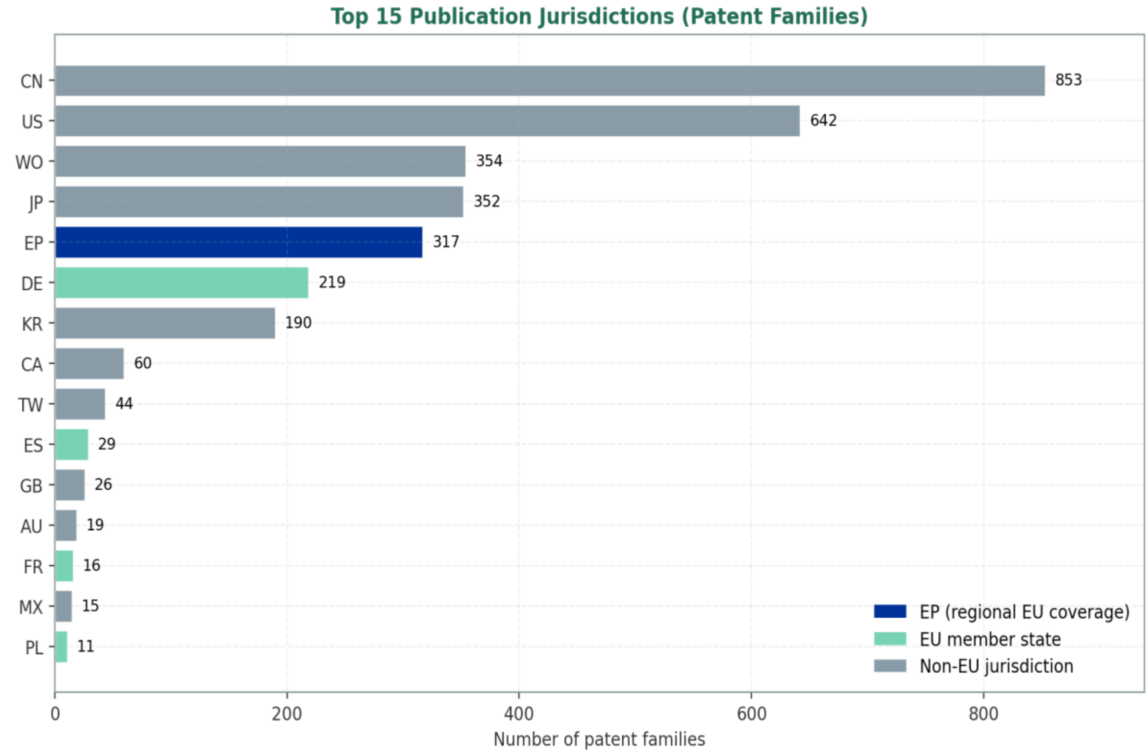

Figure 4 Top Publication Jurisdictions

China leads publications with 853 families, followed by the United States (642), WO (354), Japan (352) and the European Patent (EP) regional route (317). The EP position deserves careful reading: unlike national filings, one EP publication can mature into patents in up to 27 EU member states (and several non-EU European countries via the European Patent Convention). In terms of market coverage, an EP publication is therefore substantially more valuable per filing than a national-only filing. With 317 EP publications plus 321 additional filings in EU member-state national offices (Germany, Spain, France, Poland, Austria, Denmark, Sweden, Finland, Hungary, Portugal, Belgium, Italy, Luxembourg, Slovenia, Netherlands, Romania, Croatia), Europe receives 638 distinct family-level publications in total — placing it on par with the United States and ahead of Japan as a target market for patent protection.

The WO (PCT) route also reveals strategic international ambition: 354 families take the PCT path, which preserves optionality to enter multiple jurisdictions up to 30 months from priority. Combined with the strong EP presence, this indicates that a substantial share of cobot inventions are engineered for global deployment, with Europe consistently among the primary target markets.

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7. THE EUROPEAN INNOVATION ECOSYSTEM

This section analyses Europe in a strict EU-27 sense. Non-EU jurisdictions (UK, Switzerland, Norway, Iceland, Turkey, Israel, Russia) are excluded from all figures and totals below.

7.1. A Distributed Publication Footprint Across EU Member States

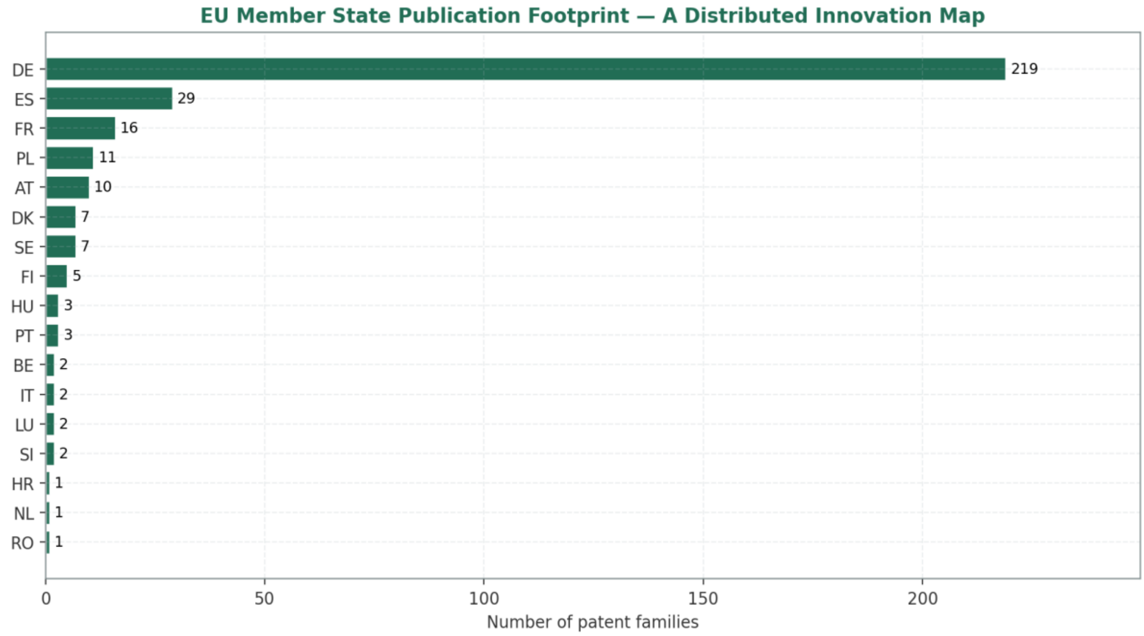

Figure 5 EU Publication Footprint

Germany is the dominant EU national office with 219 publications, reflecting the country's deep industrial base in automotive, mechanical engineering and factory automation. Spain follows with 29, France with 16, Poland with 11 and Austria with 10. Smaller but strategically significant footprints appear in Denmark, Sweden, Finland, Hungary, Portugal, Belgium, Italy, Luxembourg, Slovenia, the Netherlands, Romania and Croatia. This distribution is a structural European strength: cobot innovation is not locked into a single national cluster but spread across both the continent's traditional industrial heartland and several high-skill specialist economies (notably Denmark, home to some of the world's pioneering cobot companies, and Austria, with its strong mechatronics sector) (Figure 5).

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7.2. EU-27 as a Global Applicant Bloc

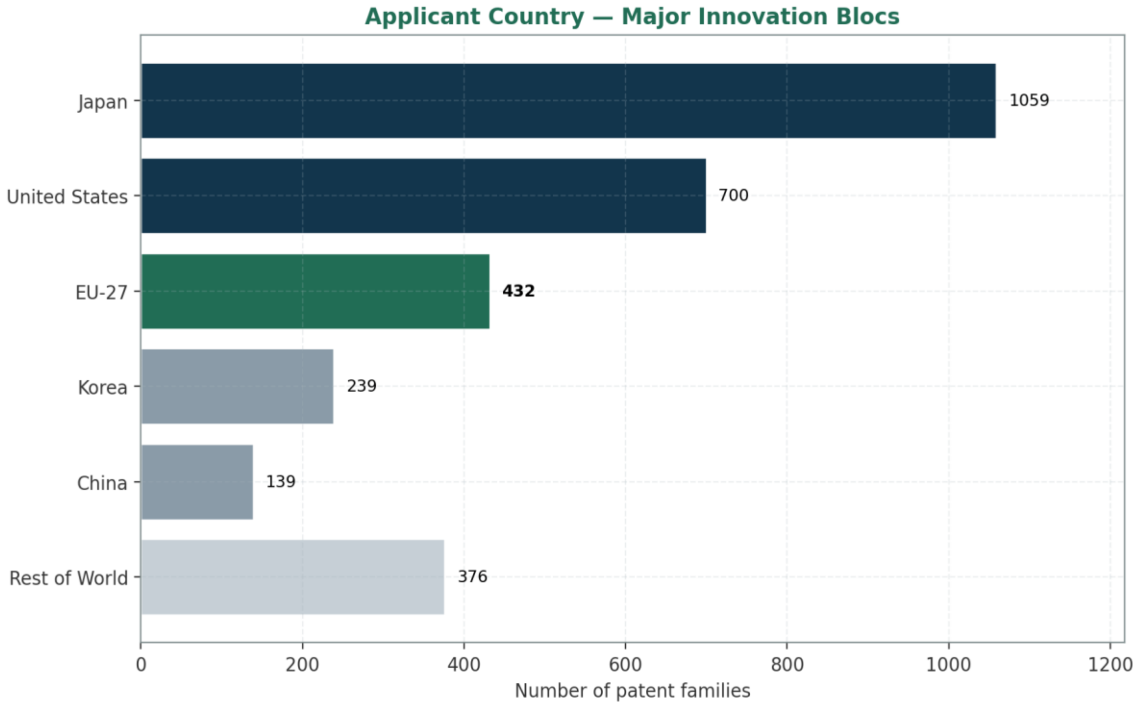

Figure 6 Applicant Countries by Innovation Bloc

When applicant-country data are aggregated to the bloc level, the picture of European strength comes sharply into focus. Japanese companies own 1,059 patent families and US companies 700, but EU-27 companies collectively own 432 families, clearly ahead of Korea (239) and China (139). This result runs contrary to the widespread narrative that European industry is lagging on robotics. Once Europe is viewed as the integrated economic bloc it is in practice, it is a global top three player in collaborative-robotics IP ownership (Figure 6).

The composition of this EU-27 total is itself informative. Germany contributes 248 applicant-attributed families, France 52, Austria 27, Denmark 24, Finland 22, Italy 20, Sweden 15, Croatia 8, Poland 7, plus smaller contributions from the Netherlands, Slovenia and Slovakia. This cross-country diversity means EU cobot innovation is resilient to any single-country economic cycle and benefits from complementary specialisations: Germany’s automotive and machine-tool industry, France’s aerospace and food-processing automation, the Nordic countries’ mechatronics and precision manufacturing, Austria’s industrial robotics heritage, and Southern and Central European emerging clusters.

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7.3. Siemens and the Distributed European Champion Model

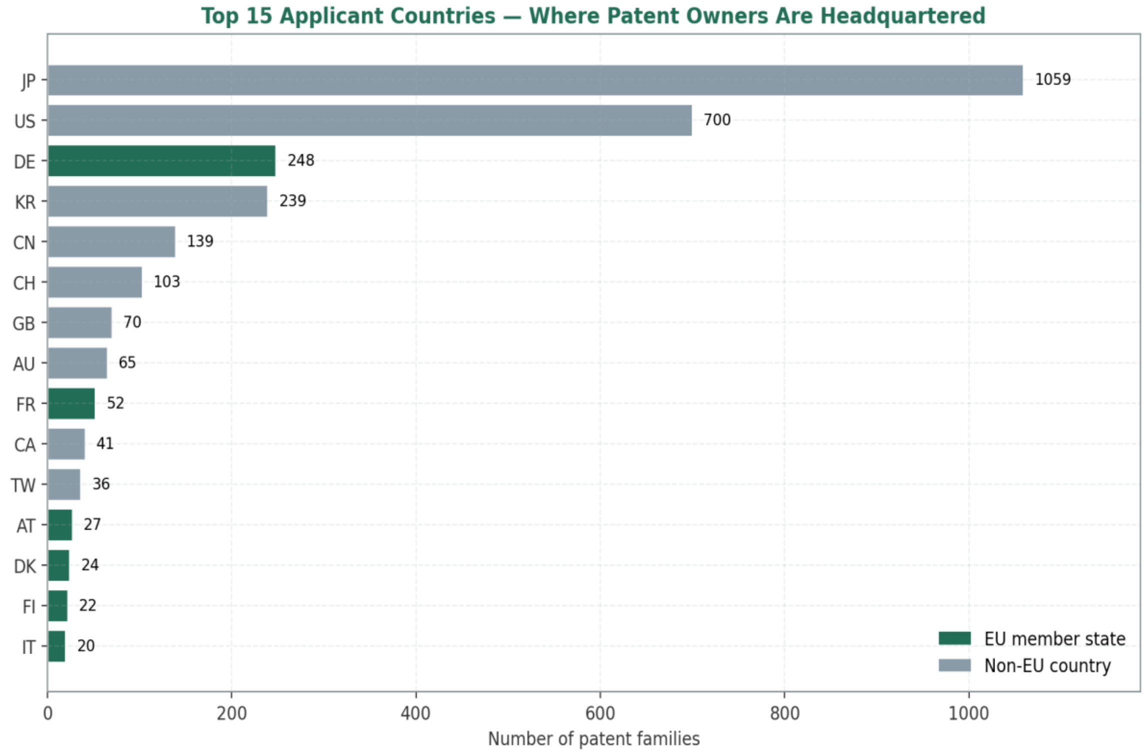

Figure 7 Top Applicant Countries

At the individual-company level, Siemens AG (Germany) is the most visible EU representative in the top 15 applicant list with 12 families. However, the European story is not a single-champion story — it is a distributed-champion story. Below the top 15, EU industrial and automation specialists contribute steadily across the full applicant list, and Europe's inventor counts reinforce the same picture: German-based inventors (263), French (51), Italian (27), Swedish (25), Danish (23), Austrian (22), Finnish (22), Spanish (12), Polish (12), Hungarian (10) and others. Aggregated, EU-27 inventors account for approximately 482 of the inventor-attributed families, a concentration of human capital comparable to that of the United States.

This distributed model has a specific strategic advantage in collaborative robotics. The technology does not depend on a single dominant incumbent but on tight integration between robot OEMs, system integrators, standardisation bodies and end-user industries. Europe's dense network of specialised SMEs, engineering consultancies and Tier-1 automation integrators — combined with the continent's leadership in safety standards — is structurally well suited to this kind of ecosystem innovation.

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8. TECHNOLOGY CLASSIFICATION

The IPC and CPC breakdowns reveal the technical anatomy of cobot inventions and confirm that the dataset is tightly focused on the collaborative-safety subdomain of industrial robotics.

8.1. IPC Main Groups - the Manipulator Stack

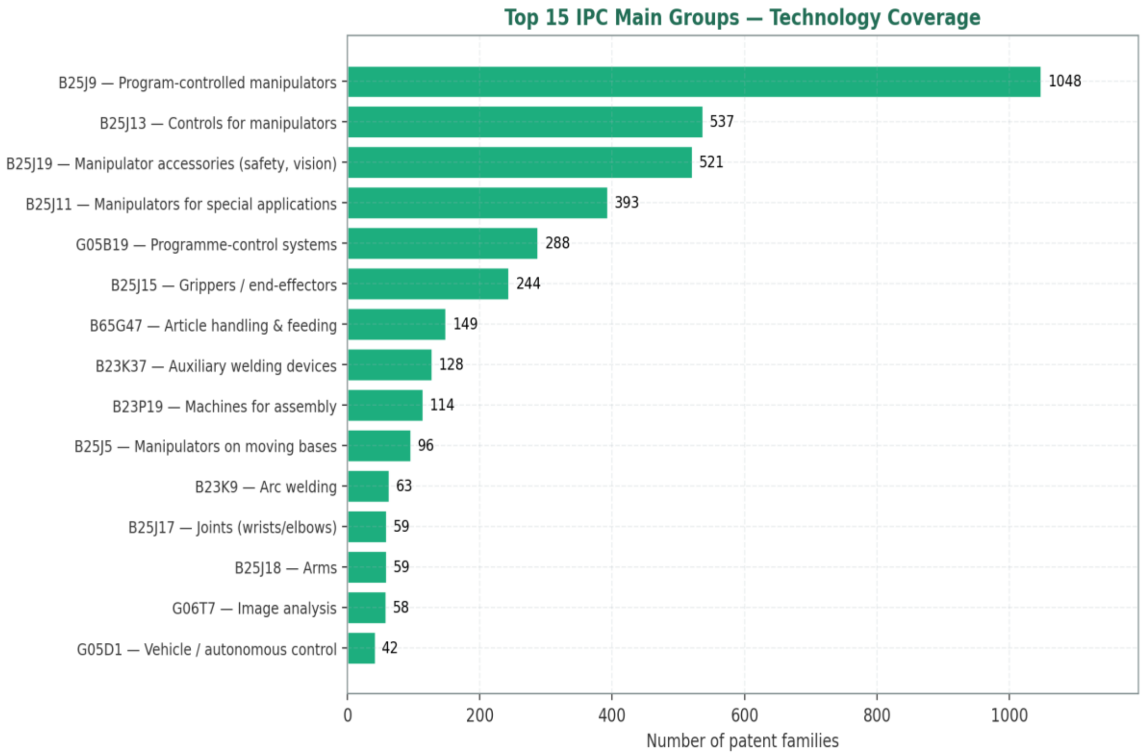

Figure 8 Top IPC Groups

The IPC distribution is dominated by the B25J manipulator family: B25J9 (program-controlled manipulators, 1,048 families), B25J13 (manipulator controls, 537), B25J19 (manipulator accessories including safety devices and vision, 521), B25J11 (manipulators for special applications, 393), and B25J15 (grippers and end-effectors, 244). These five codes together describe the full hardware and control stack of a collaborative robot: the arm itself, its control system, its sensors and safety envelope, its application profile, and its interface with the environment through the end-effector (Figure 8).

G05B19 (programme-control systems, 288) and G05B2219 (on the CPC side, 484) capture the digital control layer: the software that actually executes collaborative behaviour. Application-domain codes are distributed across B65G47 (article handling, 149), B23K37 (auxiliary welding devices, 128), B23P19 (assembly machines, 114), B23K9 (arc welding, 63), B23Q7 (machine-tool feeding, 37), and B23P21 (assembly lines, 33), confirming that the dataset captures cobots in their three canonical industrial use cases: assembly, welding and material handling.

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8.2. CPC Subgroups - the Fine-Grained Safety Focus

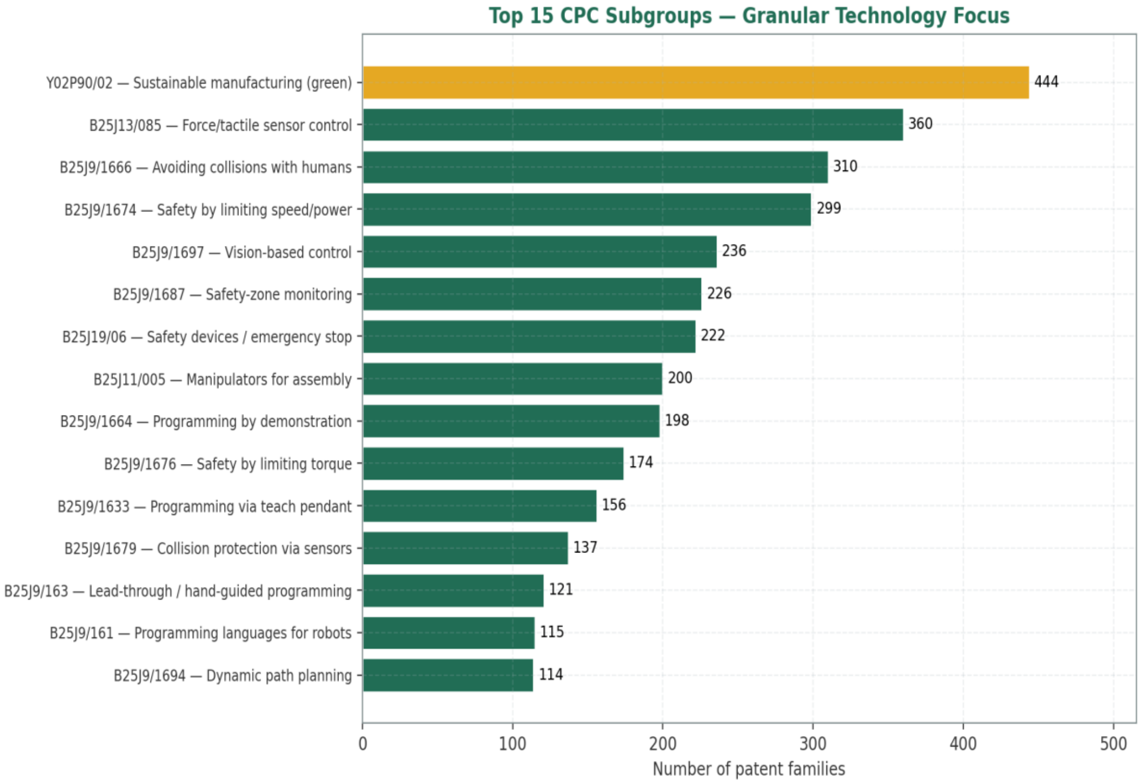

Figure 9 Top CPC Subgroups

The CPC subgroup distribution is where the cobot-specific character of the dataset is most visible. B25J13/085 (force/tactile sensor control, 360 families) and the B25J9/16xx cluster - B25J9/1666 (avoiding collisions with human operators, 310), B25J9/1674 (safety by limiting motion parameters, 299), B25J9/1697 (vision-based control, 236), B25J9/1687 (safety-zone monitoring, 226), B25J9/1664 (programming by demonstration, 198), B25J9/1676 (safety by limiting torque, 174), together constitute the technical heart of modern cobot safety. These are the exact techniques referenced in ISO/TS 15066 and the ISO 10218 series, and their prominence in the dataset confirms that the search successfully isolated genuinely collaborative inventions rather than generic industrial robotics (Figure 9).

The highest-ranked CPC subgroup is Y02P90/02 with 444 families. The Y02 scheme is a dedicated CPC branch for climate-change-mitigation technologies, and Y02P90/02 specifically tags sustainable manufacturing inventions. That almost 35 % of the dataset carries this tag is a remarkable signal: the EPO's classification taxonomy treats a substantial share of cobot inventions as environmental-technology contributions — a reading that aligns closely with the EU's Green Deal and sustainable-industry policy framework. It also indicates that cobot IP is structurally positioned to benefit from green-transition funding streams, environmental-technology transfer programmes, and climate-linked industrial policies.

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8.3. CPC Assigning Offices - the EPO's Global Classification Leadership

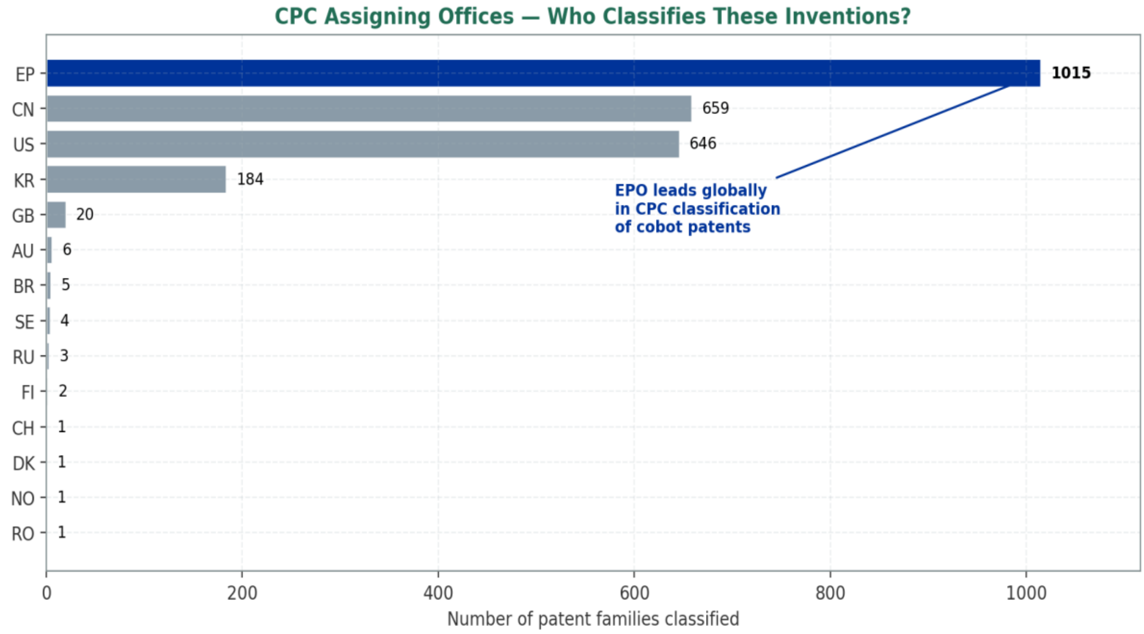

Figure 10 CPC Assigning Offices

The CPC assigning-office table is perhaps the single most compelling indicator of European positioning in this landscape. The European Patent Office has classified 1,015 of the 1,282 families, 79 % of the entire dataset, under the CPC scheme, ahead of the CNIPA (659), the USPTO (646) and the KIPO (184). The CPC itself is a joint project of the EPO and the USPTO, and the Y02 environmental-technology scheme was originally developed by the EPO. The fact that the EPO applies CPC tags to such a large share of the global cobot corpus confirms its role as the de-facto world reference for categorising this technology (Figure 10).

This has practical consequences for industry strategy. Any party, European or non-European, conducting a prior-art search, technology scouting exercise, freedom-to-operate analysis or competitive-intelligence study on cobots will in practice rely heavily on EPO-applied CPC tags. The classification expertise is European; the taxonomy leadership is European; and this is a durable strategic asset regardless of where the underlying inventions are filed.

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9. COMPETITIVE LANDSCAPE

9.1. Top Applicants - Japanese OEMs Lead, with Strong European and Specialist-Integrator Presence

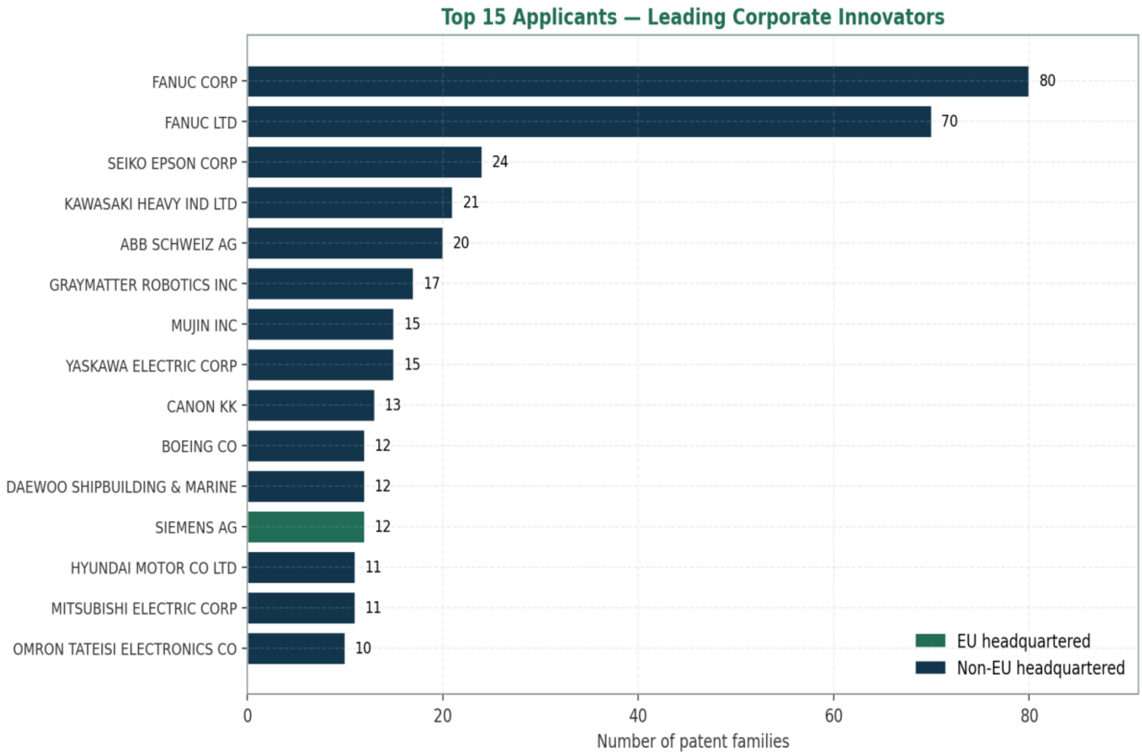

Figure 11 Top Patent Applicants

The applicant ranking is led by Japanese industrial-robot OEMs, Fanuc Corporation (80 families under that entity name and 70 under the legacy "Fanuc Ltd" designation, giving roughly 150 combined), Seiko Epson (24), Kawasaki Heavy Industries (21) and Yaskawa Electric (15). These companies have three decades of continuous R&D investment in programmable manipulators and are natural leaders in the collaborative-robot subdomain as well (Figure 11).

Several other types of applicants appear in the top ranks. Graymatter Robotics (17) and Mujin (15) are specialist AI-driven robotic-integration companies representing a newer generation of applicants focused on software-centric cobot deployment. Canon (13), Boeing (12), Siemens (12), GM Global Technology Operations (9), Hyundai Motor (11), Honda (8), Kia (9), Toyota (7), Daewoo Shipbuilding (12) and Samsung Heavy Industries (6) represent large industrial end-users — automotive, aerospace and shipbuilding companies — whose presence in the list demonstrates that cobots have moved well beyond the robotics industry itself and are now being patented by the sectors that deploy them. ABB (Schweiz AG) also appears prominently with 20 families; while ABB is headquartered outside the EU, its industrial footprint and customer base are deeply integrated with the EU market.

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Siemens AG is the clearest EU-headquartered representative in the top 15. The European presence in the remainder of the applicant table (positions 16–1,000) is substantial and highly fragmented — consistent with the distributed-champion model described earlier. This fragmentation is sometimes misread as a weakness, but in a technology that depends on system integration, industry-specific customisation and standards compliance, having hundreds of specialised applicants is often more productive than having two or three dominant ones.

9.2. Top Inventors and Research Hubs

Table 1 Top Inventors

Inventor	Families
GUPTA SATYANDRA K	17
KABIR ARIYAN M	17
SHAH BRUAL C	17
GUHA RISHAV	13
GONG CHENG	10
DIANKOV ROSEN NIKOLAEV	9
AHIRE AVADHOOT L	8
OBA MASAFUMI	8
OOBA MASAFUMI	8
DENYS KANUNIKOV	7

The inventor ranking is led by the Gupta / Kabir / Shah research cluster (17 families each), who publish together and represent a concentrated academic-industrial research programme focused on AI-driven cobot manipulation. Several additional high-productivity inventors appear in the list, including multiple Japanese and Korean inventors at the OEMs named above and European inventors at Siemens and specialist automation firms. The presence of apparent name variants (Oba Masafumi / Ooba Masafumi; Diankov Rosen Nikolaev / Diankov Rosen / Rosen Diankov; Sato Takashi / Satou Takashi) reflects transliteration inconsistencies in the raw Espacenet data rather than different people and should be read as a single prolific inventor in each case (Table 1).

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10. LANGUAGE DISTRIBUTION

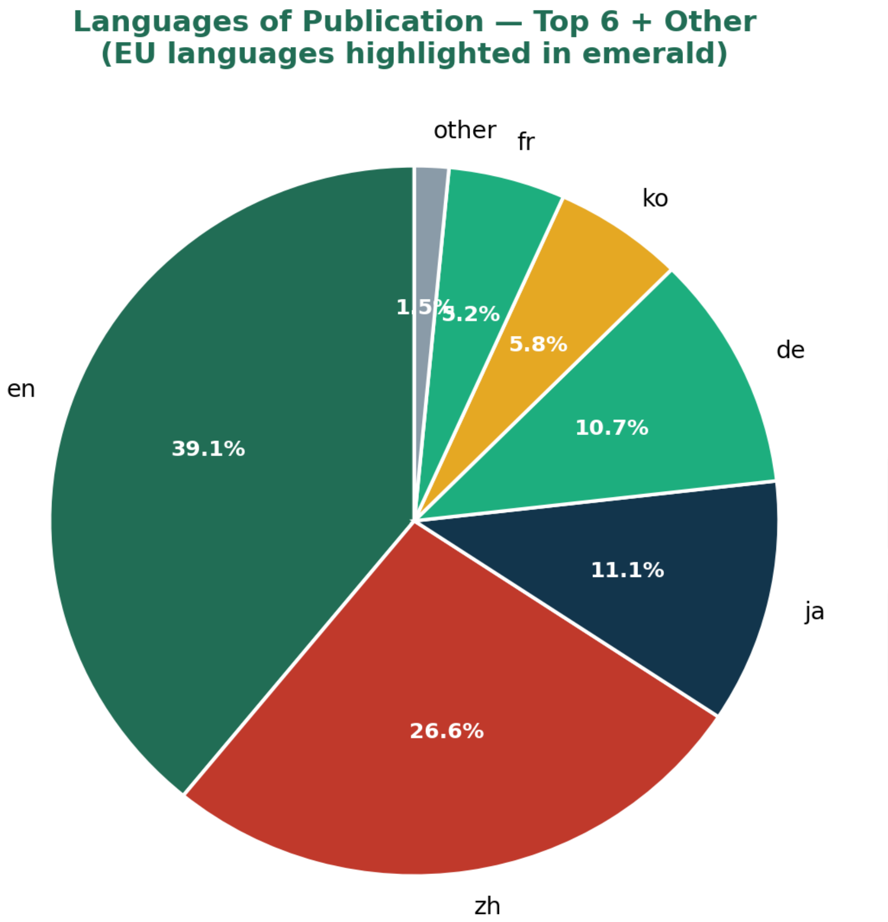

Figure 12 Publication Languages

English is the publication language of 1,260 of the 1,282 families. This is expected: English is the working language of the EPO, the WIPO/PCT system and the USPTO, so any EP, WO, GB, US, AU or IN publication contributes to the English total regardless of the applicant's country of origin. Chinese (858) and Japanese (358) reflect the volume of CN and JP national filings. The German total of 346 is particularly significant for the European analysis: it captures both DE national filings and German-language EP publications and is a direct measure of the scientific and industrial depth of the German-speaking industrial community in this field (Figure 12).

French (167), Spanish (27), Swedish (4), Dutch (2), Italian (2), Portuguese (2), Danish (1), Finnish (2), Croatian (1) and Romanian (1) together represent Europe's broader linguistic diversity. Although small in absolute numbers, these non-dominant-language filings are evidence of genuine national-level inventive activity in the respective EU member states — patent applicants generally draft in their home language at the national office before moving to EP/PCT. Taken together, the European-language filings confirm the distributed innovation picture seen in the geographic data.

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11. CONCLUSION

The Espacenet dataset analysed in this report gives a coherent and structurally optimistic reading of the collaborative-robotics landscape, and particularly of Europe's position within it.

The field itself is in a clear expansion phase. The 2016 inflection driven by ISO/TS 15066, followed by the sustained 2020–2023 plateau during and after COVID-19, demonstrates that cobot innovation has moved past the experimental stage and is now a structural component of industrial automation worldwide. Priority-year filings have held above 130 per year for four consecutive years, a level unprecedented in the forty-year history of the field.

Europe's position in this landscape is stronger than raw national rankings suggest. When EU-27 member states are viewed as the integrated economic bloc they are in practice, Europe is the third-largest applicant bloc in the world — ahead of Korea and China. European innovation is distributed across Germany, France, Austria, Denmark, Finland, Italy, Sweden, Poland and several additional member states, which is a durable structural advantage rather than a fragmentation problem. Siemens represents the most visible EU corporate champion in the top 15, but the deeper European strength lies in a dense network of specialised automation firms, integrators and industrial end-users across the continent.

Three further findings reinforce Europe's distinctive positioning. First, the European Patent Office classifies 1,015 of the 1,282 families under CPC, more than any other office, making the EPO the global authority on cobot taxonomy and classification. Second, the CPC Y02P90/02 sustainable-manufacturing tag appears on 444 families, directly linking cobot IP to the EU Green Deal and the Sustainable Products Regulation framework and positioning European industry to capture green-transition policy support. Third, the combined EP + national-EU publication footprint of 638 families makes Europe one of the primary global target markets for cobot protection, on par with the United States.

Taken together, these findings suggest that European industrial strategy in collaborative robotics should focus on three mutually reinforcing levers: continued regulatory and standards leadership (ISO 15066, ISO 10218, CE safety marking, the AI Act's industrial provisions); deepening the EPO's classification and quality-of-patent leadership as a soft-infrastructure asset for the whole European innovation system; and leveraging the Y02P90/02 green-production alignment to channel Horizon Europe, Innovation Fund and national recovery resources toward EU-based cobot development and deployment.

The cobot field is not one where Europe needs to catch up on raw volume; it is one where Europe is structurally well positioned, and where the policy, classification and ecosystem advantages documented in this report compound over time.

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